Experiential Training and Risk Management Behaviour amongst Pilots

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I certify that the content of this thesis has not already been submitted for any degrees and is not being currently submitted for any other degrees.

I certify that to the best of my knowledge, any help received in the preparation of this thesis, and all sources used, have been acknowledged in this thesis.

Brett R. C. Molesworth
Abstract

General aviation pilots continue to be over represented in aircraft accidents in comparison to their commercial counterparts. Of those general aviation aircraft accidents that occur, a large proportion has been attributed to poor aeronautical decision-making. Previous research suggests that a leading factor that precipitates poor decision-making is an unrealistic assessment of the risks. Contemporary aviation training programmes do not necessarily target risk management as a distinct skill. Rather, it is assumed that risk management skills are acquired through pilots’ interaction with the environment and through the acquisition of factual information relating to the statistical frequency of accidents and/or incidents. The primary aim of this thesis was to examine the utility of various training strategies to improve pilots’ risk management behaviour. Throughout this thesis, it was assumed that pilots’ risk management behaviour would be reflected in their performance during a variety of low-flying activities. Three experiments were conducted, the first of which examined the utility of three different training approaches, where pilots were either cognitively active (i.e., flying a simulated flight and receiving feedback in relation to performance) or cognitively inactive (i.e., reading a newsletter or watching a video) during training. The second experiment examined the impact of cognitive involvement and feedback on individual’s risk management behaviour, while the third examined the extent to which information acquired during a low-flying training flight would generalise to other tasks which differed in terms of cognitive load. The results provided support for a training programme that engaged the pilots cognitively during training. However, the extent to which the information acquired during training will generalise to other tasks appears to be contingent on a number of factors (i.e., memory, experience, and cognitive involvement). The results of this study are discussed in terms of both a theoretical and an applied perspective.
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Chapter 1: Introduction

Aviation activities can generally be classified into three distinctive categories: General Aviation (GA), commercial airline operations, and military operations. The area of most interest in the following research is general aviation. This area is of particular interest for a number of reasons. Firstly, there appears to be a disproportionate amount of accidents between GA and other types of operations. For example, in the commercial sector in Australia, the average fatal accident rate per 100,000 hours flown between 1991 and 2001 was 0.115. In comparison, the general aviation sector averaged 1.227 accidents per 100,000 hours flown for the same period (Air Transport Safety Board [ATSB], 2002), while statistics relating to military operations remain confidential. Furthermore, on average GA accounts for 60% of the total hours flown, but 92% of all aviation accidents in the aviation industry (Spirkovska & Lodha, 2002; Wiegmann & Taneja, 2003).

The second reason why the general aviation industry is of significant interest, is that, in the majority of cases, it provides the initial training and education for pilots who later progress to the larger and more prestigious commercial sector (Spirkovska & Lodha, 2002). For pilots to progress from GA to the commercial sector, they must first obtain flight experience, which is measured by the total number of hours flown. To achieve this, trainee pilots, once qualified, often become instructors, and train and educate other commercial-orientated pilots. As a result, pilots within GA are more exposed to situations where experience, or the lack of experience increases their vulnerability to adverse outcomes in comparison to their commercial counterparts who, on average, have a greater level of flying experience.
Pilots within the general aviation industry vary depending upon their flying experience. Typically, pilots within general aviation range from student pilots with fewer than twenty hours of flight time, to an experienced pilot with tens of thousands of flight hours (Wiegmann & Taneja, 2003). In addition, general aviation pilots tend to fly aircraft that are considerably less sophisticated than their commercial counterparts. For example, a commercial pilot may fly a Boeing 747-400 with advanced navigational aids, communication devices and satellite tracking. In contrast, a general aviation pilot will generally fly aircraft that have basic navigational aids, are slower, cover shorter distances, carry less fuel and often fly at much lower altitudes (Civil Aviation Safety Authority, 2001; Hirst, 1974). Another important distinction is the infrastructure that exists to support the pilots. A commercial pilot will have a network of staff working in dispatch, planning, fuel management, safety management and meteorology, in addition to increased air traffic control coverage, which is not readily available to GA pilots. The relative lack of infrastructure, combined with the limited experience of pilots is such that GA operations are generally regarded as inherently more risky than commercial airline operations.

A feature that distinguishes between aviation and other transport industries, such as the automotive industry, is the level of regulation. For example, aviation personnel, and pilots in particular, must abide by regulations that are set at both an international and at a federal level. Furthermore, pilots employed within a specific organisation must adhere to an organisation’s Standard Operating Procedures (SOPs). SOPs are designed and implemented by organisations to regulate tasks so that they can be performed systematically. Ideally, if a SOP is followed, irrespective of the individuals who follow the SOP, the outcome should remain the same. Both
regulations and SOPs serve to govern and regulate individuals’ behaviour to protect the general public, organisations and aviation personnel.

At an international level, the International Civil Aviation Organisation (ICAO) establishes international standards, recommended practices, and procedures covering all aspects of the aviation industry, such as licensing, rules of the air, aeronautical meteorology and aircraft accident investigation (Hooper & Findlay, 1998). Within Australia, aviation operations are governed by the Civil Aviation Safety Authority (CASA). CASA’s role is to monitor and ensure compliance with international and commonwealth aviation regulations. At an organisational level, organisations must ensure that they adhere to the rules and standards set by both ICAO and CASA. Often, to facilitate compliance to these rules and standards, organisations introduce and implement standard operating procedures.

Within both the general aviation industry and the commercial airline industry, a significant proportion of aircraft accidents can be attributed to the failure to follow established procedures and regulations (Reason, 1997; Klinect, Wilhelm, & Helmreich, 1999). Although it is difficult to obtain the precise proportion of accidents resulting from violations, there is a considerable body of evidence to suggest that violations play a key role in the accident sequences (Mason, 1997; Reason, 1997; Klinect et al., 1999). Klinect et al. (1999) estimate that approximately 54% of errors (unsafe acts resulting from unintentional behaviours) committed within the commercial aviation sector are the result of intentional non-compliant acts or violations. Furthermore, Helmreich (in press) contends that those pilots who intentionally fail to adhere to the rules or regulations (violation), commit on average, 25% more errors. Finally, Mason (1997) estimates that as much as 70% of the
violations committed result in accidents, compared to Klinect et al.’s (1999) more conservative figure of 54%.

Klinect et al. (1999) observed 184 flight crews on 314 segments, and recorded the types of threats that flight crews were subjected to, and the errors that they committed during normal operations. In total, 578 unsafe acts (threats and errors) were observed. These unsafe acts were broken down into five categories, namely: (1) Intentional non-compliance (violations); (2) Procedural; (3) Communication; (4) Proficiency; and (5) Operational decision. Further analysis of the data revealed that intentional non-compliance, otherwise known as wilful violations, occurred most frequently at 54%. Interestingly, although intentional non-compliance occurred most frequently, the consequences tended to be less severe (Klinect et al., 1999). In combination with previous research (Helmreich, in press), these results suggest, that the consequences associated with violations are more evident when paired with an error.

Reason (1997) argues that violations often avoid detection or attention when they are associated with accidents, simply because they are rarely the last event in an accident sequence. Furthermore, specific violations are often difficult to detect because employees purposely set out to conceal the violation committed to avoid disciplinary action/s (McFadden & Towell, 1999). Alternatively, violations may be concealed or purposely overlooked by the employer for other reasons, such as an economic benefit to the company or organisation. Therefore, obtaining statistics that accurately reflect or represent the prevalence of violations in complex industrial domains tends to be difficult. Nonetheless, the fact that violations occur within the aviation environment is of significant concern.
Non-compliance with regulations and procedures involves both intentional and unintentional actions. For example, a pilot might fly through a newly created restricted area, knowing that it is a shorter track to the destination and with the expectation that he/she will not be caught (intentional). In contrast, another pilot might be unaware of the newly created restricted area and unintentionally transits through the airspace (unintentional). While both situations involve non-compliance, it may be argued that, since the aetiology of the violation is different, different training methods need to be employed to prevent a recurrence.

A significant proportion of pilots’ training is concerned with understanding and recalling the rules and regulations associated with aeronautical operations. In addition, pilots are generally trained to use standard operating procedures to effectively manage routine situations and predicable emergencies. However, the availability of the rules, regulations and SOPs does not necessarily guarantee that they will be employed (McCarthy, Healey, Wright, & Harrison, 1997). Furthermore, breaches of rules and SOPs are not confined to pilots alone. Maintenance personnel and dispatch crews within aviation are equally prone to breaches in rules and SOPs that result in accidents (Kraus & Gramopadhye, 2001). Abeyratne (1998) estimates that violations committed by maintenance personnel and which result in aircraft accidents, may be as high as 15%.

An example of the consequences of the failure to employ standard procedures is illustrated by the crash of an American Airlines Douglas DC-10 shortly after departing Chicago airport on May 25, 1979. During the take-off role, and shortly after rotation, pieces of the port engine fell away from the aircraft. This was quickly followed by the entire engine and its pylon. The DC-10 banked left sharply and impacted the ground, fatally injuring the 271 people on board (NTSB, 1979).
subsequent investigation established that maintenance crews from both American Airlines and Continental Airlines had devised a special procedure for removing the engines as a means of replacing the forward and self-aligning bearings on the rear bulkhead, as required by the manufacturer (NTSB, 1979). This innovative, but unauthorised procedure, caused fractures in the upper flanges on the pylons rear bulkhead, eventually causing the engine to give way. The accident investigation concluded that the engine and pylon separation resulted from damage sustained during improper maintenance procedures (NTSB, 1979).

The crash of the American Airlines DC-10 highlights the potential consequences of violating a standardised rule or procedure. The fact that breaches of rules and SOPs appear more frequently than desired within the aviation industry (Reason, 1990) suggests that more attention needs to be directed to establish the underlying causes and the nature of such actions.

Rules are generally devised with the intention of preventing and protecting humans from potential harm (Reason, 1990). They may be likened to a ‘safety net’, where operations that are performed within the confines of the safety net are presumed to reduce the potential for a dangerous situation to arise (Feyer, Williamson, & Cairns, 1997). While strictly adhering to rules and SOPs does not entirely guarantee one’s safety, it nonetheless, is one of the most effective measures to protect against harm.

Rules and SOPs are also designed to make behaviour more predictable (Vogel, Kircher, Alm, & Nilsson, 2003). This predictability facilitates behavioural responses, especially when decisions are based on another individual’s behaviour. However, when rules are violated, the ability to predict another’s behaviour is dramatically reduced and safety is jeopardised. The notion that rules serve to predict behaviour and
facilitate safety was examined with 36 participants who were asked to watch a video containing a variety of road traffic scenes. The film was paused at different intervals and participants were asked to comment on the likely development of the situation in the two seconds after the film was paused (Vogel et al., 2003). It was concluded that the scenes where traffic violations occurred were more difficult to predict than when no violation occurred. This suggests that the availability and the conformity to rules facilitate behaviour and has the potential to improve the overall level of safety.

1.1 Errors

Humans, at every level of experience, have the capacity to make mistakes. However, within highly complex environments such as aviation, the nuclear industry and medicine, these mistakes have the potential for broad implications (Kraus & Gramopadhye, 2001). Simply being able to summarise and categorise the types of errors that occur does not necessarily prevent them from reoccurring (Feyer, Williamson, & Cairns, 1997). Reason (1997) refers to mistakes committed by humans as ‘human error’, which is explained as an occurrence where a planned sequence of physical or mental activities fails to achieve an intended outcome. In contrast, a violation is explained as the deviation from a safe working practice (Lawton, 1998), where a deliberate infringement of a socially accepted behaviour, standard operating procedure, or rule is committed (Parker, Reason, Manstead, & Stradling, 1995). The distinguishing feature that separates an error from a violation is ‘intention’. An individual will commit a violation when he/she perceives greater value in the outcome than any perceived consequences of the action. In contrast, an unintended infringement is more likely to be an error rather than a violation. For example, an
unintended infringement may involve entering a restricted area, without being aware (Reason, 1997). Finally, a deliberate violation is malevolent, when there is an intention to bring about suffering, such as sabotage or terrorism (Parker et al., 1995).

Reason (1997) explains that human error generally manifests in one of the three stages that constitute an action. The first stage in which human error may be evident is in the planning stage or ‘intention’. The planning or intention stage generally incorporates the goals and means by which the goals will be achieved. The planning stage is followed by an execution stage, and a consideration of the extent to which an action has been successful (Reason, 1997).

Reason (1997) suggests that there are two possible explanations as to why a plan may fail. Firstly, the plan may have been adequate, but the actions may have failed to support the plan. Alternatively, the actions may support the plan, but the plan may have been inadequate (Reason, 1997). In the first situation, where an adequate plan exists, but the actions fail to execute the plan effectively, failure is categorised as unintended. Commonly, unintended failures are referred to as slips or lapses (Reason, 1997). Slips relate to attention and/or perceptual failures, whereas a lapse generally involves the failure of memory.

The second possible explanation as to why a plan may have failed involves higher-order cognitive processes. Generally, an error manifests itself in the planning phase where information is assessed, intentions are formulated, and any foreseen consequences of the planned action are recognised (Reason, 1997). The error/s resulting from this stage is referred to as a mistake. Mistakes can be further divided into two sub-categories: Knowledge-based and rule-based. Knowledge-based mistakes occur when an individual has exhausted all of his/her available knowledge in a particular area and a mistake occurs as a result of attempting something novel
In contrast to knowledge-based mistakes, rule-based mistakes occur through either the misapplication of a particular rule, the application of a bad rule, or the failure to apply a good rule (a violation) (Reason, 1997).

The third subcategory of rule-based mistakes (failure to apply a good rule) is referred to as a violation. As previously explained, violations are deviations from safe working practices, such as rules, regulations and standard operating procedures (Lawton, 1998), which may be either deliberate or erroneous (Reason, 1997). As illustrated in Figure 1. Reason refers to violation as a form of ‘error’ that is rule-based in nature.

Summary of the principal types of Errors

![Summary of the principal types of Errors](image)

*Figure 1. Summary of principal error type (Reason, 1990. p72).*

In contrast to Reason (1997), Parker et al. (1995) distinguish errors separately from violations. Furthermore, Parker et al. (1995) suggest that errors become evident due to information processing problems, whereas violations appear to be motivationally based. Where errors can be understood in relation to the cognitive function of individuals, Parker et al. (1995) argue that violations can be better
understood within a broader organisational and social context (Parker et al., 1995). Consistent with this perspective, where errors can be managed through training, the redesign of human-machine-interface, and/or by providing better information, violations can only be prevented by addressing the safety culture of the organisation or by attempting to change the attitude, beliefs and/or norms of the individuals that comprise an organisation (Parker et al., 1995).

While Reason (1997) and Parker et al. (1995) propose different factors that precede either an error or a violation, the fact remains that they both agree that errors and violations play a significant role in the aetiology of accidents.

1.1.1 Violations

Violations are defined as the deliberate infringement of a socially acceptable behaviour, standard operating procedure or rule that is intentional (Reason, 1990; Mason, 1997; Parker et al., 1995; Reason et al., 1990). More often than not, a violation will result from a well-intentioned desire to get the job done (Lawton, 1998). Furthermore, violations do not necessarily result in an accident. For example, exceeding the speed limit while driving rarely results in an accident (Lawton, 1998). From the individual’s perspective, the penalties associated with a violation such as speeding (fines or accident) are rare and unpredictable, and the threat of a penalty is presumably outweighed by the perceived benefit (arriving at the destination in less time). From a publics’ perspective, however, the economic and social costs associated with motor vehicle accidents that potentially result from violations, are perceived as significant (Lawson, 1998). Moreover, injuries resulting from motor vehicle accidents
increase the burden placed on the health care system and the associated economic costs.

Violations occur when working to the rule is not optimal behaviourally (Battman & Klumb, 1993). In this case, an individual perceives that working within the confines of the rules will require more effort or time in comparison to working outside the rules. In aviation, this is often the case where safety and production goals are in conflict (Lawton, 1998). An example of this type of situation can be derived from the crash of a Valujet Douglas DC-9 on May 11, 1996, into the Florida Everglades, which resulted in the deaths of all 105 passengers and a flight crew of five. The DC-9 departed Miami International Airport en-route to Atlanta in what was described as near perfect weather. Briefly after the departure, smoke filled the cabin and the flight crew declared an emergency and requested clearance to land back at Miami International Airport. The aircraft subsequently crashed, at high speed, west of Miami (NTSB, 1996).

The National Transportation Safety Board concluded that a leading cause of the accident was a fire that ignited in the cargo compartment and that was initiated by one or more oxygen generators that were improperly carried as cargo (NTSB, 1996). Information obtained after the accident suggested that the contractor employed by Valujet, SabreTech, deliberately prepared, packaged and identified unexpended chemical oxygen generators for transportation on a commercial flight. Although Valujet had a ‘no-carry’ policy regarding potentially hazardous material, the contractor deliberately violated both company and regulatory procedures and placed the hazardous material on-board. Furthermore, the canisters were mislabelled as empty and were not marked as hazardous material (NTSB, 1996).
During the loading of the aircraft, a Valujet employee noted the cargo of canisters, although his curiosity was not aroused because the packaging was marked as empty and a no hazardous material identification sticker fixed to each cylinder (NTSB, 1996). It appears that both the employees from SabreTech and Valujet were aware of, at least in part, the contents of the cargo and the ‘no-carry’ policy of Valujet. However, in spite of this knowledge, they continued to permit the transportation of the canisters. It appears that the actions of the employees from SabreTech and Valujet in no way intentionally sought to cause any harm, but the employees were more concerned with transporting the cargo than any possible consequences. Their decision to ignore or violate company policy resulted in an obviously unfavourable consequence (McCarthy et al., 1997). If the employees of Sabretech and Valujet had realised the potential consequences of such a violation, they may not have committed the violation.

Mason (1997) and Battman and Klumb (1993) contend that violations are generally committed as a result of humans attempting to optimise their behaviour. Humans have the ability to optimise their behaviour through the application of skills and knowledge, or a change in mood. This occurs through the use of external variables such as tools, colleagues and guidelines (Battman & Klumb, 1993). From an organisational perspective, the optimisation of human performance, more often than not, leads to an increase in productivity and greater economic gains (Battman & Klumb, 1993). However, in high-consequence systems such as the nuclear industry, medicine and aviation, any potential gain may be outweighed by the threat to the environment and/or to the health or lives of others (McCarthy et al., 1997).

Within the aviation industry, pilots are educated concerning the rules and regulations, and they are trained to use standard operating procedures to effectively
deal with routine situations and predicable emergencies (Lawton, 1998). However, the availability of the rules, regulations and SOPs does not necessarily guarantee that they will be employed (McCarthy et al., 1997). The following example illustrates the potential consequences that may be associated with violating certain rules and/or SOPs. On September 23, 1997, a Cessna 172 operated by Pegasus Air collided with trees and impacted a small lake on approach to land at Bremerton National Airport, Seattle. The private pilot and his two passengers were fatally injured on impact. The pilot intended to fly himself and his two friends on a cross-country night flight even though he had not met the minimum three hours of required night flying prior to take-off. The instructor who reviewed the pilot’s logbook did not notice the discrepancy and permitted the pilot to rent the airplane prior to the accident. The National Transportation Safety Board concluded that one of the probable causes of the accident was the pilot’s failure to adhere to night flying regulations. This failure to adhere to the night flying requirements was such that the pilot did not have sufficient knowledge or skill to fly under night visual conditions (NTSB, 1997).

Battman and Klumb (1993) suggest that there is a small proportion of the general population who will comply with a rule on the basis that the rule exists. For the remainder of the population, there appears to be a cost-benefit analysis involved where the amount of effort required to comply with the rule is weighed against the expenditure in terms of time and other costs. Support for this assertion can be derived from a study commissioned by the British Rail (1998) that examined the frequency and risks associated with violations by railway shunters. The study consisted of a short questionnaire in which the participants were able to respond to each question by ranking five likely reasons why they committed a violation. The participants had a choice between fourteen different reasons as to why they committed a violation. The
fourteen reasons where initially derived from unstructured interviews with shunters. Thirty-nine percent of the shunters indicated that the sole motive behind committing a violation was that it constituted a quicker way of working (Lawton, 1998).

Battman and Klumb (1993) refer to the notion of optimising work as behavioural economics, where rule compliance is based on social factors, rather than cognition. The fact that violations persist is a result of shared attitudes, beliefs, norms, practices and the existing safety culture within an organisation (Battman & Klumb, 1993).

The Challenger Space shuttle accident in 1986 highlights the importance of shared attitudes and the safety culture of an organisation in preventing potential accidents. Seventy-two seconds after ignition, the Challenger space shuttle was destroyed by a massive explosion that fatally injured the seven occupants. The cause of the explosion was traced to an O-ring seal that allowed explosive hydrogen gases to escape from storage tanks (Presidential Commission Staff, 1986). The explosion occurred at a height of 48,000 feet and took milliseconds to totally destroy the space shuttle. The O-ring that failed was known to have been unreliable at the low temperatures at which the space shuttle was to be launched. Irrespective of the concerns raised by the engineers prior to the accident, there was pressure exerted by management within the organisation that had a vested interest in ensuring that the launch proceeded (Presidential Commission Staff, 1986).

Preceding the accident, the National Aeronautics and Space Administration (NASA) became aware of the potential fault with the O-rings and subsequently upgraded the critical ratings of the O-ring to number one. This rating indicated that the component could cause the potential loss of both crew and spacecraft (Presidential Commission Staff, 1986). As a result, NASA engineers redesigned the O-ring joint,
but the proposal was then placed on hold. A series of meetings took place prior to the launch where the O-rings were discussed, but due to the lack of presence of NASA managers at the meetings, the importance of the matter was said to have been missed. In December, a month prior to the accident, the problems associated with the O-ring were again said to have been ignored, based on the grounds that the new design was ‘on its way’ (Reason, 1990).

The night prior to the accident, the chief engineer became aware of the forecast decrease in temperature, and challenged the launch of the shuttle (Presidential Commission Staff, 1986). However, due to the five unsuccessful launches that had previously taken place, pressure was exerted by management to continue with the launch. Reason (1997) argues that the existing safety culture of NASA did not permit and encourage an environment where potential problems could be openly discussed and cooperative solutions proposed. Instead, individuals who sought to challenge the system appeared to be given as little attention as necessary to quickly mask or hide their concerns. In failing to promote a work environment that facilitated free and open communication, violations that had the potential to cause harm went unchecked and, ultimately, resulted in the loss of the space shuttle (Mason, 1997).

### 1.1.2 Cognitive Failures versus Attitude, Belief and Values

A distinguishing factor between errors and violations is that errors are based on cognitive failures and are largely unaffected by the attitudes, beliefs and values of the individual (McCarthey et al., 1997). Reason (1997) suggests that an individual may commit an error without violating and an individual may commit a violation without erring. In an attempt to distinguish between the errors and violations, five hundred and
twenty motorists were asked to complete a questionnaire relating to the frequency with which they committed various errors and violations. The results indicated that the frequency of violations decreased with increasing age across both genders, whereas errors remained consistent irrespective of age and gender. In addition, men appeared to report more violations than women (Reason et al., 1997).

Reason et al. (1997) concluded that violations are characterised by deliberate deviations from safe working practices. Moreover, individuals choose to deviate from these safe working practices because their interpretation of what is ‘safe’ differs from the work practice definition. In contrast, errors result from individuals’ failure to achieve the intended outcome.

Violations can be categorised into one of three groups according to their intention and outcome (Reason, 1990; McCarthy et al., 1997). Firstly, violations may be intentional with a desire to achieve a bad outcome. For example, a person may commit sabotage to deliberately destroy a piece of machinery. Secondly, a violation may not be intentional and, therefore, may be classified as unintentional or erroneous. The third type of violation occurs when a violation is intentional, but the outcome is unintentional (Reason, 1990).

Reason (1997) divides the third type of violation into two further categories: Routine and exceptional. Routine violations are described as habitual behaviour that becomes integrated within the skills of an individual, such as speeding on a motorway. Exceptional violations do not appear as common as routine violations. Generally, an exceptional violation will occur only in a particular set of circumstances, and generally when safety is at stake. An example would involve a bystander who runs into a burning house to rescue a child trapped inside.
Violations appear to circumvent one layer of a defence. Defences serve as a protective layer between the operator and a potential accident (Reason, 1997). They range from rules and regulations, to physical barriers between an operator and machinery (Reason, 1997). When a violation is committed, an individual performs a task outside the boundaries of safe working practices (defences) (McCarthy et al., 1997). Reason (1997) suggests that performing a task outside the boundary of safe working practices increases the likelihood of committing an error.

1.1.3 Violations and the Current Study

The significance of violations committed within the aviation industry is of importance to the current study as it provides a unique tool and context to measure pilots’ willingness to engage in risk. Specifically, under the Civil Aviation Regulations, Low-Flying CAR 157, an aircraft must not fly over a populated area at a height lower than 1,000 feet, or any other area (i.e., non-populated) at a height lower than 500 feet. When pilots are engaged in a low-flying activity they must balance the associated risks of descending to an altitude conducive of completing the task at hand, flying in accordance with the low-flying regulation and, at a height that they perceive suitable in the event of an emergency (i.e., engine failure or stalling the aircraft). Moreover, while the regulations state a minimum altitude in which pilots are permitted to descend during low-flying activities, in the event of an engine failure or inadvertently stalling the aircraft, a pilot must ensure that the aircraft has sufficient altitude to glide to a suitable area to land or have sufficient altitude to restart the engine if possible or recover from the stall. Therefore, by incorporating a low-level flying scenario in the current study, it was assumed that pilots adopting a more risk averse behaviour during a low-flying flight would remain at a higher altitude, on
average, in comparison to those pilots who are more inclined to engage in riskier behaviour.

‘The primary aim of this thesis was to examine the utility of various training strategies to improve pilots’ risk management behaviour’. The incorporation of a low-flying scenario provided the opportunity to examine pilots’ willingness to engage in risk-taking behaviour (i.e., violations). Throughout this thesis and the duration of the study (February 2002 to February 2005), it was assumed that pilots’ risk management behaviour would be reflected in their performance during a variety of low-flying activities.

Molesworth and Wiggins (2004) contend that traditional training programmes within aviation focus on providing pilots statistical data and warnings, with the expectation that there will be a change in operator’s attitude, followed by a change in behaviour. The presentation of this information often occurs through a number of different media including, video, newsletter and classroom activities. Within Australia, one method of providing this information is through a bi-monthly magazine titled Flight Safety, which is published by Airservices Australia. Flight Safety contains predominately case examples of aircraft accidents that have occurred throughout Australia and the world over the preceding three months, although not always limited too. While the contents of this magazine and others similar are designed to educate pilots to the circumstances surrounding aircraft accidents, with the expectation that they will learn from the examples, there appears to be no empirical evidence in support of these assumptions. Therefore as noted previously, the primary aim of this thesis was to examine the utility of various training strategies (i.e., newsletter, videos, and simulated flight) to improve pilots’ risk management behaviour.
1.1.4 Research on Violators

Research concerning the commission of violations appears to concentrate primarily on the motor vehicle industry, and there appears to be some variation in the results. For example, some studies conclude that violators appear to exhibit certain personality traits that are distinguished from the general population (Cocolas, 2000; Levine, Lee, Ryman, & Rahe, 1976). Other studies are not as conclusive in relation to personality and report small differences between violators and the general population (Panek & Wagner, 1986; Sanders, Hoffman, & Neese, 1976). As a result, additional research is required before any concrete conclusions can be drawn about violators and their personality characteristics.

In an effort to develop an understanding of both the demographic and psychological basis of violators, Retting, Ulmer, and Williams (1999) examined the driving records of motorists who were involved in accidents at intersections. Specifically, the study investigated motorists who disobeyed red light signals. Two accident report databases were employed for the study and a total of 3,753 accidents were examined during a five-year period between 1992-1996. The study indicated that drivers who were generally younger than 30, were male, and who had a previous alcohol-related driving conviction and who had an invalid licence, were more likely to be involved in an accident associated with a traffic signal being disregarded.

Consistent with the results obtained by Retting et al. (1999), Trimprop and Kirkcaldy (1997) found that individuals who were involved in a motor vehicle accident were more likely to commit further violations. One hundred and twenty drivers between the age of 16 and 29 were examined. The results revealed a moderate correlation between accidents and violations committed while driving. In addition, the study revealed that the drivers who committed violations appeared to have a higher
level of arousal, tend to be thrill and attention seeking, and preferred socially stimulating activities. Finally, those drivers who had committed violations appeared to have less experience, consistently underestimated the associated dangers, and tended to overestimate their ability.

Support for the results obtained by Trimprop and Kirkcaldy (1997) is provided by Parker, West, Stradling, and Manstread (1995) who examined self-reported violations, and concluded that a deliberate deviation from a safe driving practice was predictive of accident involvement. While violations decreased with age, the frequency of errors did not. Men, irrespective of their age, committed more violations than women, and participants who rated themselves as particularly good drivers tended to commit a greater number of violations.

Within the aviation industry, Levine et al. (1976) attempted to predict violations on the basis of the behavioural characteristics of pilots and aircrew on-board an American aircraft carrier. Eight hundred and seventy-nine air wing support personnel and 156 aviators who were involved in accidents on board aircraft carriers, participated in the study. A 22-item questionnaire was administered examining six specific scales namely logic, adventurousness, discipline, focus on immediate life situations, concern with self, and brashness. The results indicated that the only characteristic that could be correlated with accident involvement was ‘adventurousness’. The adventurous personality is consistent with the notion of ‘risk-taking’ and sensation seeking. Individuals who score high on this dimension are more likely to take chances and seek pleasure from activities such as skydiving, motorcycle riding, and bungie jumping (Levine et al., 1976).

Risk-takers generally perform activities for pleasure or sensation and appear to value the rewards of the activities more than low risk-takers or low sensation seekers
Risk-taking can be defined as a class of behaviour that encompasses a choice between two or more options, where one of the options has the probability of producing adverse effects that are not fully known to the risk-taker at the time (Lane & Cherek, 2000). This differs from individuals who are unable to distinguish dangerous situations from those that are not safe (Levine et al., 1976). Generally, the reason why risk-takers or high sensation seekers engage in certain activities can be divided into two distinct categories. Firstly, sensation seekers may take risks due to the intense reward and the thrill that emerges from participating in the activity (Greening & Stooplebein, 2000). This may be achieved through the sensation of free-fall for a parachutist, the accelerated heart rate for a gambler, the ‘high’ or ‘rush’ of cocaine or heroin, or the g-forces and blur of scenery for an accelerating motorcyclist (Horvath & Zuckerman, 1993). Secondly, high sensation seekers may perceive themselves as less vulnerable to misfortune (Weinstein, 1980). That is, these individuals may be unrealistically optimistic about future life events. Therefore, they would expect others to be the victim of misfortune, rather than themselves (Gerrard, Gibbons, & Warner, 1991; Horvath & Zuckerman, 1993). Weinstein (1980) refers to this characteristic as ‘optimistic bias’.

The principle of optimistic bias was examined by Weinstein (1980) with 258 college students. Students were asked to make a comparative judgment about the likelihood that certain events would be experienced during their life. Overall, student
rated their own likelihood of experiencing a positive event as greater than the average, and rated the probability of experiencing negative events as below average (Weinstein, 1980). The results appear consistent with similar studies in which motorists rated themselves less likely than the average of being involved in a motor vehicle accident (Robertson, 1977) and in which female marines, who practiced unprotected sex, rated themselves as less likely to contract Human Immunodeficiency Virus (HIV) and/or become pregnant (Gerrard et al., 1991).

The reasons why people underestimate the likelihood of experiencing a negative event and overestimate the likelihood of experiencing a positive event, relate to their own perceptions of vulnerability (Taylor & Brown, 1988). In other words, an individual will commonly underestimate the risk of a negative event because they focus on risk-reducing attributes, such as genetic predispositions and their own preventative or protective behaviour (Weinstein, 1980). The same individuals fail to concede that other individuals may also engage in risk-reducing behaviour and that they may also ignore their own risk-increasing behaviour. Weinstein (1983) found that highlighting these risk factors to the perceived risk adverse individuals would only increase their illusion of invulnerability. This illusion relates to the perception that they are less vulnerable to negative events than others in the general population (Gerrard et al., 1991). Therefore, this type of information appeared to act as a reminder that there were many risk-increasing attributes and behaviours that these individuals did not possess, thereby strengthening their perception of invulnerability.

There are presumed to be two factors that moderate the perception of risk-relevant behaviour on the perceived vulnerability to negative consequences (Gerrard et al., 1991). These are the perceived control over the event and the perceived undesirability of the event. Perceived control relates to individuals’ perceptions that
they have been successful in the past in controlling the risks associated with negative events (Gerrard et al., 1991). This may lead to the conclusion that risks taken previously can be successfully controlled in the future. Therefore, focusing on prior behaviour appears to decrease the perceived vulnerability to undesirable consequences (Gerrard et al., 1991). Weinstein (1984) supports this notion and notes that people report less vulnerability to negative events, when the events are perceived as controllable.

The second factor that relates to risk-relevant behaviour is undesirability. Undesirability involves the self-protective or motivational component of risk-taking behaviour (Perloff, 1983). The more that an individual perceives a particular event as undesirable, the more likely it is that vulnerability to an adverse event will be underestimated (Gerrard et al., 1991). Ishii-Kuntz, Whitbeck, and Simons (1990) suggest that this illusion of invulnerability relates, in part, to a lack of knowledge about the frequency of events. For example, Ajdukovic and Ajdukovic (1991) administered an anonymous questionnaire to 750 students and found that they did not perceive themselves at risk of Acquired Immune Deficiency Syndrome (AIDS), partly because they did not accept AIDS as a personal problem, and that they regarded themselves as having a fairly high level of knowledge in the area.

Cocolas and Sleath (2000) also found a relationship between knowledge, or perceived level of knowledge, and violations. Cocolas and Sleath (2000) administered a personality questionnaire to 199 pharmacists who had been cited for violating one or more board of pharmacy regulations, 95 pharmacist leaders, and a further random sample of 494 licensed pharmacists. The pharmacists were asked to complete a 38-item personality profile questionnaire that examined eight constructs, including, ascendancy, responsibility, emotional stability, sociability, cautiousness, original
thinking, personal relations and vigor. The results indicated that those pharmacists who had advanced degrees and/or who belonged to a pharmacy organisation were less likely to commit a violation. In addition, these pharmacists appeared to score at a higher level in the area of ascendancy, original thinking and vigor (Cocolas & Sleath, 2000). This suggests that knowledge and intellect may contribute, at the same level, to the commission of violations.

Cocolas and Sleath (2000) used the Gordon Personal Profile Inventory (GPP-I), which is a combination of the Gordon Personality Profile (GPP) and the Gordon Personal Inventory (GPI). A relatively high score on the ‘ascendancy’ dimension relates to individuals who tend to take an active role in group discussions. They also are more self-assured and tend to actively make independent decisions. An individual with a high score on ‘original thinking’ would be regarded as a person who likes to work on difficult problems, who is intellectually curious, and who likes thought-provoking questions and discussions. Finally, a person who returns a relatively high score on the vigor dimension, tends to be an energetic and rapid worker who accomplishes more than the average individual (Cocolas & Sleath, 2000).

Loo (1978) explored the notion of individual differences in personality with motorists and violators in relation to the content embedded in traffic signs. Personality factors such as extroversion, introversion and neuroticism and the cognitive style dimension of field dependence-independence were examined to determine whether any relationships existed. Field dependence-independence involves testing individuals’ ability to separate figures from the ground in the visual field. The participants were asked to verbally identify the traffic signs that were embedded in actual street signs. The results indicated that the participants who took longer to verbally identify the embedded traffic signs had also been involved in more accidents.
and were convicted of a relatively greater number of traffic-related offences. These participants were also classified as extroverts on Eysenck’s extroversion dimension scale (Loo, 1978).

According to Petrie (1978), extroverts tend to seek pleasure from thrill seeking behaviour, and are able to withstand pain more effectively than introverts. Extroverts are also less tolerant of sensory deprivation, whereas introverts are more easily over-stimulated and, therefore, are more tolerant of sensory deprivation. The relationship between sensation seeking, and introversion and extroversion is evident from the higher scores obtained by extroverts on the Sensation Seeking Scale (Zukerman, 1983).

Support for the proposition that extroversion is related to sensation seeking, can be derived from a study that investigated the relationship between parental driving records and the driving records of their children (Ferguson, Williams, Chapline, Reinfurt, & De Leonardis, 2001). Previous research indicates that psychological factors relate to certain driving practices, resulting in violations or accidents (Lawton, 1998; Retting et al., 1999; Trimpop & Kirkcaldy, 1997; Parker et al., 1995). Ferguson et al., (2001) capitalised on this research and explored the relationship between the driving records of parents to the driving records of their children to investigate the extent to which there were any similarities involving accidents and violations. The procedure utilised data from the North Carolina driver history file and matched 155,349 samples. The results indicated that parents’ violations were predictive of their children’s violations. Similarly, parents’ involvement in accidents was also predictive of their children’s involvement in accidents. While the results appear conclusive, the interpretation of the results is open to debate. In particular, it is not clear whether there are certain characteristics that are unique to violators and which, in part, may be
inherited or whether children of parents who violate, learn from their parents’ influence and adopt the same or similar behaviour.

Renner and Andrele (2000) further examined the relationship between sensation seeking and introversion and extroversion using 98 juvenile traffic offenders and 149 licensed drivers. The participants were asked to complete Eysenck’s personality questionnaire and an impulsiveness/venturesomeness/empathy questionnaire. The results indicated that traffic offenders recorded a relatively higher mean score on the extroversion dimension than did the control group. While Aiken (1993) and Renner and Andrele (2000) have found support for the notion that extroversion is positively correlated with violations or accident involvement, contradictory evidence can be found in Roy and Choudhary (1985) and Pestonjee and Singh (1980).

Pestonjee and Singh (1980), examined the personality dimensions of neuroticism-extroversion as they correlate to road accident involvement in India. The study comprised forty bus drivers, of whom half had been involved in accidents while driving buses during a five year period. The participants were asked to complete an Indian adaptation of Eysenck’s Maudsley Personality Inventory. Initially, the forty participants were divided into two groups: A non-accident group and an accident group. The accident group was further divided into a single-accident group and a multi-accident group. There was no statistically significant difference observed between the non-accident group and the accident group, or between the single-accident group and the non-accident group on the ‘extroversion’ dimension. However, statistically significant differences were observed between the single-accident group and the multi-accident group, and between the non-accident group and the multi-accident group. The results suggest that extraversion/introversion appears to be only
partly correlated to accident involvement, and that there appear to be other factors involved including, anxiety, withdrawal, life changes and/or aggression (Mayer & Treat, 1977) that may also impact behaviour.

1.1.5 **Aggression, Frustration, Stress, and Information Processing Ability**

Schuman, Pelz, Ehrlich, and Selzer, (1967) propose an association between young drivers who are involved in accidents or violations, and physical aggression. Consistent with this perspective, Wilson and Jonah (1988) examined the relationship between driving risk and aggression, and involvement in accidents and violations and found a positive correlation between aggression and accident involvement. Similarly, Donovan and Marlatt (1982) examined drivers who had committed violations and who had been involved in accidents and their scores on the Buss-Durkee Hostility Inventory and found that individuals who obtained relatively high scores on the inventory were also rated as aggressive.

In contrast to Wilson and Jonah (1988) and Donovan and Marlett (1982), Panek and Wagner (1986) found no evidence to support the association between aggression and violation. Panek and Wagner (1986) administered the Hand Test that purportedly identifies personality traits such as direction, aggression and acting-out, in addition to a self-report driving questionnaire. One hundred and seventy-five female drivers ranging in age from 17 to 72 years participated in the study which was designed to determine whether the three predictors of the aggressive-directive behaviour on the Hand Test (direction, aggression and acting out) could be related to violations. Although there was no significant correlation between aggression and violations (Panek, Wagner, Barrett, & Alexander, 1978), Panek and Wagner's (1986)
study identified two important points relating to personality traits and violations/accidents. Firstly, personality traits which could be considered as relating to ‘impulsivity’, tended to be associated with accidents. However, personality traits that tended to be related to a ‘lack of environmental awareness/attention’, tended to be associated with violations. Panek and Wagner (1986) established that those personality traits that were related to accident/violation involvement also appeared to differ as a function of age (Panek & Wagner, 1986).

Involvement in accidents and violations appears to be negatively correlated with age (Furnham & Saipe, 1993). As motorists age, they appear to be convicted of fewer violations and are involved in fewer accidents. This relationship also appears within the aviation industry, with accident rates decreasing with a function of age (McFadden & Towell, 1999). It is important to note that these trends do not appear to be evident for aggression.

Unlike the relationship between age and violations, Schuman et al. (1967) found that drivers who become angry relatively easily, also appear to be more likely to be involved in a traffic violations rather than an accident. In addition, younger female drivers who are considered relatively ‘impulsive’ appear to have been involved in a greater number of accidents, in comparison to those females who could be considered to have a ‘lack of environmental awareness/attention’ and who have committed a greater number of violations. In contrast, older drivers who commit violations scored higher on ‘acting-out’ than on either the ‘direction’ or ‘aggression’ scale (Panek & Wagner, 1986). These findings appear to lend support to Panek et al. (1978) who concluded that, as a group, the personality traits associated with violators appear to differ from those personality traits associated with people involved in accidents.
According to Baron and Richardson (1994), frustration is assumed to increase the likelihood of aggression. Frustration is defined as the interpersonal discomfort of ongoing, goal-directed behaviour (Berkowitz, 1993). Frustration appears to lead to aggressive behaviour when it is sufficiently unpleasant to produce negative effects. Negative effects appear to result in aggressive behaviour only when it is interpreted as anger, rather than as fear. Aggressive behaviour may result if frustration is combined with the displeasure about not reaching one’s goals (Berkowitz, 1993). This displeasure may be heightened when a frustrated individual interprets his/her behaviour to be outside his/her control. Moreover, aggressive behaviour or aggression tends to be evident if frustration provokes intense hostile emotions, such as anger (Berkowitz, 1993; Baron & Richardson, 1994).

In the case of motorists, a greater intensity of negative emotions is positively associated with self-reported ratings of skilled performance (Lajunen, Parker, & Stradling, 1998). In contrast, motorists who emphasise safety appear to have a more ‘realistic’ view of their driving skill (Lajunen et al., 1998). Safety-conscious drivers do not appear to become as frustrated in conditions that do not satisfy their expectations. These drivers may simply not let their anger influence their driving behaviour, even if they are frustrated (Lajunen et al., 1998). In comparison, those drivers with an unrealistic outlook of their driving ability may resolve that they have the right to express their anger and frustration through any means (Lajunen et al., 1998).

Another factor that appears to be related to the involvement in motor vehicle crashes is the purpose of the journey (Chliaoutakis et al., 2002). In a study with 241 young motorists, Chliaoutakis, Darviri, and Demakakos (1999) found that if motorists had no predefined destination, they were more likely to be involved in a motor vehicle
accident. Chliaoutakis et al. (2002) propose that drivers without a specific or predefined destination and who are ‘driving just for fun’ can also be classified as ‘irritable’. Those drivers who drive ‘just for fun’ appear to have additional motives, compared to a driver with the single goal of travelling from point A to point B. These additional motives may relate to sensation seeking, the expression of hostility, antisociability and aggressiveness (Naatanen & Summala, 1976).

Chliaoutakis et al. (2002) suggest that additional motives amongst younger drivers may relate to the fact that they have nothing better to do. Therefore, it reflects the emptiness in their lives. This emptiness becomes a purpose when they are ‘driving just for fun’. Moreover, ‘driving just for fun’ is transformed into a medium in which young drivers can express themselves. Junger and Wiegersma (1995) suggest that oppressed individuals drive without a predetermined destination to perhaps escape certain situations, or perhaps to escape people who oppress them, or just in order to cope with stress. Irrespective of the motive, the fact that people drive without a specific destination in mind increases the opportunity for personality factors to play a role in the commission of violations and accidents.

Matthews, Dorn, and Glendon (1991) highlighted the difference between accident involvement and violations in respect of reported levels of stress using a correlational study that was conducted with 159 school leavers. The results indicated that those participants who reported having been involved in minor accidents experienced the highest level of stress. Participants who reported being involved in either no or numerous accidents obtained relatively low scores in terms of their stress levels. Overall, the general level of stress appeared to be higher amongst participants involved in accidents in comparison to those participants who reported having speeding convictions (Matthews et al., 1991). It could be argued that those individuals
who are better able to manage stress are, in turn, better able to manage their cognitive capabilities (Reason et al., 1990), and are more likely to avoid accidents (Fergenson, 1971).

The ability to manage one’s cognitive affairs directly relates to the efficiency with which humans process information (Reason et al., 1990). The relationship between information processing capacity and performance has been investigated by Fergenson (1971) amongst motorists. Fergenson (1971) matched participants for driving experience and then divided them into four groups according to their accident and violation involvement. The first group consisted of five participants who had been involved in two or more accidents in the past three years but had not recorded any traffic violations. The second group had two or more violations but had not been involved in any accidents. The third group consisted of participants who were involved in two or more accidents and/or violations within the last three years. The final group consisted of participants who had recorded no accidents or violations within the past three years.

The participants were asked to perform an exercise that measured their reaction time to certain stimuli. The results indicated that the high violation, zero accident group processed information more rapidly than any other group. The information processing response of the low violation group and the zero and high accident groups remained relatively consistent. It is possible that individuals with a relatively low capacity to process information will become more easily overloaded. In a critical situation, this ability to process information more rapidly and more efficiently may enable these individuals to avoid accidents (Fergenson, 1971). Fergenson’s (1971) results indicate that those individuals who process information more rapidly, also appear to be involved in fewer accidents.
Generally, reaction times in cognitive task exercises are associated with psychometric intelligence which, in turn, is said to be a reflection of the speed with which individuals process information (Neubauer, Rieman, Mayer, & Angleitner, 1997). It is also theorised that reaction time can be characterised as a logarithmic relationship against the number of stimuli available. Hence, the more intelligent the individual, the less time is required to process information (Neubauer et al., 1997). Therefore, in analysing the results of both Fergenson (1971) and Neubauer et al. (1997), it might be concluded that individuals who are involved in frequent violations but not accidents, may process information quicker and at a more rapid rate than their more accident-prone counterparts. Furthermore, it might be concluded that these same individuals who are able to process information quickly, may be characterised with a higher degree of psychometric intelligence.

It is important to note that the relationship reported between reaction time and information processing may be a result of a number of confounding variables. For example, Baltes and Lindenberger (1997) explain the relationship as a result of the speed with which information travels through the nervous system. Alternatively, Hertzog, and Bleckley (2001) contend that age plays a significant part in the speed with which information is processed, where older individuals tend to process information at a relatively slower rate, in comparison to younger individuals. In addition, the relationship between reaction time and information processing may be a result of higher-level cognitive functions such as attention, learning and motivation (Neubauer, 1997).

While there appear to be a range of explanations concerning the relationship between reaction time and information processing, the fact that reaction times are correlated with psychometric intelligence is clear (Neubauer, Spinath, Riemann,
Angleitner, & Borkenau, 2000; Fink & Neubauer, 2001). Although, there is no direct empirical data to support the following assumption, it can be proposed that an accident may result when an error is made while a violation is being committed. Those individuals with a higher level of psychometric intelligence avoid these accidents as a result of their ability to process information more rapidly. If this assumption is correct and psychometric intelligence cannot be enhanced, alternate methods of accident prevention must be sought (i.e., specific training and education).

On the basis of the research outcomes pertaining to individual differences and other factors that influence the commission of violations/accidents, two important points can be identified. Firstly, there are psychological features that distinguish individuals who commit violations from those individuals who are involved in accidents, although the basis for this distinction remains unclear. Secondly, and somewhat more clear, is that age is negatively associated with the commission of violations (Panek & Wagner, 1986). As people age, they appear to commit fewer violations, which suggests the possibility that life and operational experience may impact the commission of violations.

### 1.2 Summary

In summary, the results from previous research indicate that errors appear to be related to skills (Reason, 1997), while violations appear to be related to attitudes and knowledge. An error will be made unintentionally, whereas an individual will generally commit a violation because they perceive it as a more efficient and effective way of working. Skills may be enhanced, taught or practiced to reduce or even eliminate errors. In contrast, attitudes appear to mature over time (Parker et al., 1995).
Individual attitudes appear to be influenced by many factors, both environmental and social. The fact that, in the majority of instances violations are seen as a precursor for accidents (Retting et al., 1999; Trimpop & Kirkcaldy, 1997; Parker et al., 1995), highlights the implications for the management of safety (Lawton, 1998). This has significant implications within the aviation industry where reducing the number of violations has the potential to reduce the number of errors committed and, therefore, reduce the number of accidents. As a result, safety management programmes need to focus on developing training programmes to reduce the potential impact of violations on accidents. In line with these goals, the central aim of this thesis was to examine the utility of various training strategies to improve pilots’ risk management behaviour. Specifically, Experiment 1 and 2 examine the utility of various training programmes to improve pilots’ risk management behaviour, while Experiment 3 examines the extent to which information acquired during a low-flying task will generalise to other flight activities. In addition, Experiment 3 will also examine the role of personality characteristics in the commission of violations and risk-taking behaviour, as discussed in this chapter.
Chapter 2: Risk

The aim of this chapter was to discuss risk management and examine the different training techniques employed to effectively improve risk management skills. This is important, as it appears from the evidence presented in Chapter 1 that there is a direct link between risk-oriented behaviour and the willingness to commit a violation. Therefore, it might be concluded that improving risk management is the key to improving safety in aviation. To examine this proposition, the following chapter investigates the differences between hazard and risk perception and discusses why some individuals are more tolerant or accepting of risk than others. Finally, this chapter explores different training techniques employed in the automotive industry and other industries which provide direct demonstrations of individuals’ limits and the risks involved in the task.

2.1 Risk Management

Risk management refers to the calculated assessment of a situation where potential threats are identified and analysed in relation to their perceived consequences (Sibinga, 2001; Wogalter, Young, Brelsford & Barlow, 1999). Almost all activities in which humans engage involve a level of risk, and risk-taking can potentially lead to adverse outcomes (Hunter, 2002). Excessive risk-taking potentially jeopardises both the risk-taker and any other individual/s who may be directly or indirectly related to the performance of a task (Lane & Cherek, 2000). Conversely, risk takers often view risk-taking as an effective means to an end, where the outcome outweighs the perceived consequences.
The aviation industry is one example of a high-hazard industry, where pilots, almost on a daily basis, are confronted with decisions that involve a certain level of risk. More often than not, the outcomes of this interaction with the system do not lead to unfavourable consequences. However, there are occasions where pilots fail to perceive, interpret, or disregard the risks associated with an activity and the consequences are catastrophic (Molesworth, Wiggins, & O’Hare, 2003; Hunter, 2002). Therefore, training and education relating to successful risk management practices are important in the aviation industry so long as safety remains paramount.

Lowrance (1980) and Slovic, Fischoff and Lichtenstein (1979) suggest that when operators assess the potential risks involved in a situation against the benefits of the perceived outcome, they base their assessment on two variables: a) The likelihood of injury; and b) the severity of the potential consequences. Furthermore, Wogalter et al. (1999) propose that the likelihood or probability component is the most important component of the two, because people base their risk perception on the likelihood of being injured. Slovic, Fischoff, and Lichtenstein (1980) suggest that, to motivate people to act cautiously, one must provide them with the probabilistic nature of the world’s events and the ability to think intelligently about rare, but consequential events. Slovic et al. (1980) refer to intelligence in this context as being able to think objectively. Desaulniers (1991) claims that, to achieve this, individuals would be required to systematically distinguish between relatively small probabilities such as 1/100,000 versus 1/10,000,000 while performing a number of other tasks systematically. Within the aviation industry, pilots are continually provided with statistics relating to fatalities, accidents, and incidents which vary depending upon the type of flying undertaken. Relying on individuals’ ability to first calculate and then distinguish between these probabilities within the aviation industry, remains
problematic and, therefore, other methods of improving pilots’ risk management
techniques need to be explored.

According to Brown and Groeger (1988), for individuals to effectively manage risk/s, there must be two key components present. Firstly, operators must be aware and identify that a hazard exists. They also must have sufficient information concerning the potential hazard in relation to the environment (likelihood and severity of injury). Secondly, operators must have information or knowledge concerning the ability of the operator and the object being operated (i.e., motor vehicle or aeroplane) (Brown & Groeger, 1988). Often, if there is an imbalance between these two influences, the potential for an accident greatly increases. Vernick et al. (1999) attribute the imbalance between the potential hazard and the ability of operator as a leading cause in the fatality rate amongst young motorists. Specifically, Vernick et al. (1999) contend that young motorists are more likely to be involved in a fatal accident as a result of their unrealistic perception of their ability, in comparison to their older counterparts.

In contrast to Vernick et al. (1999), Greening and Stoppelbein (2000) and Greening (1997), suggest that the potential for an accident greatly increases when problems arise in the process of choosing a course of action to manage the risk. This is commonly referred to as ‘response efficacy’. This is an assessment of how appropriate courses of action are to deal with the risk. While Brown and Groeger (1988) propose a two-stage process in order to manage risk, the results of the research conducted by Greening and Stoppelbein (2000) allude to a third stage in the process. According to Greening and Stoppelbein, it would not be unreasonable to assume that an individual will choose between courses of action to manage the risk, following the identification of a hazard. An individual will often decide the most appropriate course
of action amongst competing matches, based on what he/she perceive will result in the most desired outcome. This process, where an individual chooses an appropriate course of action does not appear dissimilar to a perspective concerning human reasoning titled Case-Based Reasoning (CBR) (see Chapter 4). Briefly, according to the principles of CBR, an individual who experiences repeated exposure to a particular operational environment, will acquire and retain information specific to that domain in the form of case examples (Kirsner, Hird, Page, Doasee-Jelinek, & Randell, 1997). When the same individual is confronted with a novel situation requiring a decision, it is hypothesised that he/she will model their decision based on what is perceived as the most appropriate case example (Kolodner, 1997). Both processes are highly contingent on a number of factors such as, experience, knowledge, ability, perceived vulnerability and age, which are discussed in detail in this chapter.

Current training approaches adopted within the automotive industry to positively influence motorist risk management behaviour focus on hazard identification and awareness (Brown & Groeger, 1988). More specifically, these approaches focus on providing motorists with the objective risk of being involved in an accident associated with a particular behaviour. The objective risk of an event involves the quantification of risk based on police records and accident statistics. These identify specific categories of traffic hazards, such as motorists caught for drink driving, speeding and/or following too close in fog. These statistics are then used to develop education programmes and/or advertising material to inform motorists of the potential hazards.

Brown and Groeger (1988) suggest that there is only limited evidence relating to the success of training programmes where objective levels of risks are provided. They attribute this to the quantification of the potential hazard, rather than the
potential risk. The distinguishing feature between the two is that the potential hazard relates to the frequency of an accident sequence, while the potential risk incorporates the frequency of an accident sequence in addition to the number of times that the behaviour was exhibited without the consequences of an accident (Brown & Groeger, 1988). This is mainly due to the fact that no baseline data are collected relating to the frequency with which such behaviours occur without being associated with an accident sequence.

Consistent with Brown and Groeger (1988), Anderson (1978) has also found that the quantification of potential hazards did not reduce drivers’ involvement in accidents and traffic violations six months after exposure to the material. In explaining these findings, Anderson (1978) suggests that exposing individuals to factual information about accident involvement and traffic hazards may serve individual biases in which it is reasoned that accidents occur to others and not themselves. This, in turn, may confirm a self-fulfilling prophecy, that a particular individual is safer and more skilful than other road users. Similar views have been expressed by Svenson (1981), Finn and Bragg (1986), and Matthews and Moran (1986).

McKenna and Horswill (1999) further explored the relationship between accident involvement and risk management and found that, on average, a typical motorist could expect to be involved in an accident once every ten years. However, even if a motorist is involved in a motor vehicle accident, there is a high probability that the driver in question may not be at fault.

Where an individual is found to be especially error-prone, a relatively common initiative amongst driver education organisations is to send these individuals to advanced driver training courses. Such driver training courses involve skid control
and vehicle handling techniques. However, there is evidence to suggest that motorists who have graduated from such courses tend to be even more accident prone and commit more traffic violations than their untrained counterparts (Williams & O’Neill, 1974). This outcome differs from the experience where drivers are trained in hazard perception. Drivers involved in these types of courses tend to reduce their risk-taking behaviour (McKenna & Horswill, 1999). These results suggest that improvements in performance are most likely to occur following specific training that targets the skill of hazard perception, rather than the application of a generic skills training programme.

2.2 Hazard Perception

Hazard identification appears to play a critical part in risk management, due to the fact that only the hazard identified can be taken into account. If none of the relevant hazards are identified, then any decision will be biased as a result (Faber & Stewart, 2003). A biased decision in relation to risk management does not suggest that it is based on an intentional preference. Rather, a biased decision is based on the fact that not all of the available information (i.e., hazards) is obtained prior to formulating a decision. A hazard may be both physical (fixed, stationary or moving object/s) (Brown & Groeger, 1988) and/or abstract (regulation or knowledge). Therefore, in the case of aviation, a hazard may be represented physically by other aircraft, obstacles, weather and/or in abstract terms such as a regulation. Hazard perception is the process of identifying object/s or circumstances and perceiving them as hazardous (Brown & Groeger, 1988; McKenna & Horswill, 1999).
Wogalter, Brelsford, Desaulniers and Laughery (1991) suggest that information pertaining to the likelihood of an injury occurring is used infrequently when evaluating the hazardousness nature of a product. Rather, information concerning the severity of the potential injury/s, is used when forming a risk assessment of the hazardousness of a product. Wogalter et al. (1999) conducted a series of studies which demonstrated this preference amongst undergraduate students. The students were given a number of prepared lists, containing the names of products and activities. They were asked to evaluate the items on both potential hazardousness and the severity of potential injury. The results indicated that, when evaluating consumer products, students were more concerned about injury severity than the perceived hazardousness of the product (Wogalter et al., 1999).

When highlighting information about injury potential in consumer products, Desaulniers (1991) suggests that providing graphical information is the most effective means of highlighting the potential dangers that may exist. In particular, the severity of the injury, rather than the likelihood of the injury tends to evoke greater use of heuristic processing due to the vivid mental image conjured (Desaulniers, 1991). This mental image can be further enhanced through the presence of warnings which increases both the perception of the product’s hazardousness and the compliance behaviour required (Wogalter et al., 1999). Therefore, the perception of a situation as ‘risky’ will alter, depending upon the nature of the activity and/or the hazard encountered (Wogalter et al., 1999; Desaulniers, 1991; Wogalter et al., 1991). In other words, a motorist who is speeding will generally do so based on the likelihood of being caught and incurring a penalty, rather than the potential severity of an accident.

Deery (1999) further explores the notion of hazard and risk perception where, instead of referring to risk perception in terms of likelihood and severity of potential
injuries, risk perception is considered in terms of subjective experience and objective risk. Subjective experience is described in relation to an individual’s evaluation of the risk or hazard. It is, at least in part, a learned response to a potential hazardous situation, which develops through experience. In contrast, objective risk quantifies the level of risk, where the reliability of the estimation is dependent on the quality of the information that includes the calculation (Deery, 1999). Although Deery (1999) deals primarily with motorists and their responses to traffic hazards, there is no reason why these outcomes cannot be applied within other environments, including aviation. Moreover, subjective experience within the aviation industry is dependent, at least in part, upon the pilot’s experience, where it is anticipated that if pilots experience a given situation, they will learn from this experience and adapt or modify the principles used and apply them at a later date when necessary. The notion that involvement creates ‘experience’ which is utilised at a later date is consistent with the principles of Case-Based Reasoning (CBR) (discussed at length in Chapter 4).

Risk perception, as described by Deery (1999), involves an individual’s subjective experience of risk in a potentially hazardous situation. In the case of motorists, subjective experience is presumed to constitute three key components: Basic vehicle handling skills (psychomotor); knowledge about traffic laws; and higher-order perceptual and cognitive skills (the choice of appropriate responses/actions in the face of a hazard and choosing the correct response). Deery (1999) suggests that both the basic vehicle handling skills and the knowledge about traffic laws develop relatively quickly in comparison to higher-order skills. In fact, Hall and West (1996) suggest that both the basic vehicle handling skills and knowledge about traffic laws are learnt after only approximately 15 hours of driving. By contrast, the development of more complex, higher-order perceptual and cognitive
skills that are required for safe operation, appear to develop only after several years of experience. Deery (1999) suggests that it is the successful development of these higher-order perceptual and cognitive skills that distinguishes novices from experts.

Mayhew and Simpson (1995) further examined the distinction between novice and experts in a review of the literature pertaining to motorists’ perceptual skills. They found a clear distinction where, relative to experts, novices displayed a limited range of horizontal scanning. Specifically, novices checked their mirrors less frequently, glanced at objects less frequently, utilised peripheral vision less frequently, and fixated on fewer objects than more experienced drivers. Research in other areas, such as radiology and chess have revealed similar findings, suggesting that inexperienced or novice individuals perceive situations differently. Specifically, it appears that novices perceive only what is occurring at the present, rather than what occurs in the larger context (Milech, Glencross, & Hartley, 1989).

Additional support for the notion that novices perceive situations less holistically can be derived from Benda and Hoyos (1983), who conducted an analysis of novice motorists in potential hazardous situations. They reported that novice drivers assess traffic hazards on the basis of a single, rather than multiple characteristics. For example, novices assess all wet roads as equally dangerous, whereas experts differentiate each wet road and their degree of potential risk. Milech et al. (1989) suggest that such a holistic perception, where multiple characteristics are assessed, stems from the ability to reorganise knowledge in memory, based on different schemata and scripts. Sweller (1998) defines a schema as a cognitive structure which entails domain specific information.

Brown and Groeger (1988) propose that, with experience, risk management strategies amongst motorists tend to improve as drivers adopt more efficient search
strategies facilitating hazard detection. Furthermore, as motorists gain experience, they learn to associate risks and hazards with certain aspects of the traffic system (i.e., dangerous intersection, driver's behaviour). Moreover, they appear to acquire knowledge about certain characteristics of other road users (schemata), which enables them to identify and predict, with more accuracy, the nature of potential hazards. Goldstone (1999) refers to this ability to detect stimuli in the environment and respond appropriately as perceptual learning. Improvement/s in perceptual learning will generally result in improved hazard detection which has the potential to facilitate improvement/s in risk management strategies.

In a review of the literature relating to perceptual learning, Goldstone (1999) approaches the distinction between novices and experts from a slightly different approach than Brown and Groeger (1988). Goldstone (1999) proposes that attention can be selectively directed towards particular stimuli. Through experience, individuals learn which stimuli demand more attention than others. In potentially high-consequence situations, such as the aviation industry, individuals are rarely provided the opportunity to learn from their mistakes. With fatality rates in general aviation eight times that of automotive industry (Wiegmann & Taneja, 2003), the potential opportunities to learn from mistakes are greatly reduced. However, it is often from mistakes and life experience that the most valuable lessons are learnt (DeJoy, 1992). Goldstone (1999) proposes that if individuals are exposed to these important lessons, improvement/s in performance will result. Haider and Fremsch (1996) suggest that such exposure provides individuals with the opportunity to learn to discriminate between relevant and irrelevant information. This discrimination enables individuals to selectively process what is considered relevant information, rather than processing both the relevant and irrelevant stimuli (Haider & Fremsch, 1996).
Quimby, Maycock, Carter, Dixon, and Wall (1984) took a slightly different perspective on risk perception and examined the relationship between motor vehicle crash frequency and the time taken to detect and respond to hazards. They found that those individuals who had been involved in a greater number of accidents took substantially longer to detect and respond to potential hazards. This occurred despite controlling for age, driving exposure and simple reaction time. These findings suggest that accidents are more likely to result from inadequate hazard identification strategies, in addition to the frequency with which individuals are exposed to particular hazards.

It is often incorrectly assumed that a positive correlation exists between simple reaction time, hazard detection and response time (response latency). However, Quimby and Watts (1981) found that drivers under the age of 25 were able to make more rapid decisions on simple task activities than older and more experienced drivers, although, these younger drivers also displayed longer hazard perception latencies (time taken to detect and respond to hazard) than older drivers. These results suggest that, while the older drivers are slower at responding to a particular hazard, they are, nonetheless, quicker at identifying potential hazards. Similarly, McKenna and Crick (1994) noted that younger drivers were more likely to miss hazards and would take longer to detect those hazards that they perceived, than older, more experienced drivers. These results highlight the distinction between novices and experts in relation to risk and hazard perception.

When compared to their more experienced counterparts, a novice detects potential hazards at a relatively slower rate, although they appear faster than their older counterparts in responding. While these results distinguish between experienced and inexperienced drivers, they may have occurred for a number of reasons, one of
which may relate to the fact that older drivers assess a number of different ways of responding to a situation. Nonetheless, Deery (1999) contends that this distinction results, at least in part, from novices’ inefficient information acquisition strategies. This has important implication for risk management training, where emphasis needs to be placed on hazard detection and perception, rather than response latency (McKenna & Crick, 1994; Quimby & Watts, 1981; Deery, 1999; Brown & Groeger, 1988).

2.3 Risk Perception

While hazard perception focuses on identifying objects or items as potentially threatening or dangerous (hazardous), risk perception involves the probability that the hazard will pose a threat. Central to this notion of risk perception is an individual’s personal experience (Gregerson, 1996; Faber & Stewart, 2003). For example, if motorists rarely experience a pedestrian stepping out from the curb onto the road (hazard), then they would be less cautious when they observe a pedestrian close to the edge of the road (Deery, 1999). In addition, an overview of the literature relating to risk perception suggests that individuals’ perception of what constitutes a risky situation is also related to their age (Panek & Wagner, 1986; Furnham & Saipe, 1993; McFadden & Towell, 1999), gender (Reason et al., 1990), type of licence held (Retting et al., 1999), level of confidence (Weinstein, 1980), personality traits, such as sensation seeking and impulsiveness (Deery, 1999), and the level of alcohol consumed (Retting et al., 1999). This suggests that, unless risk perception training specifically deals with these variables during training, the potential results of the training may not be as effective.
Risk perception, in part, is based on identifying hazards. As experience is acquired, an individual’s hazard detection and perceptual ability increases. However, a potential hazard does not necessarily represent danger (Brown & Groeger, 1990). Therefore effective risk perception involves, in some form, an assessment of the hazard/s, and in turn, of the potential danger.

It is the assessment of the potential danger where subjective biases can be experienced. Brown and Copeman (1975) successfully isolated individuals’ subjective biases in a study with young male drivers. The drivers were asked to rate the severity of the potential hazard, the level of which had been agreed upon by the motorists. It was then possible to quantify, separately, the ‘undervaluing’ of the potential hazard and the overrating of their ability by asking the participants to rate each situation. The results confirmed Brown and Copeman’s impression that young motorists overrate their own ability. Brown and Copeman suggest that the overrating of one’s own ability may also contribute to driver’s misconception of the risks involved in certain situations, which may, in turn, result in an accident. As a result, Brown and Copeman suggest that there is a need to employ different types of countermeasures when dealing with young drivers, where emphasis should be placed on improving self-knowledge, in addition to their assessment of danger (Brown & Copeman, 1975).

Watts and Quinby (1980) took a rather different approach to Brown and Copeman (1975) in distinguishing between hazard evaluation and the self-evaluation of one’s ability. They measured the speed at which the participants travelled and the distance between the motor vehicle and different road features (i.e., bends, bridges, pedestrian crossings) and then calculated the safety margin, by factoring the known vehicle stopping characteristics. From each calculation, a value, either positive or negative, was obtained which was said to reflect the safety margin. Watts and Quinby
(1980) claimed success with this approach, as it yielded a metric of drivers’ estimate of their ability and the hazardousness of the road environment. The results suggested that, in order to design effective accident countermeasures, efforts should be devoted towards reducing the discrepancy between real and apparent hazards, rather than training that simply focuses on improving individuals’ attitudes and skills.

Pelz and Krupat (1974) also examined the level of perceived risk by motorists in specific traffic situations using videotaped sequences featuring different driving situations. Three different groups of drivers were examined. The three groups differed based on a self report of accident involvement and/or violation/s committed. The first group consisted of those drivers who were considered safe drivers, determined by the lack of involvement in accident/s and/or violation/s. The second group included those drivers who had been involved in an accident/s but not violation/s. The third group consisted of those drivers who had been involved in either a violation/s, or both an accident/s and a violation/s. The results indicated that the safe driver group (group 1), not only displayed a shorter response latency in recognising hazards, but also responded to those hazards in a more controlled manner (less abrupt). In contrast, the third group of drivers responded most abruptly to the hazards and also perceived the lowest level of risk associated with the hazards identified. The second group, as predicted by Pelz and Krupat, fell between the two other groups in terms of response latency and the perceived level of risk associated with the hazards.

Although the studies conducted by Pelz and Krupat (1974), Brown and Copeman (1975), and Watts and Quinby (1980) used slightly different approaches to examine risk perception, the results yielded similar findings. Specifically, they suggest a distinction between younger and less experienced individuals, and their older and more experienced counterparts. Williams and O’Neill (1974) and Hunter
suggest that specific training techniques addressing risk and hazard perception are more beneficial, specifically with those individuals who are considered less experienced than generic training programmes designed to address similar issues. Such training techniques appear to provide individuals with the skills necessary to effectively differentiate between competing responses, in order to achieve an optimum outcome (Williams & O’Neill, 1974; Hunter, 2002). Therefore, it might be concluded that a distinction lies between how these individuals perceive the threat of hazards, and that inexperience appears to be paired with a lower level of perceived risk. Addressing this discrepancy between real and apparent hazards, has proven to be an effective method of improving individuals’ risk perception (McKenna & Horswill, 1999), rather than concentrating on changing attitudes and personality (Hunter, 2002), which appears to be the focus of classroom-based training.

2.4 Risk Acceptance and Tolerance

There is a vast amount of research relating to the personality characteristics that constitute risky behaviour, but it is not clear why certain individuals are more willing to accept a greater level of risk than others. This notion of risk tolerance or acceptance (Oppe, 1988) may be explained by a trade-off between risk and the amount of ‘gain’ associated with an activity (Sokolowska & Pohorille, 2000; Hunter, 2002.). The following section investigates the factors that may influence an individual’s willingness to accept higher levels of risk.

Deery (1999) acknowledges that there is limited evidence available relating to individual risk acceptance, although there is some indirect evidence that young drivers are more willing than older drivers to accept a relatively higher degree of risk while
driving. This acknowledgement is based on evidence indicating that young drivers are
more complacent or are willing to accept shorter distances between their vehicle and
the preceding vehicle (Evans & Wasielewski, 1983), are more willing to ‘run’
yellow/orange lights (Koneci, Ebbesen, & Koneci, 1976), and tend to speed more
often than their older counterparts (Wasielewski, 1984).

In explaining the potential differences in risk orientation, three theoretical
perspectives can be considered. The first of these theoretical perspectives is the
constant risk model, which maintains that individuals have an ideal level of acceptable
risk. To maintain this ideal level or equilibrium, behaviour is adjusted (Wilde, 1982).
McKenna (1988) conducted a review of the evidence for and against the constant risk
model and concluded that the willingness to accept different levels of risk is the sole
determining factor in individuals’ overall accident involvement, rather than a quest to
maintain internal equilibrium. Therefore, McKenna concluded that there is little
evidence in favour of the ‘constant risk model’, although subsequent work has raised
questions about these earlier conclusions.

McKenna (1988) appears to base his criticism of the constant risk model on
the relationship between risk and accident involvement. However, McKenna and
Horswill (1999) argue that, “there are considerable methodological problems in the
use of accident involvement as a measure of personal accident liability” (p. 37). They
proceed to explain the problems associated with individual difference measures and
accident involvement, as those individuals who use accident statistics may falsely
assume that those involved in an accident are, in some way, responsible. Thus, the
potential impact of constant risk on performance remains unresolved.

In contrast to the constant risk model, Ranney (1994) contends that behaviour
in relation to risk is a product of the perceived likelihood of encountering a hazard and
the level of importance attached by the individual to the consequences of the event. This view is referred to as the zero risk theory, and it is posited that, as self-confidence increases, the level of perceived risk diminishes. Ajdukovic and Ajdukovic, (1991) and Gerrard et al. (1991) relate this theory to the notion of invulnerability, where people participate in risky activities because they perceive that they are relatively less vulnerable to negative events than others in the general population.

Lester and Bombaci (1984) have also conducted research examining this notion of invulnerability amongst the pilot population. In a pencil and paper study, pilots were presented with various risky aviation scenarios and five possible explanations justifying their choice. The results indicated that 43% of the pilots chose a response consistent with their perception of invulnerability. Hunter (2002) interpreted this outcome as evidence to support the zero risk theory, drawing the link between the attitude of invulnerability and the fact that the pilots reported that there was no risk from various scenarios.

Hunter (2002) tested the validity of the zero risk theory in the aviation context by examining both the risk perception and risk tolerance/acceptance of pilots through a pencil and paper study. Oppe (1988) defines risk perception as danger that is either seen, missed or misperceived, whereas, the definition of risk acceptance implies that certain individuals value human life less than others (Oppe, 1988). Stein and Allen (1987) add to the definition of risk acceptance and suggest that risk acceptance is the risk threshold or the level of perceived risk that an individual is willing to accept. Hunter’s (2002) study was designed to examine both these constructs; risk perception and risk acceptance with four hundred and two American pilots. The results indicated that those pilots with higher levels of experience and qualifications identified lower
levels of perceived risk in the situations that were presented. The results were interpreted as support for the zero risk theory, as higher levels of experience and qualification were found to be associated with lower levels of perceived risk, although the results from Hunter’s study were not consistent across all the different participants. Moreover, the participants who were classified as student pilots tended to have a lower level of perceived risk, irrespective of experience. Nonetheless, these results are encouraging since they identify a deficiency with pilots’ skills rather than their personality. Deficiencies in skills are far easier to address than influencing pilots’ personality.

Consistent with the zero risk theory, the threat avoidance model of risk perception is based upon the principle that individuals learn to anticipate hazardous events and avoid them as a means of reducing the likelihood of negative consequences. Fuller (1984) suggests that when individuals are confronted with discriminative stimuli (threat) from which a potentially aversive event may result, their behaviour or action is dependent upon known rewards and punishment of alternate responses. Therefore, a distinction is evident between learner drivers and their more experienced counterparts, suggesting that the inexperienced drivers are more likely to delay avoidance responses, rather than anticipate a response when confronted by a discriminative stimulus. In justifying the difference between these two behaviours, Fuller (1984) suggests that, for motorists, most learning occurs through direct experience, such as near misses, accidents, and when unsafe responses occur. It is from these situations that individuals best learn the association between threat and avoidance.

A recurring theme that appears to be evident throughout the constant risk, zero risk, and threat avoidance approaches, is the principle that individuals assess the level
of risk present based on their experience. Therefore, to improve risk management amongst pilots, it would appear necessary to ensure the acquisition of experience, where pilots are given the opportunity to assess risk and receive feedback on their responses.

2.5 **Personal Biases Affecting Decision-Making**

The literature relating to risk management is based on the assumption that a decision-maker has valid and appropriate information about the risks and benefits between certain choices when making a decision. However, it is important to note that the application of an optimal decision-making process does not necessarily result in an optimal outcome. For example, in 1989, a DC10 cruising at 37,000 feet experienced a catastrophic uncontained failure of the number two engine located on the tail of the aircraft (NTSB, 1989). The catastrophic uncontained failure created a hail of shrapnel which punctured the hydraulic lines of all three independent systems that powered the flight controls, leaving the pilots with no control over the ailerons or rudders. The pilots then had to decide whether to attempt to manoeuvre the crippled aircraft to the closest airport equipped to manage with the anticipated emergency, or land the aircraft in the closest field. As a result the aircraft performed a crash landing at Sioux City, fatally injuring 111 people. While only one member of the flight crew had limited experience manoeuvring an aircraft without the use of the ailerons or rudders, none of the crew members had any formal training in the situation that presented, and therefore they had limited information concerning the potential performance. It appears that they balanced these factors and reached a decision, which under the circumstances could be described as optimal.
Research conducted by Lichtenstein and Slovic, (1971; 1973) illustrates that reaching an optimal decision is often difficult to achieve when individual biases impede the decision-making process. Lichtenstein and Slovic, (1971; 1973) used a number of gambling scenarios to investigate individuals’ tendency to bias their decision in line with their underlying values. They provided participants with a choice between two bets, where bet A had a much greater likelihood of winning in comparison to bet B, although the payoff for bet B was substantially higher. Participants were first asked to indicate how much money they would like to place on each bet. They were then asked to assume that they owned a ticket to play in each bet, and then indicate the lowest price that they would be willing to sell this ticket. The results indicated that bet B was associated with a higher selling price in approximately 88% of trials. From the remaining participants who chose bet A, 87% indicated a higher selling price than bet B. An underlying assumption of the study was that the presumed selling price and the choice reflected the attractiveness of each gamble for the participants. Therefore, the participants’ choice should be reflected in the higher selling price. These results suggest that different cognitive strategies are used for different circumstances. Specifically, when making a judgement about pricing, people who find gambling attractive tend to use the potential amount to win as a natural starting point. An adjustment is then made to factor in the less than ideal likelihood of winning, although this adjustment appears insufficient when compared to the odds of winning. Lichtenstein and Slovic (1971; 1973) suggest that the reason why the pricing and choice responses are inconsistent, is because one of the responses does not accurately reflect what they perceive as the most important attribute when gambling.

Another bias relates to the availability of the hazard, which directly relates to the extent to which the hazard has previously been experienced (Wells & Evans,
This is referred to as the ‘availability bias’, since an individual will judge a hazard, situation or event as more likely to occur if instances of an event are easier to recall or imagine (Tversky & Kahneman, 1973). In such situations, previous experiences are employed as a means of assessing the frequency or probability of a situation or an event occurring. Wells and Evans (1996) suggest that previous experiences may be either direct, where it was personally experienced or indirect, such as exposure through a media coverage. The following example highlights how the experience might affect individuals’ risk estimation.

Lichtenstein, Slovic, Fischhoff, Layman, and Combs (1978) conducted an experiment examining how people judge the frequency of death from various causes, including asthma, tornadoes and motor vehicle accidents. A list of 41 causes of deaths was first created and from that list, 106 pairs were constructed. Within these 106 pairs, each cause appeared approximately six times and the ratio of the relative frequency varied systematically between each appearance. The participants were then asked to rate which one of the two causes was more likely to be experienced by the average person living in the United States of America. They were then asked to quantify how many more times this cause of death is more likely, than the other stated cause. The results indicated a direct correlation between participants’ estimations and participants’ past experience involving each lethal event. Similar results were obtained by Christensen-Szalanksi, Beck, and Koepsell (1983) in a study comparing physician and college students who were exposed to patients carrying various diseases. Although the risk perception between the two groups varied as a result of experience, for both groups there was a direct positive correlation between risk estimates and the frequency of encounters. The results from these two studies lend
support for the notion of availability bias, and the potential adverse impact on the
decision-making process.

Simon (1955) suggests that individuals often choose a decision based on the least effort required. In other words, he suggests that, in most situations, people appear to ‘satisfy’ rather than ‘maximise’. Therefore, when people are choosing between alternatives by considering the best return for the least risk, they will generally be content with a choice that exceeds a predetermined criterion or target. Simon (1955) provides a hypothetical example where an individual is contemplating selling a house. The individual might consider $15,000 as an acceptable price for the house and anything over this price as satisfactory, while anything less is considered unsatisfactory. While both an offer of $16,000 and $25,000 might be considered satisfying, the latter would be preferred by most individuals. However, Simon suggests that if the first offer of $16,000 was presented and this satisfied the seller, then they would be more likely to opt for this outcome, rather than expending more effort to search for the higher price. If the same individuals were to maximise their outcome, he/she would be more likely to search for the best possible combination, rather than just meeting a predetermined standard.

Within the aviation industry, a potentially serious bias is the success-induced bias, where either success or failure has a direct impact on the estimation of risk (March, 1994). March (1994) suggests that, in any given situation, the successful outcome is a combination of both ability and luck. If an individual attributes more ability than luck to a successful outcome, then there is a potential for a bias to result. Equally, if an individual attributes more luck than ability to a successful outcome, then there is an equal chance that an alternate bias will result. With any inclination to over-attribute luck to the outcome, there will be an overestimation of the risks
involved and the result would more likely lead to a reduction in risk-taking behaviour. By contrast, if ability was over-attributed to success, than it would likely lead to an increase in risk-taking behaviour (March, 1994).

The impact of the success-induced bias is illustrated by Wells and Evans (1996) who compared the risk perceptions of design professionals (architects and interior designers) to adults over 65 years of age. The perceptions related to the potential for injury from 18 common consumer products and architectural features around the home. Both the design professionals and the other adults were asked to estimate the perceived level of risk associated with the products which were ranked according to the annual injury rate amongst the elderly population. The results indicated that the more commonly used items were the most underestimated by the elderly, although these featured high on the list of the most common causes of injuries around the home. These items included doors, toilets, sinks, windows and particular floors and their coverings. Items which were used less frequently, such as pools and stools, were overestimated by the elderly in relation to the level of perceived risk of injury (Wells & Evans, 1996). These results suggest that individuals, who routinely use certain products without any negative consequences, tend to associate a lower level of perceived risk with these products, than individuals who use these products infrequently.

March (1994) suggests that persistent success results in a tendency to underestimate the amount of risk involved in a task. The same appears to be true for ‘luck’, where an overestimation of risk will typically result (March, 1994). In the aviation context, Clarke (1986) suggests that pilots potentially reflect upon a flight as being successful, purely if a safe landing is performed at the conclusion of a flight and
no damage is sustained to the aircraft or its occupants. This belief may be validated through industry magazines and aircraft accident reports.

While the literature relating to risk management assumes that the decision-maker has valid and appropriate information about the risks and benefits between certain choices when formulating a decision, the potential impact of certain biases on the decision-making process may result in an unfavourable outcome. Specifically, personal biases of which individuals may not be consciously aware, may adversely influence performance. Such biases may reflect individuals’ underlying values (Lichtenstein & Slovic, 1971; 1973), the relative frequency with which an event or hazard has previously been experienced or is able to be recalled (Tversky & Kahneman, 1973), individuals’ willingness to expend effort to satisfy a predetermined criterion (Simon, 1955), and/or may reflect previous success or failure on the task (March, 1994; Clarke, 1986). Therefore, to improve individuals’ risk management behaviour, individuals need to be made aware and acknowledge the potential impact of such biases when formulating decisions.

2.6 Cognition and Risk Management

Effective risk management appears dependent, and is restricted by, the cognitive limitations of the decision-maker. Simon (1995) identifies two key restrictions that hinder effective decision-making, which include: The fixed and known alternatives aware to the decision-maker and their associated consequences, and/or the perception and cognitive interventions of the decision-maker. Yates (1990) suggests that personal representation or the way that an individual perceives the problem or decision to be made, underpins these two restrictions. Yates further
acknowledges that two different people presented with the same problem will formulate their decision based on different representations of the problem.

Sarasvathy, Simon, and Lave (1998) refer to individuals’ cognitive representation of a problem as the ‘problem space’. Within this problem space, individuals are said to construct hypotheses, and operate on problems in order to identify an appropriate solution. This problem space is said to be influenced by several moderators such as experience (Hale, 1987), personal responsibility, and control (Sarasvathy et al., 1998). Sarasvathy et al. (1998) explain that, as a result of internal representation limits, one individual in a given situation is able to generate more alternatives to a problem than another individual when provided with the same information situation. Sarasvathy et al. (1998) compared bankers with entrepreneurs in their perception and management of a variety of risks and concluded that a distinction could be made between bankers and entrepreneurs based on the level of risk that they were willing to accept. This was reflected by the way that they internally represented the problem, where entrepreneurs were able to generate more solutions than bankers as a result of fewer limitations on the problem space.

Where decisions are restricted by either the fixed or known alternatives and their associated consequences, it is important to have the correct information, which is accurate, up to date, and reliable. In situations where resources cannot be easily obtained to check and validate the information provided, such as during a flight, individuals must rely on the information that is stored in memory to assist with the assessment of risk. Organisations that have come to understand and appreciate these limitations introduce fixed decision rules to minimise the potential consequences of an inappropriate decision, rather than trying to forecast the future (Cyert & March, 1993).
In addition to the cognitive limitations imposed by the decision-maker in managing risk assessment, the assessment of any potential risk is influenced by the thoughts, feelings, and the behaviour of the individuals (Sibinga, 2001). These thoughts, feelings and behaviour are, in turn, not only influenced by psychological factors, but are also influenced by social, cultural and political factors. Such broad and diversified influences, more often than not, result in different risk assessments or perceptions between individuals with any given situation and even over time for the same individuals (Sibinga, 2001).

Rundmo (2000) describes risk perception as a subjective assessment of the likelihood of experiencing negative outcome while being exposed to a potentially hazardous situation. According to Zajonc (1980), risk perception comprises two components: An emotional component and a cognitive component. The sequential order of the two components are subject to some debate. Lazarus (1990) for example, argues that cognition precedes emotion. Zajonc (1980) contends the reverse. That is, an individual will generally feel worry or insecurity first, and then seek to explain or justify the emotion. Support for the proposition that emotion precedes cognition can be drawn from Rundmo (2000) who examined the attitude of 730 Hydro plant employees in relation to their perception of risk and behaviour. It was concluded that ‘worry’ and the perception that the employees felt safe/unsafe was the biggest predictor for the cognitive assessment of risk. In addition, the acceptability of rule violation appeared to be the best indicator of future behaviour. This acceptability of rule violations was directly linked to the frequency of violations (Rundmo, 2000). These results have potential implications for training programmes that are designed to improve individuals’ risk perception. Specifically, if there is evidence to suggest that emotion precedes cognition in the subjective assessment of risk perception, then
emphasis needs to be placed on emotive cues in training programmes that are
designed to improve individuals’ risk perception. Based on these findings, if training
programmes are to be successful in improving individuals’ risk perception, they first
may need to consider employees’ attitude prior to implementing any training.

2.7 Anticipation, Decision-Making and Risk Management

The following section examines the relationship between expertise and the
management of risk. Understanding the relationship between expertise and risk
management is important, as ultimately, this should facilitate the development of
more effective training techniques and risk management practices. This section also
considers whether the knowledge and experience which experts obtain is best derived
from active involvement in a task or from indirect experience, where the person
observes or reads about the information. The aim of this discussion is to identify the
optimal techniques to facilitate the acquisition of knowledge and experience.

Research relating to expert/novice decision-makers suggests that experts
possess superior knowledge structures that permit more effective decision-making
than their novice counterparts (Williams, Davids, & Williams, 1999; Wiggins &
O’Hare, 1995). Experts, as described by Dreyfus and Dreyfus (1986), have the ability
to recognise impromptu, similar classes of problems and apply solutions as necessary.
Furthermore, experts appear to evaluate options sequentially, discounting the
irrelevant options that do not match the present situation (Wiggins & O’Hare, 1995).
While doing so, experts utilise their long-term memory to compare and evaluate the
current situation and modify those strategies that will aid in solving the current
situation (Mullin, 1989).
In contrast to experts, novices can be described as relatively new and inexperienced individuals who attempt to solve problems by evaluating the current situation and comparing it to similar problems (Mullin, 1989) through a means of backward chaining (Klein, 1989). Backward chaining occurs where individuals systematically work backwards from the point where they have identified a problem, and compare hypothetical alternatives to the desired solution until a satisfactory result emerges (Klein, 1989). This method is time consuming and cumbersome and also relies heavily upon the creativity of the individual (Wiggins & O’Hare, 1993). More often than not, this process is unsuited to the decision-making process due to time constraints (Klein, 1989).

Groot (1965) examined the distinction between experts and novices by examining skilled chess players to identify the key distinguishing features between the two. Groot exposed both chess masters and club players to different game configurations for intervals of between five and ten seconds and then asked if they could recall the positions of the chess pieces. The chess masters were able to recall with 93% accuracy the position of the chess pieces from memory. In comparison, club players recalled the position of the chess pieces with an accuracy of 51%. Similar results were obtained from Chase and Simon (1973b) who added a control condition into the experiment where they randomly arranged the chess pieces on the board, rather than in a structured game configuration. Chase and Simon (1973b) concluded that the results provided evidence that the chess masters possessed a more advanced task-specific knowledge, which permitted a more rapid and efficient process for retrieving information from memory.

A recurring theme that emerges from the research relating to comparisons between experts and novices is that experts appear to possess superior knowledge
structures and more elaborate task-specific knowledge than novices (Williams et al., 1999). Williams et al. (1999) also suggest that experts are better able to utilise information obtained in a way that will permit the anticipation of an action or response which, in turn, facilitates more effective decision-making. This is presumed to occur from a superior ability to encode and retrieve task-specific information. Eysenck and Keane (1995) refer to encoding as the way that information is transferred into a format that permits storage in memory. In contrast, Eysenck and Keane (1995) refer to retrieval as the way that information is accessed in order for it to be processed in response to the task at hand.

Ericsson and Chase (1982) suggest that the superior encoding process that experts possess is a result of their advanced perceptual capability (ability to perceive or comprehend large amounts of information accurately) and their enhanced knowledge relating to the task. An enhanced knowledge base facilitates the recoding of information into fewer, larger ‘chunks’ of information that are easily remembered and then decoded to produce the original pattern (Egan & Schwartz, 1979).

Allard and Burnett (1985) examined the notion of chunking with basketball players and non-basketball players using a schematic diagram of a basketball court. The basketball court was presented in two different conditions. Firstly, the court was represented in a structured format, where basketball players would be expected to stand. Secondly, the court was presented in an unstructured format, where the position of the basketball players was assigned randomly. In both conditions, participants were given five seconds to study a diagram of a basketball court where coloured markers were placed, representing the position of players. They were then asked to recall as much of the play as they could. The results indicated that, for the structured condition, the basketball players viewed the schematic diagrams for shorter periods of time and
were more accurate in their recall of the position, compared to non-basketball players. For the unstructured condition, the difference between the two groups in relation to accuracy and time became negligible. These findings were interpreted as evidence to suggest that experts are able to absorb more information in a single glance than less skilled players because their knowledge base permits them to chunk information into meaningful units (Allard & Burnett, 1985). However, they also highlight the limitations associated with expertise.

A problem within industries such as road transportation and aviation is that, in order for individuals to develop a knowledge base that is representative of an expert, they have to acquire sufficient experience. In some cases, this type of experience is derived from serious incidents/events (Deery, 1999). In this case, experience is obtained at a relatively high cost. Therefore, many training programmes attempt to educate individuals through classroom instruction where the emphasis is placed upon error mitigation (Robertson, 1980). However, there is evidence to suggest that specific education programmes that are designed to improve safety may actually have the opposite effect (Robertson, 1980). For example, Williams and O’Neill (1974), found that motorists who were required to attend an advanced driver training programme as a result of previous accident involvements, were more accident prone after the programme and committed more traffic violations than their untrained counterparts.

Deery (1999) attributes the lack of success of such education programmes to the fact that they do not focus on the skills that are important in preventing crash causation. Such skills include hazard perception and the identification and response to risk factors associated with accidents. One such method of training that has incorporated the skills of hazard perception and the identification and response to risk factors with promising results is a technique where inexperienced drivers provide a
running verbal commentary about their driving and the hazards perceived while
driving with an instructor seated alongside (Gregerson, 1993). The instructor provides
feedback and appropriate instruction relating to their driving and verbal commentary
throughout the training period. Other successful training initiatives include Personal
Computer (PC)-based instruction with mediation, where individuals obtain direct
experience through active participation without the potential consequences that are
normally associated with real-life situations (Regan, Deery, & Triggs, 1998). PC-
based mediated instruction allows the instructor to regulate the level of exposure that
the individual is subjected to and provide appropriate feedback in relation to their
performance. Regan et al. (1998) concluded that PC-based mediated instruction has
potential within the automotive industry, but such training is highly contingent on
both the nature of instruction and the PC-based programme.

McKenna and Crick (1997) examined a slightly different approach to risk
perception training which included watching a video of potential traffic hazards
associated with motor vehicles. The video was paused at different segments when a
traffic hazard was unfolding, and the participants were asked to make predictions as to
what they expected to occur next. The results indicated that the inexperienced drivers
showed a marked improvement in their risk perception skills. McKenna and Horswill
(1998) attribute the success of such video training initiatives to the fact that they
foster and develop experience to hazardous situations which would, otherwise, have
taken many months or years to develop.

While the research conducted by Williams, Ward, Knowles, and Smeeton,
(2002) was not specifically directed at improving individuals’ risk perception, they
were successful in improving individuals’ anticipatory skills through active
involvement in a training task. Specifically, Williams et al. (2002) attempted to teach
tennis players anticipatory skills to facilitate the prediction of where an opponent would hit a tennis ball during a tennis game. Previous research in the area of expertise amongst tennis players indicated that more skilful players are faster than their less skilful counterparts in anticipating opponents’ tennis stokes. Such anticipatory ability has been linked to perceptual skills, such as players’ visual search behaviour (Williams et al., 1999). Perceptual skills are one of the most important skills underlying effective motor performance, since they facilitate individuals’ ability to anticipate future events based on information that is detected early in a visual display (McKenna & Horswill, 1998). Enhancing an individual’s ability to anticipate an opponent’s intention based on postural cues may provide an opponent with the information necessary to win tournaments (Williams et al., 1999).

Williams et al. (1999) conducted two studies to examine the notion of anticipatory ability with both skilled and less skilled tennis players. The first study sought to test whether skilled tennis players possess greater anticipatory skill than their less experienced counterparts. Sixteen tennis players participated in the study where they were shown video footage of an opponent playing a tennis stroke and were required to respond as quickly and accurately as possible to the stroke. The results confirmed expectations that skilled tennis players exhibit superior anticipatory skills in comparison to less skilled players. On average, these players made a decision approximately 140ms earlier than less skilled players. There was also a notable difference in the gaze behaviour between the two groups. The less skilled players appeared to focus on the more obvious, deterministic cues from the racket and ball regions, whereas, the more skilled players utilised task-relevant information which centred around the central body area (Williams et al., 1999).
Williams et al.’s (1999) second study intended to examine whether anticipation skills could be improved through a training programme based on video simulation. Thirty-two recreational tennis players were randomly divided into four groups. The first group received explicit instructions both in the laboratory and on the tennis court. They also viewed video footage which was paused and played in slow motion at different intervals to highlight important information. The second group (guided discovery) also received explicit instructions, but in comparison to the first group, the explicit instructions did not focus on important information cues underlying performance. The information that these participants received merely directed attention to potential areas of interest. The third group consisted of a placebo condition where the participants observed an instructional video focusing on technical skills. The final group consisted of a control condition where no instruction or training was provided.

Williams et al.’s (1999) second study indicated that both the explicit instruction group and the guided discovery groups’ anticipation skills improved significantly post-test. However, there was no significant improvement in anticipation skills with the placebo and control groups post-test. In relation to the decision time and response accuracy, there appeared to be no significant difference between the four groups. These results can be interpreted as lending support for training programmes that actively involve participants in the training task and that provide explicit instructions. While no distinction could be made between the explicit instruction group and the guided discovery group in relation to differences in performance, Masters (1992) and Maxwell et al. (2000) suggest that in situations that are characterised as stressful environments, adopting a training regimen similar to that experienced by the guided discovery group should yield more favourable results. This
suggestion is made on the assumption that the guided discovery approach allows trainees to explore various ways to solve problems and encourages a flexible and adaptive approach (Masters, 1992; Maxwell et al., 2000).

The training approach adopted by Williams et al. (1999), where participants are not only actively involved in the training but also receive personalised attention, including instruction and feedback appears to be supported by other researchers. For example, DeJoy (1992) conducted a study examining gender differences in risk perception by drivers. The results indicated a direct correlation between the risk-taking behaviour of individuals and the level of perceived risk associated with the outcome. Therefore, if a low-level of risk was perceived to be associated with a particular outcome, then the behaviour would tend to be more risky. DeJoy (1992) attributed this behaviour to the fact that, although young males perceive driving to be dangerous activity, they do not perceive this danger as applying personally to them. To change this inaccurate perception, DeJoy proposes that training techniques need to adopt a principle where the risk is personalised to the driver. While there appears to be no training programme that has, to date, empirically examined this approach, Williams et al. (1999) adopt principles similar to those suggested by DeJoy (1992).

A recurring theme that appears evident with the research conducted by Williams et al. (1999; 2002), McKenna and Crick, (1997), Regan et al. (1998) and Gregerson, (1993) is the impact of different levels of cognitive involvement in the training task. Cognitive involvement is defined as a state which involves being immersed psychologically in an environment and making a decision/s or judgement/s about a situation/position. In contrast, cognitively inactivity reflects a state where individuals are not involved in any decision/s or judgment/s about a situation or position. It is proposed that providing a training technique where the participants are
cognitively active during the training facilitates the acquisition of information taught, thereby improving subsequent performance. In comparison, a training technique where the participants are cognitively inactive is not expected to facilitate the acquisition of information taught.

2.8 Summary

In summary, there is considerable evidence to suggest that risk-taking can lead to negative consequences (Hunter, 2002). Within a high consequence industry such as the aviation industry, the potential for negative events to have negative outcomes is greatly enhanced if risk-taking behaviour is not mitigated. There is also evidence to suggest that current training approaches that focus on providing individuals with objective risk estimates fail to prevent individuals from engaging in risky behaviour (Brown & Groeger, 1988; Anderson, 1978; Svenson, 1981). Although there is limited research examining why different individuals are more willing to tolerate higher levels of risk, there is a general consensus that, in order to reduce this behaviour, alternative training methods need to be employed (DeJoy, 1992; Hunter, 2002).

DeJoy (1992) proposes that personalising the level of risk in training is one possible solution to minimising risk-taking behaviour. Furthermore, Regan et al. (1998) propose that active involvement in the task will also facilitate reductions in risky behaviour. There also appears to be a distinction in the results between training methods where the participants are more cognitively active during the training, in comparison to a training method where the participants are relatively cognitively inactive. While positive results have been obtained employing some of these principles, the research investigating these issues is limited. Therefore, the current
research proposes to incorporate the principles of active involvement, personalised risk and differing levels of cognitive involvement to further explore their relationship in reducing pilots’ risk-taking behaviour. Specifically, in experiments one and two the principles of active involvement and personalising the risks involved in an activity are examined to improve pilots’ risk management behaviour. The third experiment incorporates the results from the first two experiments and examines the extent to which information acquired during a training programme which actively involves the individual in the task and personalises the risks, generalises to other flight activities. Finally, while the emphasis of this chapter was to highlight the benefits of personalising the risk during training to minimise risk-taking behaviour, the following chapter considers the role of social context in influencing behaviour, specifically in terms of risk management.
Chapter 3: Behavioural Modification through Attitude

The aim of this chapter was to examine violations and risk-taking behaviour in the light of culture, norms and social psychological theories, to facilitate a greater understanding of why certain pilots violate certain rules and/or operating procedures. Gaining a more thorough understanding of the origins relating to violations should facilitate the development of preventative strategies. Previous research appears to address or attempt to mitigate the occurrence of violations by employing training programmes without fully considering the social aspects (i.e., cultures and norms) of learning. In this chapter, the factors that may potentially impact the mitigation of violations, and which have the potential to cause adverse consequences, are examined.

3.1 Cultures, Norms and Aviation

Society consists of individuals who are influenced by their social environment (Zaidel, 1992). In the case of aviation, the behaviour of personnel is influenced by other personnel, organisational norms, aviation rules and regulations, and by standard operating procedures. At the same time, these individuals (aviation personnel) share in the collective influence on other personnel (Guerin, 2001). As a result, certain cultures and/or norms develop.

Cultures consist of shared values, practices and norms (Helmreich, Wilhelm, Klinect, & Merritt, 2001). Norms relate to those standard behaviours that are practiced and accepted in groups or cultures (Prapavessis & Carron, 1997) and provide insight concerning acceptable behaviour. Individuals who understand and accept these norms are more likely to become affiliated with the culture and/or group, than those who do not (Prapavessis & Carron, 1997).
Both cultures and norms appear to develop as a result of two key factors. Firstly, individuals within a particular cohort must be receptive to others’ influence. Secondly, a small shift in behaviour can be amplified or multiplied through the interaction with others, ultimately resulting in an altered social environment or a modified culture (Zaidel, 1992). Social groups or cultures quickly develop certain characteristics where opinions, views and practices are formed (Helmreich, in press). In turn, these opinions, views and practices help strengthen the alliance between members and provide a certain sense of belongingness or affiliation (Hogg & Abrams, 1998).

Groups may vary in many respects, including the duration for which they exist, dress sense, language spoken, values, and the places that they inhabit. Further, the group to which people belong has a significant influence over their life experiences (Guerin, 2001; Hogg & Abrams, 1998). This is said to be reflected in a ‘collective consciousness’ which is presumed to act as a moral constraint upon individuals’ behaviour (Durkheim, 2003).

If the desire is to alter a group’s behaviour, it may be possible to target a small number of individuals with the expectation that they will share their experiences with others in the larger group, thereby creating a gradual shift in the group’s behaviour. This is often the aim with traffic safety campaigns that target, for example, the use of restraints in motor vehicles (Zaidel, 1992). In an attempt to modify the driving behaviour of a particular cohort of motorists, Zaidel (1992) exposed a small number of motorists to a television advertisement campaign and examined the effect on the larger population. Although the results of the experiment did not yield statistical significance, an analysis of the results in relation to the time taken to achieve a
gradual shift provides a clearer explanation. In particular, a shift in group behaviour may be relative to the size of the group/culture.

Other principles of social science, such as reward, punishment and compliance with leaders or authority figures may have been used to ensure compliance with society’s rules and laws (Lindzey & Aronson, 1968). It is often the case within any given society, that only a small number of individuals will actually be treated by law enforcement agencies or the judicial system. Typically, it is assumed that the knowledge about these select individuals’ experiences will become common knowledge and will propagate to act as a general deterrent for the remainder of the population (Zaidel, 1992). This assumption is also referred to as the ‘carry-over effect’ (Helliar-Symons, 1983).

Evidence to support the ‘carry-over effect’ can be drawn from an experiment with motorists who were perceived to be following too closely to the vehicle in front (Helliar-Symons, 1983). An electronic message was flashed to the motorist that read, “following too closely, move apart”. The experimenter hypothesised that the sign would attract the passing attention of the motorists and that the motorists would increase their separation between the vehicle ahead and also adopt similar behaviour at other locations. It was theorised that greater separation distances would eventually be practiced and a modified driving culture would be established. However, the results revealed that only a small site-specific effect occurred and there was no evidence of subsequent increases in separation distances/times elsewhere (Helliar-Symons, 1983). These results suggest that social or group influences, if not continually reinforced, are likely to be time-limited and may not generalise effectively.
It appears that modifying behaviour, attitudes or beliefs for the benefit of the general good, takes some time (Helliar-Symons, 1983). In contrast, unless intervention occurs for activities that are illegal, a snowball effect will tend to occur quite rapidly. Wright (1981), for example, contends that an increase in illegal parking in an urban setting, if left un-policed could multiply to the point where it would be near impossible to travel down an urban street because the parked cars either side of the road would encroach onto, and block, the main thoroughfare. To bring the level of compliance back to a desired level, a large, non-linear increase in compliance is required for a longer duration than was required for the initial destabilisation. This indicates that a small and relatively short campaign may prove ineffective over the long term, if modifying group behaviour is sought for the benefit or good of society.

In the aviation industry, the behaviour of pilots is observed both intentionally (through Air Traffic Control (ATC)) and vicariously (general observation or aviation interested personnel) on a relatively regular basis. If a pilot’s behaviour is inappropriate (i.e., committing a violation) and his/her actions are being observed, either intentionally and/or vicariously, a potential shift in the general population may result. On the basis of the experience in other domains, such shifts would be expected to have a rapid onset and would require a non-linear increase in compliance to bring the level of compliance back to a desired level.

Helliar-Symons (1983) and Wright (1981) imply that behaviour, which is observed by others, induces a change in the observer’s behaviour. Linzey and Aronson (1985) explain this effect where, through observation, the behaviour of an individual changes due to the impact of social influences. This influence may occur through learning, imitation, compliance with leaders or authority figures, conformity to norms, laws, and regulations, and acceptance of persuasive messages. The
following example highlights the importance of both observation and a shared experience in interpreting a potential ambiguous situation.

Zaidel (1992) describes a hypothetical situation where a motorist is following another vehicle and notices that this vehicle is slowing down. This deceleration of the vehicle, and, depending on the circumstances such as the driver’s experience, the driver’s driving habits, norms, laws and/or regulations that the driver is accustomed to, are open to a number of interpretations. For example, it may be the case that the driver is decelerating to avoid a hole in the road or slowing down through a police radar checkpoint. The information provided by the other driver may be crucial and of high value, so long as both drivers share similar driving experiences. Therefore, through the use of observation, certain cues may, indirectly, inform individuals about appropriate or required behaviour. This form of indirect communication is likely to be an important source of information to direct future behaviour.

Communication has the ability to clarify intent and may explain otherwise confusing behaviour, thereby reducing misinterpretation, frustration, and conflict (Zaidel, 1992). Communication, both direct and indirect, has the potential to influence others behaviour. However, problems may arise when individuals observe (non-verbal communication) particular behaviours (i.e., violations) and interpret these behaviours as the norm (i.e., social influence). This potential influence on one’s behaviour is a powerful medium for learning (Kahneman & Tversky, 1982). The process of social influence involves the behaviour of one person affecting or changing the way that another person behaves, feels or thinks about a particular stimuli (Zimbardo & Leippe, 1991).

There are a number of techniques of social influence (i.e., imitation, modelling, laws, and persuasive messages). Each technique targets the way that
humans think, recall, feel, and formulate decisions (Zimbardo & Leippe, 1991).

Generally, social influence occurs in three different forms: Interpersonal, persuasion and/or mass media. These settings differ in both the level of personalisation and the size of the target audience to whom the influence is directed. Two of these major determinants of successful persuasion or influence are: (1) Establishing some type of similarity between the source of the influence and the audience; and (2) creating a positive association in peoples’ minds (Zimbardo & Leippe, 1991).

An effective example of similarity and positive association relates to smoking campaigns in the United States that specifically targeted African Americans. Over the thirty years preceding 1990s, cancer death rates among African Americans increased by approximately fifty percent (Zimbardo & Leippe, 1991). It was argued that a major contribution to this increase in smoking involved advertising campaigns and billboards that appeared in largely African American communities. The advertising appeared in laundromats, movies, fuel stations, magazines, and on public transportation. In addition, many social and sporting events were underwritten by tobacco companies, along with donations and prizes bearing some affiliation to tobacco companies. In total, the United States Public Health Service estimated that, in 1984, 80 to 90 percent of all advertising in minority communities was for cigarettes.

The success of the marketing campaigns of cigarette companies was due to the fact that they were designed to appeal to the values and beliefs of the African American community. In addition, there were monetary rewards for the community, sporting, and social organisations as a result of cigarette advertising. Both tactics were designed to use and manipulate attitudes and behaviour to effect behavioural change. Moreover, the tobacco companies’ advertising was designed to draw similarities
between the African American community and the people using the products in the advertisements.

Similar strategies are employed within aviation, where the principles of social influence are enlisted for, more often than not the benefit, rather than the detriment of the industry. For example, within the training environment, in both the general and commercial sectors of aviation, younger and less experienced pilots are paired with the more experienced pilots during a course of an operation. This pairing often facilitates the transfer of knowledge, and ultimately improves performance. Clearly, however, the same principle may lead to a potential problem if such role modelling is undertaken when performance involves inappropriate behaviour, poor habits and/or poor practices.

3.2 Imitation of Others

Imitation, or modelling, is defined as following another person’s example without being instructed or forced, and with no direct communication between the source of the example and the imitator (Zaidel, 1992). In addition, the person/s known as the source of the example may be unaware of their position and may become, even unwittingly, a role model. Similar, while role model/s may be unaware of their position, so to, may be the imitator/s. Finally, it is also possible that the imitator/s may be unaware of the exact nature of their behaviour. In contrast to the naïve imitator, imitation may be used deliberately in training, education, propaganda, and marketing to manipulate a situation (Zaidel, 1992). Such purposeful manipulation may result in both positive (increased revenue for tobacco companies) and negative outcomes (increase mortality rates amongst smokers).
Lefkowitz, Blake, and Mouton (1955) examined the notion of imitation with pedestrians crossing at intersections against red lights. Their aim was to investigate the level of compliance. A series of confederates were used to cross intersections against the red light and carried a special red flag to indicate their intention. This was observed by other pedestrians. The results indicated that other pedestrians were more likely to adopt the ‘red flag carrying behaviour’ at intersections if they observed others doing so (Lefkowitz et al., 1955). Similar findings have been reported with other studies examining motorists and their driving habits at pedestrian crossings (Rothe, 1990; Diaz, 2002; Zaidel, 1992).

Zaidel (1992) describes a conversation he had with another colleague who asked naïve drivers to travel behind a confederate where, in half of the cases, the confederate stopped for a pedestrian (also an experimenter) to cross the road at a marked pedestrian crossing. In the other half of the cases, the confederate did not stop at the intersection. The confederate in the leading car then turned into a side street, and at the next block, the naïve drivers were confronted with a similar situation. The results indicated that a higher percentage of drivers who observed the confederate stop for the pedestrian, also stopped for the pedestrian. Thus, the impact of imitation is dependent, in part, upon the imitator’s repertoire of behaviour. This implies that the imitator must have both the ability to perform the particular act, as well as an inclination to do so, and/or no strong objection against the behaviour (Zaidel, 1992; Zimbardo & Leippe, 1991).

The impact of imitation-induced violations within the aviation industry are potentially far more severe than in other industries where the risk of injury is lower. For example, if a pilot observes the actions of another pilot committing a violation, and the action results in a favourable outcome, the observer may perceive the
behaviour as positive and a part of the normal or accepted operating procedures. This 
behaviour may then be adopted by the observing pilot and may soon become a normal 
part of his/her behaviour. Eventually, a snowball effect occurs and the behaviour may 
become prevalent throughout the pilot population (Zaidel, 1992). In order to 
counteract this inappropriate behaviour (violation), an increase in compliant 
behaviour will be required for a longer period than was initially required for 
destabilisation (Wright, 1981).

3.3 Conformity

People appear to be attentive to cues that convey information about social 
norms, and try to comply with the norms that they believe are in force. In fact, some 
individuals may feel distressed if they do not comply with the norms they know are in 
propose that the factors responsible for adherence to social norms (i.e., perceptual, 
emotional, and cognitive) are innate and that at a particular stage in the human 
evolution, compliance to social norms was of benefit to individuals’ survival. In 
addition to the benefits of complying with social norms, norm compliance per se is 
used to control individuals’ attitude/s, thereby increasing their level of 'fitness' 
as relating to features that increases the likelihood of survival, such as appearance and 
positive impressions.

Norm compliance appears to increase when individuals are being observed. If 
non-compliance to social norms is exercised in the presence of witnesses, distress may 
be experienced by the non-complier (Goffman, 1959; Hogg & Abrams, 1998).
Researchers examining norm compliance have established that even with a trivial norm such as holding one's fork with the wrong hand, people feel that they are non-compliant, and experience varying levels of distress (Wenegrat et al., 1996). Wenegrat et al. (1995) conducted a series of experiments with university students who were asked to watch a series of videotapes, where, in one series social norms were violated, and in the other series, they were not. Violations of social norms ranged from scratching one's foot in an interview situation, to sniffing loudly during a recitation. The experiments indicated that compliance to social norms, especially those that are perceived to be salient to the individual, form part of a signalling system that is used to create positive impressions to improve fitness.

Wenegrat et al. (1996) also examined norm violations within a group setting in an attempt to examine whether adherence to social norms is selectively advantageous. It was hypothesised that social norm violations within a group setting would draw attention to group membership, and would be more salient than committing a violation outside a group setting. A total of 247 participants were asked to watch videotapes of models violating norms in a group setting. Participants were then asked to rate the models on dimensions relevant to their fitness. The results indicated that those models who violated group norms recorded significantly lower fitness relevant ratings than those models who did not (Wenegrat et al., 1996). Therefore, it might be concluded that conformity to social norms is stronger in both a group setting and when being observed. In addition, conformity may have a strong evolutionary underpinning, where conforming to social norms increases one’s fitness for survival.

Within any chosen field, discipline, profession or situation where one has to interact with others in a social context, there are both formal and informal rules. Compliance and adaptation to these rules is often in the best interest of the individual
and potentially increases the likelihood of survivability or fitness. Furthermore, if it is
the desire of an individual to belong or be affiliated with a particular social group,
they may choose to adopt certain characteristics of that group that they feel are salient
to facilitate inclusion (Hogg & Abrams, 1998).

Conformity to rules and norms are equally applicable within the aviation
industry. Pilots, for example, train and operate in multi-crew environments, where
direct observation and interaction are common occurrences. Under certain situations,
pilots may feel an increased pressure to conform, due to the fact that they could also
be under the observation of additional personnel such as Air Traffic Control (ATC).
In a positive situation, it may be the case that this conformity reduces the likelihood of
inappropriate or unacceptable behaviour (i.e., a breach of a rule or violation).
However, it may also be the case that this conformity increases the likelihood of
inappropriate behaviour, given that the behaviour of the group is inappropriate or
unacceptable.

3.4 Categorisation

When individuals view and then assign certain characteristics to people and
groups, they do so in a subjective, rather than an objective manner (Hogg & Abrams,
1998). They also tend to categorise others based on the perceived similarities and
differences when compared to themselves (Hogg & Abrams, 1998). Moreover, people
view others as members of the same category (ingroup member) or members of a
different category (outgroup members) (Aronson, 1999). Just as people categorise
others, they also tend to categorise themselves. This self-categorisation process
involves focusing on characteristics that are similar to other ingroup members, and
when dealing with members from an outgroup, focusing on the characteristics that are
different. Therefore, self-categorisation appears to be based on group characteristics,
and not on the characteristics of the individuals. Self-categorisation appears to
accomplish two things. Firstly, it enables one to view oneself as identical or similar to
other group members, producing a social identity. Secondly, it generates category-
congruent behaviour that is stereotypical to the social group (Hogg & Abrams, 1998).

When assessing or making a social ingroup/outgroup comparison, there is a
tendency to maximise ingroup distinctions. However, the accentuation of ingroup
characteristics is guided by the self-evaluative motivational component, which is
biased to reflect favourably on the ingroup. This tends to bias members to accomplish
a positive self-evaluation that provides an inflated sense of well-being, self-worth and
self-esteem (Hoggs & Abrams, 1988; Aronson, 1999). In an attempt to explore the
relationship between ingroup/outgroups, Park and Rothbart (1982) asked members of
three different university sororities to indicate how similar each member was to one
another. The results indicated that women perceived members in other sororities as
more similar than they perceived in their own. The results were explained in relation
to the ways in which ingroup members perceived themselves. In other words, ingroup
members perceived themselves as individuals, with unique personalities and lifestyles
distinctively different from how they perceived outgroup members (Park & Rothbart,
1982).

Support for the work of Park and Rothbart, (1982) can be drawn from Tajfel
(1981) who began by dividing complete strangers into different groups using trivial,
inconsequential methods. For example, one group was divided by tossing a coin,
while another group was divided on the participant’s opinion of an artist with whom
they were unfamiliar. Participants soon began to behave as if they had been long-life
friends in a way consistent with other group members with whom they were randomly assigned. They also openly indicated that they liked those who shared their label. In addition, they indicated that others who shared their label had a more pleasant personality and produced a better ‘output’ than those who where assigned to the other random label. Finally, participants allocated more money to group members who were randomly assigned to their group (Tajfel, 1981).

It might be concluded from the outcomes of both Park and Rothbart (1982) and Tajfel (1981) that the strength of ‘belonging’ or wanting to be affiliated with a particular group should not be underestimated when trying to comprehend individuals' behaviour. Such motivational factors may be the driving force behind certain behaviours being observed. Furthermore, these motivational factors may not be so obvious to the researcher or the individual attempting to analyse or seek explanation for this behaviour. These motivational factors have the potential to affect an individual’s attitude, behaviour and performance in a given situation (Hogg & Abrams, 1998). Analysing and seeking explanations for a pilot's performance in a given situation without considering the motivational factors in play, may miss an important learning opportunity.

Certain pilots, who may be judged as violators by others, may not actually perceive themselves as violators. This is a reflection of a categorisation process in which they categorise themselves based on the characteristics of the group which they perceive as similar, rather than focusing on the characteristics that are different. This categorisation process may lead to a positive self-evaluation and an inflated self-worth, but serves very little purpose in mitigating future tendencies towards violations. Such categorisation may affect the overall success of particular training programmes, which are designed to target these specific problems and individuals.
Training programmes with this intention in mind need to anticipate and respond to these considerations.

3.5 *Summary*

In summary, this chapter discussed how cultures evolve or develop with respect to human performance. Playing a pivotal role in the evolution of a culture is communication, both physical and verbal. Through communication, people influence or impact others’ behaviour through a method known as imitation or modelling. Often displaying a particular attitude or behaviour is sufficient enough to evoke conformity. Although, in terms of aviation, there appears to be no empirical evidence to suggest that one particular social process (i.e., modelling/imitation or categorisation) dominates the aviation culture. Nonetheless, if training programmes that are designed to reduce the number of violations committed within the aviation industry are to be successful, they need to acknowledge and address the potential impact these social processes may have.

Specifically, the central aim of this thesis was to improve pilots' risk management behaviour. As identified in Chapter 1, certain pilots appear more willing to commit a violation if it proves to be a more effective and efficient means of working. While there appears to be no empirical evidence to suggest that the occurrence of violations are propagated through one particular social process in the aviation industry, training programmes nonetheless need to consider the role in which these social processes impact on their success.
The aim of this chapter was to discuss the cognitive process involved in behavioural modification. Wiggins (1999) suggests that, in order to improve cognitive skills, such as decision-making, training programmes need to ensure that they consider the type of reasoning that the user is expected to engage during the course of skill acquisition. In general, there are two different perspectives regarding human reasoning; namely Case-Based Reasoning and Production-Based Reasoning. The following chapter considers both perspectives in terms of the implications for pilots’ decision-making and risk management behaviour.

### 4.1 Human Reasoning

Case-Based Reasoning (CBR) is based upon the notion that an individual, who experiences repeated exposure to a particular operational environment, will acquire and retain information that is specific to that domain in the form of cases or examples (Kirsner et al., 1997). The formation of these cases or examples may evolve through one of two processes: An individual may apply and modify a problem-solving strategy based on previously encountered problems, or an individual may categorically match the current situation with ones that they have previously experienced and solve it along similar lines (Leake, 1996). In both of these cases, the individual assesses the current situation, retrieves previous cases or examples, and assesses the similarity of both cases (Wiggins, 1999).

According to the principles of case-based reasoning, the emphasis during training is on building upon the existing knowledge of the learner. Ultimately, the aim is to build a repertoire of case examples for the learner to compare and contrast.
situations and identify slight differences that may exist between the examples. However, this process is highly contingent on the learner’s ability to effectively and efficiently classify individual case examples that will permit generalisation, between otherwise independent case examples (Schank, 1996). Therefore, the goal of a facilitator employing a CBR approach is to facilitate in the acquisition of the skills necessary to classify examples according to their similarities, in terms of outcome, goals, environment characteristics, and/or type of planning involved (Wiggins, 1999).

The second perspective concerning human reasoning is referred to as Production-Based Reasoning (PBR). Production-based reasoning involves the storage of information in an individual’s memory that is largely based on rules (Wiggins & O’Hare, 1993). The basis of production-based reasoning is that individuals develop an association between declarative and procedural knowledge (Wiggins, 1999). The former is based on factual information such as the knowledge of the maximum airspeed limitation of the aircraft, while the latter involves the application of declarative knowledge such as manipulating the aircraft speed to conform to its limitations (Anderson, 1993). This relationship is expressed as an IF-THEN rule/production where, initially, the declarative knowledge is sought, followed by the application of a strategy (procedural knowledge) (Wiggins, 1999). Generally, initial performance under PBR is typically slow and error prone (Ackerman, 1990). Once an individual is generally proficient with the rule/s, their performance tends to increase.

Production-based reasoning seeks to educate individuals concerning factual information (Ackerman, 1990) and the application of rules within the operational environment. Rules appear to be the most common explicit knowledge representation of a formalised system (Schmidt, Montani, Bellazzi, Portinal, & Gierl, 2001). The application of a rule or Rule-Based Reasoning (RBR) will generally occur exclusively
when sufficient knowledge is present and/or a typical problem exists. Typically, RBR and CBR are applied in situations that are mutually exclusive. Often, if it is perceived that sufficient knowledge exists, RBR will be applied first and if this fails to provide a sufficient or desired solution, CBR will be employed (Schmidt et al., 2001). Therefore, the successful application of RBR hinges on a number of factors including a typical and/or predictable situation, a structured problem, domain knowledge, and a prescribed solution (Haque, Belecheanu, Barson, & Pawar, 2000; Kirsner et al., 1997; Shin & Han, 1999; Baker, Sirca, & Schkade, 1998).

An inherent problem or limitation associated with rule-based reasoning is that individuals are forced to acquire domain knowledge by reference to rules and general principles (Kirsner et al., 1997). Rules and general principles appear to lack a certain level of richness in terms of the information. Often, it is the richness that facilitates higher cognitive learning. Furthermore, if mastery or expertise are desired, this would not be possible with rules and general principles alone (Kirsner et al., 1997). Ideally, to facilitate experience and, ultimately, expertise, individuals should be exposed to case-related examples that are rich in information (Shin & Han, 1999) rather than to rules and general principles which appear to lack the same level of richness (Kirsner et al., 1997).

Although both the case-based and production-based models can be used to enhance the development of cognitive skills, the information processing strategies used in case-based reasoning are quite different to those employed in production-based reasoning. While case-based reasoning attempts to create or build upon existing cases and examples, production-based reasoning forms the basis of knowledge, as it seeks to educate individuals concerning factual information and the application of rules within the operational environment. Therefore within aviation, where
qualifications such as licensing depict knowledge thresholds, and where real-world problems are generally unique and ill-structured, a case-based approach which is rich in information may potentially have more benefit.

4.2 Application of Case-Based Training

Case-Based Training (CBT) is founded within Case-Based Reasoning (CBR), a theoretical perspective that has been used to explain the process by which information pertaining to a task is acquired and retained in long-term memory (Haque et al., 2000). CBR is based on the premise that a potential solution to a specific problem may be found by searching a mental database of previous cases with similar problems, and adapting one of the solutions to the current situation (Bosch, Gibson, Kellner, & Allen, 1997). However, it has also been used to explain the strategies that operators employ to direct their behaviour, especially in situations of uncertainty or when confronted with ill-structured problems (Gupta & Montazemi, 1997). For example, Klein (1993) conducted a study concerning the fire-fighting techniques of experienced fire-ground commanders and found that they would draw on previous exemplars or cases that they had retained in long-term memory. These cases would be applied and modified, where necessary, to resolve a situation.

To investigate the role of CBT as a training tool, Kirsner et al. (1997) examined fourth year medical students using a case-based learning programme that was designed to facilitate the acquisition of diagnostic skills in relation to patients who had suffered a stroke. Twenty students were given access to a variety of learning tools such as models, results, analogies, and vignettes. The information contained in the vignettes related to the specific knowledge-elicitation sessions that occurred
between a speech pathologist and a patient. The objective of each vignette was to identify critical behavioural cues that could be identified by the students and, ultimately, facilitate the diagnostic process (Kirsner et al., 1997). Students were given an evaluation form to complete at the conclusion of the training session, and commented favourably about the training programme. Students specifically highlighted the creative use of resources to help facilitate the formation of case examples for future use. Although students responded favourably to the training programme, there appeared to be no formal assessment concerning the extent to which case examples were retained and the subsequent use of the case example to formulate decisions. Nonetheless, it appears that successful case-based reasoning hinges on the individual’s ability to develop a repertoire of related cases that will, ultimately, facilitate diagnoses and assist the location of the most appropriate solution for a situation.

A fundamental principle underpinning CBR is that repeated interaction with the operational environment or particular cases will result in the acquisition and retention of cases and/or exemplars that can be used to assist in problem solving exercises in the future (Kirsner et al., 1997). The formation of these cases or examples may evolve through a variety of processes including physical experience, reading, and/or observing a particular situation. Once an individual has retained certain cases or examples, he/she may apply and/or modify a problem-solving strategy based on the principles used in one of these cases. Alternatively, individuals may categorically match the current situation with one that they may have read or heard about, and solve it along similar lines (Shin & Han, 1999). In principle, CBR is based on the proposition that cases and/or examples should assist with the accurate and expedient formalisation of a response. The following example highlights an effective system
design using cases that were created to enhance the decisions made by farmers in managing various soil management situations.

Landcare Research in New Zealand developed a decision-making support system that involved farmers and scientists creating a computerised database to store all of the problems that they had encountered on the land and the successful solutions that they had applied (Bosch et al., 1997). This database could be likened to an experienced individual’s memory store. When a farmer encounters a particular problem, the farmers or scientists can draw on these cases in a way similar to the process that an expert follows to develop a solution. In doing so, the farmers are able to minimise potential losses, since, before venturing into an unknown area, the farmer is able to check the database for similar case examples and be guided by the example. While the effectiveness of this support system has not been empirically evaluated, there is a general consensus amongst the farmers and environmentalists that this system has proven most valuable for the agricultural industry in New Zealand (Bosch et al., 1997).

The literature pertaining to CBR suggests that effective decision-makers will formulate their decisions based on their own experiences during the reasoning process (Kolodner, 1997). A problem that becomes evident with this process is when a novice or an inexperienced individual attempts to use CBR to solve a situation based on limited experience. Moreover, there appears to be a direct relationship between experience and effective decision-making (Ram, 1993; Bareiss, & King, 1989). In an attempt to overcome this problem, educators attempt to assist with the development of experience through education. Experience may be gained ‘first hand’ or, alternatively, through ‘case examples’. Current research suggests that knowledge gained from activities that are realistic, meaningful and motivating are more likely to be recalled
than the same knowledge acquired through memorisation or prescriptive activities (Brown, 1988).

Material that is learnt more thoroughly appears to be related to the type of motivation that an individual possesses (Hatano & Inagaki, 1991). Motivation may be either intrinsic or extrinsic. The former is where an individual may perform a task based on the level of satisfaction derived from the process of engaging in the task (Hassandra, Goudas, & Chroni, 2003). Furthermore, intrinsically motivated behaviour is directly associated with psychological well-being, interest, the enjoyment of individuals (Ryan & Deci, 2000a), and a more detailed knowledge of information acquired (Brown, 1998). Extrinsic motivation, on the other hand, is related to external forces (Ryan & Deci, 2000b). For example, Deci, Ryan and Williams (1996) describe a hypothetical situation where a tenth grade girl is eager to become a veterinarian. She spends her whole weekend studying for a biology exam. In contrast, her friend lacks the same level of motivation and sits in her room in front of her biology books because she feels pressured by her parents. Unlike the first girl who is eager to do well to reach a goal, the second girl feels that her parents are forcing her to study. Therefore, she is motivated by external forces, and lacks the intrinsic drive or motivation to perform well.

Effective learning is said to occur when an individual has a reason for learning. This becomes apparent when individuals want to establish psychological ‘ownership’ of the information. In other words, effective learning is evident when individuals have a self-driven 'thirst' for the knowledge (Goodnow, 1988). Hatano and Inagaki (1991) attempted to explore different approaches to skill acquisition in an experiment involving comprehension, where individuals were asked to learn four steps of a recipe for making Sashimi. The results indicated that some individuals
would develop an understanding without really comprehending what they were doing. Other individuals appeared to go beyond simply understanding the recipe and applied their knowledge in a broad and flexible manner. These individuals also appeared to experiment with the recipe by varying parameters such as the cooking time and procedure. These individuals had to spend much more time, effort, and cost to gain a more comprehensive understanding of the recipe. Hatano and Inagaki (1991) argue that these individuals needed to be more motivated to spend more time and effort in gaining a more thorough understanding of the material.

Individuals appear to work best, or are more motivated to learn, when they are working within a personal domain of interest (Hatano & Inagaki, 1991). Once within this domain, there is a belief that obtaining a deep and comprehensive understanding is both valuable and worthwhile for individual gain (Brown, 1988). Problems appear to arise when individuals are forced to work outside their domain of interest, and, as a result, are unlikely to recognise the limitations of their comprehension and adopt appropriate measures to counteract these deficiencies (Hatano & Inagaki, 1991). Nonetheless, there are certain learning environments that can counteract some of these effects, thereby fostering and encouraging deeper levels of understanding.

One method of fostering a deeper understanding of knowledge is by engaging individuals in group problem-solving activities. Group problem-solving requires individuals to explain, elaborate and defend their position to others. This burden of explanation often forces individuals to evaluate, integrate and elaborate knowledge in new ways (Brown, 1988). However, the success of this approach is dependent on self-image and identification with other group members.

Individuals may also be asked to convince or teach other students to enhance their own level of understanding. This method is designed to force students to
evaluate, integrate and elaborate knowledge, to gain a deeper and more thorough understanding of the material (Hatano & Inagaki, 1991). While both motivation and the acquisition of knowledge are important in the learning process, there are other areas that are equally as important, such as the way in which the material is encoded in memory.

Irrespective of the way in which individuals acquire information, the process undertaken to encode the information remains the same. According to Logan (1988), information processing is performed systematically, where only the stimulus appears to change from situation to situation. Early models of information processing suggest a four-stage process (Broadbent, 1958). The first stage occurs when the stimuli are initially detected. This is followed by the recognition or comprehension of the stimuli. The stimuli or information are then processed, where a decision is formulated, and is finally acted upon (Wickens & Flach, 1998).

While the processing of information remains the same, Hammond (1989) contends that it is impossible to code one’s experience in a way that will guarantee retrieval at a later date. However, it may be possible to facilitate the recall of experiences based on the encoding process (Kolodner, 1997). According to Kolodner, highlighting or emphasising information that is perceived as important during exposure increases the likelihood that the information will be encoded using the highlighted or emphasised material as a reference. An inherent problem faced by novices who attempt to learn new information about novel situations is that they often encode their experiences inappropriately, so that they do not facilitate the appropriate retrieval in due course (Ross, 1987; 1989).
4.2.1 Process of Case-Based Reasoning

When individuals are confronted with new and novel situations that require a response or decision, they first label the situation and then conduct a search of memory for information based on the search label (Kolodner, 1997). The level of difficulty associated with this process is based purely on the description or the label attributed to the situation. If a new situation is experienced and the label assigned differs from a previous label that was used to describe a similar event or situation, then the success of retrieving those past events is greatly reduced. If a suitable match is not located, one generally re-interprets or re-represents the situation to find a match. Once a suitable case is located or retrieved, it may then be used or applied (Haque et al., 2000).

The application of a suitable case may take various forms. For example, a previous case may be directly applied in an attempt to resolve current problems. Alternatively, previous cases may be dissected and only the portions that are deemed applicable may be applied (Kolodner, 1997). Once the application of the case has been determined, the next step is based on inference, which is intended to lead to a result or solution. Inferences play a crucial role in the formalisation of a decision, as they are based on assumptions, where a projection or calculated guess is inferred, to achieve a desired outcome (Ram, 1993).

If a result or outcome that was formulated is different to that was expected, learning may occur due to the need to explain the difference (Kolodner, 1997). The explanation may then lead to the formation of new cases, or knowledge that is then labelled and stored in memory (Haque et al., 2000; Kolodner, 1997). This particular step, where the individual formulates a new case or knowledge, has important
implications for the decision-maker/problem solver in the process of CBR. This stage provides the opportunity for the decision-maker to add an additional case to their repertoire of cases. More importantly, the cases that are derived or formulated by the individual will have a greater level of salience, due to the effort expended in deriving the case (Goodnow, 1988).

Case examples that are experienced first hand or through other means, may reflect both positive and negative experiences. For example, Kolodner (1997) describes an example where an architect is designing an office building with a naturally lit atrium in the centre, surrounded by a circular row of offices. The architect has a design plan where the building is energy friendly, incorporating minimal energy consumption by maximising the use of natural light. The architect recalls the design of an office building from memory where glass was used on the exterior walls to illuminate the offices with as much sunlight as possible. A second case is recalled where a court house also used glass to maximise the use of light, but the court house was in a busy part of town and a great deal of privacy was lost. Both cases are used to negotiate a solution within the existing design. The architect decides to use glass, although instead of plate glass, a translucent glass brick is chosen which allows for a compromise between maximum light and privacy (Kolodner, 1997). This example illustrates that case examples may be characterised by both positive and negative learning experiences.

For examples to be used as case examples, it is important that they include three specific pieces of information: A sought-after goal (i.e., designing a building that is energy efficient while utilising natural light); a solution or method of achieving the goal (i.e., using glass); and an outcome or result (i.e., specifically using translucent glass bricks) (Kolodner, 1997). Case examples that record explanations relating to the
success or failure of the experience assist the decision-maker to discern whether strategies that were used previously should be applied or discarded in relation to further use.

While case-based reasoning appears to provide a valid and supporting account for human reasoning, there appears to be limited literature discussing those situations where an individual is unable to recall or access memory/ knowledge pertaining to a case example. Case-based reasoning is based on the premise that an individual will draw on a case example in memory to help solve a current problem. If an individual is unable to recall a case example for various reasons, they will systematically proceed to a different example that they perceive as most similar (Kolodner, 1997). The fact that cases are forgotten or are, for various reasons, not recalled, suggests that contingencies need to be put in place to minimise the potential negative impact of the failure to recall information. While theorists pertaining to case-based reasoning do not appear to directly address those situations where this occurs, an examination of the literature that is closely linked to case-based reasoning suggests that there are various methods that can be undertaken to minimise or reduce the potential impact of the failure to recall case examples. For example, there is evidence to suggest that repeated exposure increases memory of cases (Kirsner et al., 1997). In addition, learning or experiencing the material first hand (Brown, 1988) or more thoroughly (Hatano & Inagaki, 1991) also appears to facilitate the retention of information. Goodnow (1988) suggests that taking 'ownership' or having a reason to learn, can increase the salience of the information acquired and the likelihood of recall.

Case-based reasoning, as a theoretical model, is able to explain the role of encoding, retrieval and adaptation in the reasoning process (Kolodner, 1997). On the other hand, Case-Based Training (CBT), which incorporates the application of CBR,
has experienced only limited success (Kirsner et al., 1997). CBT focuses on presenting individuals with cases to comprehend, and that are then applied in a situation similar in nature to the case examples. The underlying assumption is that individuals learn from the case examples and modify their behaviour or decision when confronted with a similar situation based on the information obtained from the case example.

The utility of case-based reasoning was tested by Molesworth (2001) using a low-level flying exercise as context for knowledge acquisition in pilots. The participants were presented with three similar cases that involved examples where the pilots had descended beneath the minimum safe altitude of 500 feet and had subsequently crashed. The recurring theme amongst the three cases was the fact that the pilots decided to descend beneath the minimum safe altitude and that this resulted in a fatal accident. It was hypothesised that exposure to the three cases would result in less inclination to descend below 500 feet during a subsequent, simulated low-level decision-making scenario.

The results indicated that the cases presented had little or no impact on subsequent pilot performance during the simulated exercise. The majority of the participants admitted to actively descending beneath the minimum safe altitude, despite being able to recall the case examples. The results of this study have raised important questions relating to CBT. In particular, it appears that successful CBT may be dependent not only on the similarities between the case example and the situation, but potentially on other factors such as the specific content of the cases, the medium used to present the case examples, training, individual differences, and the salience of cases. Therefore, there appear to be a number of issues including case similarity, artificiality, transfer of learning, and the salience of the information that need to be
considered in order to provide a valid assessment of the role of case-based training as a potential training tool in the aviation environment.

4.2.2 Case Similarity

Case retrieval is a fundamental step in the process of CBR. The cases that are retrieved by the decision-maker and that are chosen for application and/or adoption are selected on the basis of similarity (Liao, Zhang, & Mount, 1998). Liao et al. (1998) contend that case similarity is determined by the decision-maker and generally relates to the resemblance between differing cases. For example, a pilot flying a Piper Warrior PA28, in deciding whether to engage in a low-flying exercise, will search for case examples relating to low-flying, rather than case examples relating to weather. During this selection process, humans appear to non-consciously assess the resemblance between case examples (Kolodner, 1997).

While there is limited research concerning the cognitive strategies involved in case selection, existing perspectives liken the process to the strategies involved in compiling electronic databases or catalogues. For example, Liao et al. (1998) propose that there are two specific case retrieval approaches, the first of which is the ‘distance’ or ‘computational approach’. This approach is based on the notion that the similarity between cases is defined by the number of ‘features’ that they have in common.

In Molesworth (2001), pilots were exposed to three cases where an accident occurred that involved low-level flying. According to the computational approach of case retrieval, the case accident examples could be summarised in relation to their features, such as the minimum altitude flown, the aircraft type, the meteorological conditions, and/or the pilots’ behaviour prior to the accident. Such cases are presumed
to be decomposed on the basis of certain features, and are classified according to these features (Liao et al., 1998).

The second approach to case retrieval is referred to as ‘indexing’ or the ‘representational approach’. This approach addresses the cases at a more abstract level. For example, the case examples presented in Molesworth (2001) might be represented as examples of violations according to the indexing or representational approach. Once the cases have been indexed or represented, each case can be compared purely on the basis of the underlying structure (Liao et al., 1998). Once each case is assessed, the cases that are considered most applicable will be retrieved and adopted. Those cases that are considered unsuitable are said to be stored for future comparison, although the location of these cases remains unclear. Nonetheless, without the process of an effective similarity measure, a CBT system is redundant.

Liao et al. (1988) quantify the process of case similarity using either a weighted normalised Euclidian distance or a Hamming distance formula for the similarity measure. Both formulas attempt to calculate mathematically, the similarity between two case examples (case X and case Y) by calculating the distance separating each case, based on the weighted importance of their attributes, as determined by the decision-maker. An alternative similarity measure calculates the common difference between the values attributed to cases that are deemed similar and those cases that are not (Tversky, 1977). It is not the intention of this thesis to examine each mathematical model relating to similarity measures, nor is it to subscribe to any preferred formula. Rather, it is designed to examine the utility of various training programmes, employing the key principles of a case-based approach (i.e., using case examples) to improve pilots’ risk management behaviour.
4.3 Artificiality and Transfer of Training

The simulated exercise presented by Molesworth (2001) was specifically constructed for the study and, therefore, did not reflect any actual location. The fact that participants flew a simulated exercise in an artificial location may have resulted in a failure to develop any conceptual ties between the simulated exercise and the pilots’ actual flying experience. For example, Gick and Holyoak (1987) suggest that success in the transfer of training is dependent upon both the perceived and actual similarities between training and the performance domain. Moreover, participants must perceive a similarity between the cases that they observed and their required performance (Woods, 1988; Rockwell & McCoy, 1988).

Further evidence of the significance of transfer in training during the training process can be drawn from Kraiger, Salas, and Cannon-Bowers (1995) who conducted an experiment into the transfer of training in computer programming. Specifically, they hypothesised that there must be some similarity between the training and the performance required to achieve a level of transfer. They evaluated the pre-test/post-test difference and the relationship between training and performance on a computer programming task after a 12 week period. There were a total of 11 participants and the training covered five specific domains relating to computer programming.

The results indicated that 10 of the 11 participants performed better post-test than pre-test. These results were interpreted as evidence to suggest that the participants were able to organise the information taught in a manner that is consistent with their more experienced counterparts. However, there was no transfer of training evident. Kraiger et al. (1995) explained these findings on the basis that the participants had not developed an understanding of the function of the particular
computer programme. While the training appeared to concentrate on the development of the computer programme, it did not provide an understanding of the specific functions and performance of the programme. This evidence suggests that successful transfer of training is dependent upon both the perception of, and the actual similarities with, the performance domain (Gick & Holyoak, 1987).

4.4 Transfer of Learning

Transfer of learning involves the application of previously learnt skills or knowledge to a new task (Schmidt & Lee, 1999). The result may be either positive or negative, where performance on a task may either improve or deteriorate as a result of practice on another task. For example, Weigelt, Williams, Wingrove, and Scott (2000) examined the degree of transfer in relation to ball-handling skills of male football (soccer) players. Twenty intermediate football players participated in the study where they were initially assessed on their ball control skills during an exercise that required them to control an approaching ball in a restricted area. The participants were divided into two groups, an experimental and a control group that were equally matched in terms of their skills. The experimental group was asked to practice juggling a football using only their feet, for ten minutes a day over a four week period, while the control group did not undertake any specific practice on the juggling task. The results indicated that a positive transfer of learning occurred from juggling practice with the feet, to juggling practice with knees and football control skills in a restricted area (Weigelt et al., 2000).

A common generalisation is that the higher the degree of similarity between tasks, the greater the positive transfer between skills or performance (Weigelt et al.,
2000). More specifically, positive transfer is said to be evident if the common elements between the tasks are identical (Schmidt & Lee, 1999). However, Sullivan (1964) suggests that the degree of transfer is a function of general intellectual ability, in which high-ability learners will show a proportionately greater distant transfer than low-ability learners. An inherent problem with this approach is that unless an intelligence test is administered prior to task transfer training, the degree of similarity between the tasks in question needs to be practically identical to facilitate even the smallest transfer of information amongst the majority of the population (Gray & Orasanu, 1987).

Patel and Cranton (1983) examined transfer of learning among three clinical disciplines; medicine, paediatrics and surgery; in which medical students were examined prior to and after each clinical rotation. The results indicated that, although similar factual knowledge and problem solving skills were involved in each disciplines, very little transfer was evident from one discipline to another. This contrasts with the results obtained by Weigelt et al. (2000) where a positive transfer of learning was associated with football skills. The findings from both studies appear to support the notion that, for effective positive transfer of learning to occur, both tasks need to have elements that are identical in nature.

The similarities between the cognitive elements of different tasks are not as clear and distinctive as physical elements (Gray & Orasanu, 1987). Different individuals may interpret the cognitive elements that constitute a certain task, differently. For example, two individuals viewing the same training video may be attentive throughout the video, but may walk away with two different messages. Specifically, a video recording that highlights the consequences of failing to lower the undercarriage on approach to land may be interpreted by one individual as
emphasising the need to perform stringent and uninterrupted downwind checks. Alternatively, it may be interpreted as a guide to making effective landings having failed to lower the undercarriage.

Unlike the transfer of learning of motor skills from one task to another, cognitive skills transferred through learning appear to require more attention and direction on the part of both the educator and the trainer. For example, the process of learning a particular motor skill is generally thought to occur through the repetition/practice of the skill (Weigelt et al., 2000). Therefore, the skill/s that are required to be learnt are in view. The effectiveness of the transfer of skills in these situations is dependent upon the physical properties of the skill and not necessarily on an abstract link between tasks. By contrast, the development of cognitive skills may require a level of priming to facilitate effective transfer.

The effectiveness of transfer of learning is generally considered to be based on the number of common elements between the tasks (Gray & Orasanu, 1987). Commonly, the failure to establish a transfer of learning is attributed to the nature of a task, and the unlikelihood that it will be generalised to a new situation. One of the core elements associated with the effective transfer of learning of a cognitive task is that the individual needs to be sufficiently immersed in the task (Lyons, Miller, & Milton, 1998). Brown, Collins, and Duguid (1989) suggest that by sufficiently immersing individuals in a task, meaningful learning can be achieved. Meaningful learning can only occur if the learning is conducted in the social and physical context in which it will be used. In other words, the transfer of learning is not guaranteed on the basis simply that the knowledge presented in ‘A’, is as it is required to be performed in ‘B’ (Gray & Orasanu, 1987).
Removing individuals from real-life experiences during training may deprive them of any physical experiences that they can reproduce (Hokanson & Hooper, 2000). For example, an inherent problem associated with CBT as a training tool is that the training often takes place outside the social and physical context of the operational environment. Therefore, one of the few measures that a trainer has to ensure effective learning is to replicate, as closely as possible, the real-life situation.

The replication of the real-life situation needs to be sufficient to immerse individuals both physically and mentally to increase the likelihood of effective learning and facilitate the transfer of knowledge (Gray & Orasanu, 1987; Hokanson & Hooper, 2000; Lyons et al., 1998). This notion, where individuals are both physically and mentally immersed in the task, is referred to as ‘situation cognition’. Situation cognition involves contextualised learning, where learning, generalisation and/or transfer is enhanced when the exercise condition involves tasks that are meaningful and performed routinely within the culture (Reiguluth & Schwartz, 1989).

In an attempt to increase the level of perceived realism in the present series of studies and to facilitate the transfer of learning of the simulated exercises, it is expected that a simulated exercise will need to reflect an actual flight as closely as possible. In addition, the design will need to reflect closely, the planning of an actual flight, while an actual geographic location should be used that is relatively familiar to the participant. By incorporating these features, the participants should be sufficiently immersed within the task and conduct themselves in a manner consistent with the behaviour that would occur within the operational environment.
4.5 Case Salience

According to Wickens and Holland (2000), for a case to be committed to memory, it must elicit a particular response that is perceived as significant by the individual. In other words, individuals must be sufficiently immersed, motivated or actually experiencing the situation before they begin to process and store the information in memory. The immediate implication of this principle in relation to case-based training, is that for effective transfer of learning to occur, the individual must perceive the situation as significant before information is able to be stored in memory and, therefore, can be used at a later date.

Kolodner (1997) argues that knowledge acquired through activities that are motivating and realistic appears to be learnt more thoroughly in comparison to the knowledge acquired through memorisation, prescriptive activities or word problems. Moreover, from a knowledge acquisition perspective, it is important for the trainees to physically experience or physically work on projects that they are interested in. Really effective learning is said to come about when students want to establish ownership of knowledge (Goodnow, 1988). This appears to be more evident when they operate within a personal domain of interest (Hatano & Inagaki, 1991).

Case-based reasoning is based upon the premise that the presentation of cases to individuals should be sufficiently salient to develop a memory trace or association (Kolodner, 1997). Moreover, knowledge will be more accessible, flexible and accurate if the learner experiences the situation ‘first hand’ (Kolodner, 1997). Support for this proposition can be drawn from research relating to teaching and learning that compares the effects of technology to the content of the information learnt. Specifically, irrespective of the medium in which the material is delivered, i.e.,
classrooms, radio, television, online and/or correspondence, there appears to be no significant difference in the amount or the quality of the information acquired (Howell, 2001; Russell, 1999).

Clarke (1983) describes different media as merely vehicles that deliver the instruction, but do not affect student’s achievement. They can be likened to a truck that delivers groceries. The type of truck in which the groceries are delivered has no influence on the nutritional value of the food. In relation to education, if the teachers’ aims are to increase the level of learning, they have to think outside the paradigm of the lecture (Howell, 2001). In doing so, teachers have to encourage or creatively plan to involve their students in the task. Moreover, the educators or trainers have to encourage the student to ‘perform’ or ‘do’ the task (Clarke, 1983; Kolodner, 1997). Therefore, it might be concluded that individuals actually need to experience a case, before case examples can be used as the basis for the modification of human performance. This should be even more evident in the case of attitudes. Attitudes appear to change over time as a result of experience. The actual performance of tasks should enhance experience which, in turn, should accelerate attitude change.

4.6 Information Processing and Automaticity

In order to address any perceived benefits of applying a case-based training programme, a thorough understanding needs to be obtained in relation to the way that individuals process information during this type of training. Broadbent (1958) suggests a four stage sequence in this case. Information that is initially detected is encoded in working memory and transferred to long-term memory where, when it is required, it is drawn upon and transferred back to working memory (Cowan, 1997;
While this process appears to be expansive and, at times, drawn out, it is often performed without any conscious thought. To enable this process to occur rapidly and without any conscious thought, the information that is extracted from long-term memory into working memory and then applied must occur automatically. Logan (1988) refers to this process as ‘automaticity’.

Automaticity is a phenomenon that occurs in ‘everyday’ life. Most people will perform certain actions or procedures with very little conscious thought or awareness (Reigeluth & Schwartz, 1989). For example, most motorists are able to drive from one point to another and hold a conversation with a passenger in the process. The procedure of driving is performed on ‘autopilot’, where very little conscious thought is required (Reason & Myceilska, 1982).

The benefits of automaticity are numerous. Automaticity allows certain activities to be performed quickly and effortlessly, freeing valuable cognitive resources to perform other, non-automated tasks. (Logan, 1988). Automaticity appears to be acquired when stimuli are repeatedly mapped to the same response through practice (Logan, 1988). Bryan and Harter (1899) contend that ‘automaticity’ is an important component in skill acquisition. Skills largely consist of numerous automatic processes and procedures (Chase & Simon, 1973a). For example, an individual who is able to type a relatively high number of words per minute does so through the process of automatic word recognition, which, in turn, translates into keystrokes and expedient typing (Salthouse, 1986).

Automatic processing tends to be rapid, effortless, and autonomous, while freeing limited cognitive resources to deal with other, more demanding tasks (Neely, 1977; Logan 1978; Marcel, 1983). This view of automaticity does not appear to be supported by all researchers, especially in relation to attentional resources. For
example, Hirst, Spelke, Reaves, Caharack, and Neisser (1980) argue that automaticity may free some attentional resources, but that there is limited research to suggest that automaticity is absolutely free of all attentional resources. Nonetheless, the benefits of being able to perform a task automatically with at least a reduction in attentional resources, can only facilitate the processing required to deal with immediate demands.

Logan (1988) avoids the controversy surrounding automaticity and attentional resources by concentrating on the relationship between memory and automaticity. Automatic retrieval from memory is said to occur with experienced individuals. In contrast, a novice will generally retrieve a solution from memory, based on an algorithm sufficient to perform the task (Shin & Han, 1999; Ng 2001; Aha, 1998). As novices gain experience, they learn specific solutions to certain problems, which are then applied when a similar problem is experienced. Individuals can then respond to a problem through the process of an algorithm or directly by applying the solution retrieved from memory. It is at this point that individuals feel that they have gained enough experience to respond to a solution from memory and abandon the algorithm entirely. Logan (1988) proposes that the point where individuals abandon the use of algorithm-based solutions for memory-based solutions is when automaticity occurs.

A simple example that effectively highlights the difference between algorithmic and the automated style of memory retrieval is the process of calculating a mathematical problem. Initially, when learning to calculate the multiplication of five and three (5 x 3), individuals will use one of the following two methods. Firstly, individuals may systematically add three lots of five such as, five plus five equals ten, plus five equals fifteen. In contrast, individuals using automaticity will search and apply their knowledge of the multiplication tables that were learnt previously.
Therefore, they will conclude without any mathematical formula, that five multiplied by three equals fifteen.

From an information processing perspective, Logan’s (1988) theory of automaticity suggests that information, irrespective of the content, will be perceived, encoded and transferred from working memory into long-term memory. This process appears to be dependent upon the individual’s exposure to the stimuli (Pirolli & Anderson, 1985). Moreover, the quality, quantity and semantics of the information attended to are directly related to the individuals’ ability to recall the information (Craik & Tulving, 1975). Therefore, automaticity is directly related to the number of times (quantity) that individuals are exposed to the stimuli. The greater the repeated interaction that the individual has with the stimuli, the more likely it is that the individuals will be able to automatically recall the stimuli. Practice appears to improve the mapping between the task and the information. Hence, increased practice reduces the time involved to recall the information from long-term memory to working memory (Logan, 1988).

If individuals provide quality and quantity attention to the stimuli, where particular focus is placed on the semantic features, rather than the physical features (Craik & Tulving, 1975), then the process of information recall may become less algorithmic and more automatic. Semantic features relate to the significance or the meaning of information, whereas physical features relate to the construct and structure of the information. An important implication that may be evident with this process is the possibility of controlling or manipulating the information to facilitate retrieval.

An important point to note in the memory retrieval process is that the recall of stimuli is automatic. Moreover, all that is required for information to be recalled from memory is attention to particular stimuli (Logan, 1988). This attention is usually
sufficient to cause the retrieval of all information that is associated with the stimuli (Logan, 1988). This theoretical perspective has been labelled Instance Theory. Evidence to support ‘Instance theory’ is derived from the Stroop Effect. The Stroop Effect occurs where different stimuli compete for limited information processing resources. For example, a study that examines the Stroop Effect will use two different stimuli, and record the time required for the participant to respond to the stimuli. A word will be presented in a particular colour, and the meaning of this word will be different to the actual colour in which it is presented. For example, the word blue appearing in a Stroop experiment, would be written in a yellow hue. The participant is required to verbally name the colour of the word, and the time in which the participant takes to name the word is recorded (Stroop, 1935). Participants take considerably longer to read a word (name of a colour) presented in a different colour than to a word (name of colour) in which the colour of the word matches the meaning. Logan (1988) explained the difference in reaction time as a result of the individual’s memory, retrieving all of the relevant information for both the colour of the word and the actual word. Due to the increase in information recalled, individuals would be expected to take longer to process all the retrieved information and conclude with an appropriate response.

In relation to case-based training, where case examples are presented to individuals for their comprehension and application at later dates, it could be argued that particular emphasis needs to be placed on the semantic features of the cases and that the cases should be presented repeatedly to facilitate mapping, and ensure that the likelihood of automating the recall process is maximised. Moreover, case examples should provide information that is clear and concise, and that summarises the
objective of the case in relation to a particular theme, rule or concept, on which the case is based.

4.7 Summary

The preceding chapter discussed two different perspectives regarding human reasoning; namely Case-Based Reasoning and Production-Based Reasoning. In brief, case-based reasoning is based upon the notion that an individual, who experiences repeated exposure to a particular operational environment, will acquire and retain information that is specific to that domain in the form of cases or examples. It is expected that when the same individual is exposed to a problem solving situation, he/she will assess the situation, retrieve previous cases or examples, and draw a conclusion based on the similarities of both cases. In contrast, production-based reasoning forms the basis of knowledge, as it seeks to educate individuals concerning factual information and the application of rules within the operational environment. While both perspectives can be used to enhance the development of cognitive skills, it appears that, within aviation where qualifications such as licensing define knowledge thresholds, and where real-world problems are generally unique and ill-structured, a case-based approach which is rich in information may potentially have more benefit.

In summary, throughout the preceding chapters it has been identified that general aviation pilots continue to be over represented in aircraft accidents in comparison to their commercial counterparts. Of those general aviation aircraft accidents that occur, a significant number have been attributed to poor aeronautical decision-making (O’Hare, Wiggins, Batt, & Morrison, 1994). Previous research suggests that a leading factor that precipitates poor decision-making is an unrealistic
assessment of the risks involved in a particular activity. Current training programmes that are employed to improve pilots’ risk management behaviour do not specifically target risk management as a distinct skill. Rather, it is assumed that risk management skills are acquired through interaction with the environment and through the acquisition of factual information relating to the statistical frequency of accidents and/or incidents. As a result, the success of such training programmes appears to be limited.

Research conducted in both the automotive industry (Regan et al., 1998; Gregerson, 1993) and various sporting domains (Williams et al., 2002) has identified the benefits of employing a training programme where the participants are cognitively involved. In terms of risk management, actively involving individuals cognitively in the training appears to directly challenge their perceived level of skill. Providing a direct demonstration of the limits, in terms of their risk management skills, appears to facilitate positive changes in risk management behaviour, in comparison to providing factual information relating to accident statistics and/or incidents. Building on this success, the aim of the current study was to examine the utility of various training strategies to improve pilot's risk management behaviour.

The first of three experiments examined the utility of actively involving pilots cognitively in the task coupled with feedback, in order to improve their risk management skills. The second experiment examined the impact of cognitive involvement and feedback on individuals' risk management behaviour, while the third experiment examined the extent to which information acquired during a low-flying task would generalise to other tasks, which differed in terms of cognitive load. Throughout all three experiments, it was assumed that pilots' risk management behaviour would be reflected in their performance during a low-flying task.
discussed in Chapter 1, low-flying was chosen as the context for the study as it provided a unique assessment tool to measure pilots’ willingness to engage in risk. This assumption was based on the fact that when a pilot is engaged in a low-flying activity he/she must balance the associated risks of descending to an altitude conducive of completing the task, flying in accordance with the low-flying regulation and, at a height that they perceive suitable in the event of an emergency (i.e., engine failure or stalling the aircraft). Therefore, it was assumed that pilots adopting a more risk averse behaviour during a low-flying flight would remain at a higher altitude, on average, in comparison to those pilots who are more inclined to engage in risky behaviour.

While the strength of the methodology stated above relates to the unique and indirect method chosen to examine pilots’ risk management behaviour, it is not without limitations. For example, it was inferred that the altitude in which pilots descend relates directly to their risk management behaviour. It was also inferred that pilots’ behaviour during a simulated flight reflected their behaviour in the operational environment. Such inference and assumptions need to be taken into account when interpreting the results and the extent to which they are generalisable (see 7.15.4 Limitations of the Study for comprehensive discussion).
Chapter 5: Experiment 1-Cognitive Involvement and Risk-Taking

The following study (Experiment 1) examines how different levels of cognitive involvement in a case-based training task influence pilots’ risk-taking behaviour during a subsequent test scenario. The study consisted of two sessions, one week apart. The first session, involved a training phase and the second session in the following week involved a test flight. The training phase utilised a case-based training approach and presented case examples using three different media. In two of the media, pilots experienced, in third person, three case examples that had a common theme throughout. These cases involved pilots violating a minimum safe altitude regulation and, subsequently, being involved in an accident. The third medium involved pilots being directly involved (first person) in a low-level exercise on a flight simulator. At the conclusion of the training session, a series of questions were asked of the pilots to facilitate their acquisition of relevant information. During the second session, in the following week, participants piloted a Cessna 172 on a computer-based flight simulator, where they were asked to read a number located on the deck of an oil tanker (low-flying exercise). The main focus of the test flight was to examine the minimum altitude to which the pilots descend during the flight operation.

It was assumed that pilots adopting a more risk averse behaviour during a low-flying flight would remain at a higher altitude, on average, in comparison to those pilots who are more inclined to engage in riskier behaviour. This assumption is based on the fact that, when completing a low-flying task, in the event of an emergency (i.e., engine failure or stalling the aircraft) flying at a higher altitude increases the options available to the pilot in order to ensure the flight ends safely. For example, greater height in the event of an engine failure will allow more time to diagnose the problem
and attempt to restart the engine, if feasible. In the event that the engine cannot be
restarted, higher altitude increases the landing options available, as the aircraft would
be able to glide a greater distance. Finally, in the event of the aircraft stalling, higher
altitude permits the pilot a greater vertical distance and more time to recover from the
stall. As a result, the following study is based upon two interrelated hypotheses.

The first hypothesis concerns breaches of the low-flying regulation (i.e., descent
beneath 500 feet over a non-populated area). The second hypothesis concerns pilots'
risk averse behaviour, which is inferred to be reflected in the minimum altitude to
which they descend during a low-flying task. Both hypotheses are related, since
engaging in a behaviour that could be described as inherently more risky involves
descending to a lower altitude which, in turn, increases the likelihood of violating the
low-flying regulations. Therefore, in Experiment 1, it is hypothesised that;

1a. Participants who experience case-related examples in first person (cognitively
active) during the training phase (flight group), will be less likely to breach
the Visual Flight Rules (i.e., descend below 500 feet) than those participants
who experience case-related examples in third person (cognitively inactive)
during the training phase (electronic newsletter and video group).

1b. Participants who experience case-related examples in first person (cognitively
active) during the training phase (flight group) will remain at a higher
altitude, on average, than those participants who experience case-related
examples in third person (cognitively inactive) during the training phase
(electronic newsletter and video group).
In addition to the two hypotheses, two research questions are proposed,

1. Do general aviation pilots prefer one particular decision-making strategy to another in the process of deciding the minimum altitude in which to descend during a simulated low-flying task?

2. Does general aviation pilots' orientation towards risk while flying, differ depending on the altitude flown?

5.1 Method

5.1.1 Participants

Participants were recruited from the Bachelor of Aviation (Flying) degree at the University of Western Sydney and from the various flying schools located at Bankstown airport. The method of recruitment involved addressing students during formal classroom sessions and obtaining contact details of those students willing to participate in the research. Fifty-one participants were recruited for the study, and were randomly divided into three groups. All the participants were naïve as to the purpose of the research.

Table 1 outlines the distribution of the participants across groups, the demographic features, and the median experience of the participants distributed across the three groups. The three groups reflect unequal sample sizes due to the randomised allocation of participants to each group and that the experimental process was conducted over two sessions, thereby reducing the controllability of group size if a participant elected not to attend both sessions. Since the participants were recruited from flight training institutions, it was expected that the data pertaining to the total hours flying experience and the total hours of low-level flying experience would be
positively skewed. Therefore, a Kruskal-Wallis, nonparametric test was used to examine whether differences existed between the three groups based on flying experience. With alpha set at .05, the results of a Kruskal-Wallis chi-square approximation, corrected for ties, failed to reveal any statistically significant differences between groups in terms of the total hours flying experience $\chi^2(2, N = 51) = 1.04, p = .59$ and the total hours low-level flying $\chi^2(2, N = 51) = 1.83, p = .40$. As a result, it can be concluded that the three groups (electronic newsletter, video and simulated flight) were not significantly different in terms of the median total hours flight experience and the total low-level flying experience.

Table 1
*Distribution of participants, demographics and median experience of participants distributed across exposure to low-level flying experience.*

<table>
<thead>
<tr>
<th>Training Group</th>
<th>Participant Numbers</th>
<th>Mean Age (SD)</th>
<th>Median total hours flying experience (range)</th>
<th>Median total hours low-level flying (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (Newsletter)</td>
<td>14</td>
<td>24.90 (9)</td>
<td>145 (343)</td>
<td>1 (20)</td>
</tr>
<tr>
<td>Group 2 (Video)</td>
<td>17</td>
<td>23.40 (9)</td>
<td>190 (430)</td>
<td>2 (60)</td>
</tr>
<tr>
<td>Group 3 (Simulated Flight)</td>
<td>20</td>
<td>25.15 (7)</td>
<td>175 (1387)</td>
<td>0 (20)</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>24.49 (8)</td>
<td>170 (1393)</td>
<td>1 (60)</td>
</tr>
</tbody>
</table>
5.2 Design

The study was designed to examine the extent to which different levels of cognitive involvement in a case-based training task impacts the risk-management behaviour of pilots during a subsequent test scenario. It comprised a one-way factorial design incorporating two levels of cognitive involvement (passive and active) as the independent variable, and the minimum altitude to which the participants descended as the primary dependent variable. Additional dependent variables included the frequency of descents beneath 500 feet, the time spent beneath 500 feet, and the level of control exercised over the aircraft. For all statistical procedures, an alpha level of .05 was set.

5.3 Materials

The material comprised a personal computer, one twenty-one inch Cathode Ray Tube (CRT) monitor, a Personal Computer Aviation Training Device (PCATD) and Elite Rudder Pedals. The personal computer was used to view the videos using QuickTime™ 6 software. It was also used to present the computer-based training material and to operate the PCATD. The flight simulator software comprised X-Plane 6.21™ developed by Laminar Research Corporation. The PCATD hardware consisted of a digital avionics stack, a remote instrument console and a Cirrus Two flight console with a Beech Yoke (without clock option). The digital avionics stack consisted of two communication radios, Automatic Direction Finding equipment (ADF), Distance Measuring Equipment (DME), transponder, autopilot and a Global Positioning System (GPS). The remote instrument console consisted of five dials that operate the ADF, directional gyro, heading bug indicator, altimeter and Omni Bearing
Selector (OBS). In addition, the remote instrument console incorporated a switch that enabled the user to select one of two different communication radios. The Cirrus Two Flight Console with the Beech Yoke supported the following features (generic flight training simulator and not all features specific to a Cessna 172):

- Hobbs meter (meter that indicates the hours in operation)
- Rudder trim control
- Magneto switches
- Engine start switch
- Alternator switches
- Battery switches
- Avionics master
- Flap switch
- Landing gear switch (latching) with position indicator lights
- Rudder trim control
- Cowl flap switch
- Fuel boost pump switches
- Fuel tank selector
- Parking brake (see Figure 2)
Figure 2. An illustration of the computer based flight simulator including the Cirrus Two Flight Console with the Beech Yoke

Mounted on the left side of the yoke was a switch that operated the electric pitch trim, while a switch on the right side of the console permitted the pilot to view 360 degrees around the aircraft. The Beech yoke was capable of full lateral motion in two dimensions. In addition, a single engine throttle quadrant with three levers was used, and was mounted on the right side of the flight console. Given that the aircraft was being flown using a fixed-pitch propeller, only the mixture lever (red) and the throttle lever (black) were necessary to operate the aircraft. The rudder pedals used in the study slid forward and aft, and did not incorporate a toe brake. The PCATD hardware was manufactured by Precision Flight Controls.

The visual information was presented to the participants on a twenty-one inch colour monitor and displayed the basic instrument functions of a Cessna 172 including the airspeed indicator, altimeter, vertical speed gauge, artificial horizon, turn and slip indicator, directional gyroscope. In addition to these basic gauges, a radar altimeter, Revolutions Per Minute (RPM) gauge and a fuel gauge were displayed on the right side of the console. A typical view that the participant would
see throughout the flight consisted of the console in which the participants viewed the aircraft’s instruments on the lower portion of the screen, and the terrain constituting the upper portion of the screen.

A flight data recorder, which is a function of the X-Plane software, was used to record the input from the pilot and the position of the aircraft. Six specific data points were saved every nine-tenths of a second and included:

1. Time elapsed
2. Vertical airspeed
3. Throttle
4. Pitch, roll, heading
5. Latitude, longitude, altitude
6. Distance travelled.

The case-based learning software was written in Macromedia Dreamweaver, and was co-designed by the staff at the University of Otago-New Zealand and the University of Western Sydney. This programme included an introductory page that described the programme and provided participants with a choice to proceed in one of two specific areas. Participants were asked to review either ‘low-flying 1’ or ‘low-flying 2’. Three low-flying cases were presented beneath the low-flying titles. Participants were randomly assigned to ‘low-flying 1’ or ‘low-flying 2’ (see Figure 3). The case examples provided were based on actual aircraft accidents, where the National Transportation Safety Board (NTSB) conducted an investigation into the associated causes, and produced a report, highlighting the findings. All six case examples (three case examples for ‘low-flying 1’, and three case examples for ‘low-
flying 2’) were characterised by pilots descending beneath 500 feet and subsequently resulting in a serious or fatal injury. With each case example, the actual location of the accident site was altered to reflect a geographic location in Australia.

Figure 3. Illustration of the introductory page featured in the electronic newsletter.

The case examples that featured on the video were an exact replication of the cases presented via the electronic newsletter. The video featured an industry expert from the Australian Transport Safety Bureau (ATSB), who read each case from a prepared script. The video was filmed on location at Bankstown Airport, Australia to increase the relevance and realism of the material and the video. Consistent with the
electronic newsletter, participants were randomly assigned to the cases presented in either ‘low-flying 1’ or ‘low-flying 2’.

The first case example in ‘low-flying 1’ contained information describing a flight where an amphibious float-equipped Cessna 206 airplane impacted the water approximately five nautical miles of the coast off Swansea, near Newcastle, Australia. The Cessna was one of numerous aircraft flying in the same general area spotting fish. These aircraft operate in support of nearby fishing vessels and the pilots, or their observers, radio information to the boat crews when a school is located. Both the pilot and passenger were fatally injured in the accident. Witnesses in the other aircraft reported seeing the aircraft prior to impact at approximately 200 to 400 feet, with a nose high attitude, and with approximately 20 degrees of flap extended before pitching nose down into the water.

The second case (low-flying 1) described how a female pilot was fatally injured while her passenger sustained serious facial lacerations during a whale watching excursion off the coast of Jervis Bay in the South Pacific Ocean. The male passenger on the flight recalls observing a whale when the aircraft was at an altitude of about 600 feet. He pointed the whale out to the female pilot who then descended to gain a better look. Due to her preoccupation with the whale, the aircraft descended and the lowest altitude that the male passenger could recall the aircraft being flown was 350 feet.

The third case (low-flying 1) involved a Cessna 207, operated by a local tour company, that collided with water while manoeuvring over the Hawkesbury River at Wiseman's Ferry. The pilot had been selling joy rides in which the aircraft would fly up and down the river about 150 to 200 feet. The pilot would reverse course (180-
degree turn) by pulling the nose up and then levelling out just above the water. The
owner/operator pilot and his passenger suffered fatal injuries.

The first case in ‘low-flying 2’ contained information about a Fletcher FU24-950 that was registered to a private individual and operated by a local power company that impacted terrain during an aerial survey flight. A lone horseback rider witnessed the aircraft flying straight and level over a newly planted pine plantation. Approximately 15 minutes later, he noticed the aircraft circling a wooded area south of the pine plantation, and at a lower altitude than had previously been sighted. Shortly afterwards, he heard a loud crash in the vicinity where the plane had been seen. Upon investigation, he discovered the two occupants fatally injured. The subsequent investigation revealed that the engine appeared to be functioning normal prior to impact. The surrounding vegetation appeared to be wilted, consistent with being sprayed with fuel, indicating that there was adequate fuel on board the aircraft. Some nearby treetops were found to be broken, consistent with being struck by the undercarriage of an aircraft. The accident investigators concluded that the most significant factor of the crash was the pilot’s failure to maintain sufficient altitude while circling the plantation.

The second case (low-flying 2) described an accident that occurred in a Cessna 182 where a film crew was conducting an aerial photographic flight filming Australian trains. The pilot descended the aircraft to a height of about 100 feet above the train and adjusted his flight speed so that he was slowly overtaking the locomotive. Shortly after, the aircraft struck two three-strand lightweight high-tensile steel wires that crossed the rail line at a 90-degree angle. The pilot subsequently lost control of the aircraft and impacted the ground 90 feet left of the passing locomotive.
The passenger in the right front seat sustained minor injuries, and the pilot and other passenger, in a rear seat, received serious injuries.

The third case (low-flying 2) described a Cessna 172 that was conducting a fire patrol flight which crashed into a mountainside east of Mt Cloudmaker, New South Wales, Australia. The pilot and his passenger were fatally injured upon impact. Two witnesses, who were in the valley at the time of the accident, reported that they were riding their motorcycles down a dirt road when they saw the aircraft flying at 300 to 400 feet above the valley floor. They then witnessed the aircraft proceed overhead and crash about a quarter of a mile in front of them. The witnesses reported that, at the time of the accident, their motorcycles had been raising some dust mainly as a result of the hot and dry weather the area had been experiencing.

5.4 Procedure

All participants were informed verbally and through the information sheet that the experiment would consist of two sessions, each of which would be undertaken one week apart. Participants were asked to complete a consent form and a demographics form. In the first session, the fourteen participants in the ‘newsletter’ group were asked to work through the computer-based training programme. Depending upon the group to which participants were assigned, they were asked to read either ‘low-flying case 1’ or ‘low-flying case 2’. In the video group, the seventeen participants were asked to either watch a video titled ‘low-flying case 1’ or ‘low-flying case 2’. The duration of the videos was 5:13 minutes for the low-flying case 1, and 8:13 minutes for the low-flying case 2. Having read the newsletter or watched a video, the participants were asked to complete a short series of multiple choice and short answer
questions that related specifically to the material reviewed (see Appendix A). The multiple choice questions were aimed at ensuring that the knowledge pertaining to the case examples had been acquired (better than chance). The short-answer questions provided the participants with the opportunity to reflect on the different scenarios and draw on the common link between the associated risk/s and danger/s from the related flights. The participants were not permitted to refer back to the material when answering the questions.

The twenty participants who were placed in the flight group were asked to fly a simulated flight on the computer-based flight simulator that departed from Williamtown, NSW Australia. Participants were randomly divided in two groups and were provided with instructions for a flight that flew either north of Williamtown or south of Williamtown. The objective in the flight to the north of Williamtown was to track 050 degrees to Tanilba Bay where participants were asked to count the number of fishing trawlers located in the bay. The participants in the flight south of Williamtown were asked to locate a house 10 nautical miles from Williamtown. The participants were asked to identify and memorise the number of motor vehicles that passed the house over a ten-minute period. Prior to departure, participants were briefed on the aims and objectives of the flight and were asked to conduct the operation in accordance with the normal rules and regulations. They were also asked to operate the aircraft as they would in the normal operational environment. Finally, participants were informed that they did not need to make radio calls, they did not need airways clearance, and that there were no restricted areas active. At the conclusion of the flight, the participants were provided with feedback in relation to their performance during the training flight. If the participants descended beneath the Minimum Safe Altitude (MSA) of 500 feet, the following phrase was read: “Do you
realise that during the course of your flight you descended beneath the MSA of 500 feet and, in doing so, you breached the Visual Flight Rules (VFR) and potentially jeopardised the safety of the flight”. If the participant did not descend beneath the MSA of 500 feet, the following phrase was read: “Well done, during the course of your flight you did not descended beneath the MSA of 500 feet and in remaining above this altitude you not only adhered to the VFR regulations, but you potentially averted an accident or incident”. Finally, the participants were asked to complete a brief, short answer questionnaire. The questionnaire asked the participant to state the number that they were required to report during the flight (i.e., number of fishing trawlers or number of cars) and provided them an opportunity to reflect on the flight and highlight any key points or lesson/s learnt (see Appendix A).

In the second session, in the succeeding week, participants from all the three training groups conducted the same simulated flight. Participants were provided with a set of instructions prior to the flight that outlined the nature of the flight and its objectives. A flight scenario was deliberately constructed so that the participants departed from Bankstown airport and tracked via Sydney International airport to an oil tanker that was located in Botany Bay. The participants departed Bankstown on runway 11 centre and then turned onto a heading of 085 degrees and tracked direct to Sydney International where they then tracked 155 degrees direct to the oil tanker. Participants were asked to read a three-digit number that was located on the deck of the oil tanker. After completing the task, the participants were asked to track back to Sydney International and make a straight in approach for runway 34 left. The respective distances were 9.5 nautical miles between Bankstown airport and Sydney International, and 3.8 nautical miles between Sydney International and the oil tanker. The overall distance of the flight was 17.1 nautical miles. Fuel levels were
manipulated so that the participants could spend a maximum of ten minutes over the oil tanker before they started to use their reserve fuel. The total fuel aboard the aircraft was 56lbs. Calculating the fuel consumption of a Cessna 172 at full throttle for the duration of the flight, plus the mandatory 45 minutes of reserves, allowed for a total flight time of 66 minutes. Upon completion of the flight, the participants were asked to complete a final set of questions. The questions were designed to examine participants’ performance on the task (number on oil tanker), as well as their ability to recall any similarities between the test flight and any other flight undertaken, including simulation/s, and the decision-making strategy that they employed throughout the task. The participants were also read the same pre-flight brief as in the first week (see Appendix A: Experiment 1 for all material and stimuli pertaining to Experiment 1). At the conclusion of the flight and accompanying questions, all participants were thanked for their participation.

Finally, both the training flight and the test flight were deliberately constructed so that pilots could successfully complete both tasks without descending beneath 500 feet and breaching the low-flying regulations. This was significant as it was important to ensure that the neither the training, nor the test flight endorsed a behaviour that was in breach of the regulations.

5.5 Results

The data obtained from X-Plane were transferred directly from the output file of X-Plane to Statistical Package for the Social Sciences (SPSS), version 11. This process was made possible, through a template within SPSS, which directly transformed the data (see Appendix A).
The main objective of this study was to examine the altitude to which the participants descended over the oil tanker. Therefore, within the SPSS file, the data pertaining to the area over the vessel had to be determined. The exact position of the oil tanker was −34.00813 degrees latitude and 151.20413 degrees longitude. A five nautical mile boundary was determined around the oil tanker and this boundary was set between −33.995 and −34.022 degrees latitude and between 151.180 and 151.228 degrees longitude. It was assumed that, within this five nautical mile boundary, the behaviour of the pilot would be oriented towards locating the number that was displayed on the oil tanker.

Prior to analysis, all of the data were tested for normality and homogeneity of variance. The results revealed that the data pertaining to the mean minimum altitude to which pilots descended over the oil tanker were significantly non-normal. Specifically, the data were positively skewed with a positive kurtosis (leptokurtic) that was significantly different from zero \( (p < .001) \) across groups.

Given the nature of the task, skewed data might have been expected, since it would be reasonable to assume that pilots would descend to an altitude somewhere in the vicinity of the MSA as per VFR regulations. Therefore, the MSA imposed a lower limit (floor effect) to which the pilots could legally descend (i.e., 500 feet above ground).

To ensure that the data were consistent with the application of parametric statistics, the data pertaining to the mean minimum altitude descended were transformed using a square root transformation as prescribed by Tabachnick and Fidell (2001). A subsequent multivariate analysis revealed that the transformed data were normally distributed with both the skewness and kurtosis non-significantly different from zero (i.e., \( z < 3.29, p > .001 \)) (Tabachnick & Fidell, 2001).
5.5.1 Frequency of Pilots Descending Beneath 500 Feet

The minimum altitude to which each pilot descended was examined in relation to the VFR low-flying regulations. In total, 71% of participants who were exposed to the electronic newsletter descended beneath 500 feet, while 65% of participants exposed to the video and 40% of the participants who flew the simulated flight descended beneath 500 feet (see Table 2). However, a chi-square analysis failed to identify a significant relationship between descent beneath 500 feet and training group $\chi^2(2, N = 51) = 3.96, p = .14$. Although these results failed to identify a significant relationship between training group and descent below 500 feet, a strong trend was evident where pilots who were exposed to the flight were less likely than pilots in the other groups to descend below 500 feet. Nonetheless, in total, 57% of participants violated the MSA regulations, irrespective of the training provided. For those participants who descended beneath 500 feet, the mean time spent beneath this altitude was 58 seconds (SD = 69).

Table 2
Frequency with which pilots descended beneath 500 feet, distributed across group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Descent below 500 feet (MSA) (Number of times)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Video</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>CBT</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Flight</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>22</td>
</tr>
</tbody>
</table>
Having established the proportion of participants who descended beneath 500 feet during the exercise and the average time spent below 500 feet, the data were examined to determine whether the participants were aware of the altitude to which they descended. This is significant, since it indicates whether the participants were aware of their behaviour throughout the exercise. A subsequent Pearson’s product-moment correlation identified a significant positive correlation, \( r(49) = .85, p < .01 \) between the actual altitude to which the participants descended and the perception of the altitude to which they descended. As a result, it can be concluded that the participants were aware of the altitude to which they descended during the exercise, and that a descent below 500 feet was not necessarily due to a lack of awareness of the operational conditions.

In justifying their descent beneath 500 feet, 38% of participants stated that they felt it necessary to complete the task. Thirty-four percent of the participants who descended beneath 500 feet justified their descent due to the sensitivity of the flight controls. The remaining 28% of participants considered that they had not descended below 500 feet. A univariate analysis failed to reveal a significant difference between groups and the pilots’ handling characteristics (due to the sensitivity of the controls) \( F(2, 48) = 1.28, p = .29, \eta^2 = .051 \) (see Table 11). This suggests that all group members experienced a similar level of control sensitivity.

Although the reasons given by the participants for the descent beneath 500 feet varied amongst the 29 participants, an overwhelming majority (72%) acknowledged that they had violated the low-flying regulations, while 14% were undecided as to whether they had violated the regulations or not, and the remainder (14%) felt that they had not violated the regulations. When asked what strategy they
used to determine the minimum altitude to which to descend during the exercise, 17% said they recalled previous situations that they have experienced, 31% considered the pros and cons of the situation, 27% used rules to assist with their decision, 14% recalled a previous example/s they have read or heard about, 3% based their decision on a model, and the remaining 7% indicated that they knew immediately whether it was appropriate or not to proceed. However, a chi-square analysis failed to identify a significant relationship between strategies used to determine the minimum altitude to which to descend and training group $\chi^2(10, N = 29) = 9.49, p = .49$; Fisher’s exact test, $p = 8.62^1$.

Finally, to determine if participants’ behaviour (descent beneath 500 feet) during the test flight could be explained in relation to their ability to process or acquire the information presented during the training flight, participants' response on the post mission questionnaire from the training flight was examined. Since only those pilots who were cognitively inactive (electronic newsletter and video group) during training experienced three case-related examples, only the data from these two groups were analysed. The mean correct answers from a maximum of twelve were 9.50 (SD = 1.02) for the newsletter group, and 9.41 (SD = 1.62) for the video group, indicating a better than chance response (chance equals 3). A univariate analysis failed to reveal a significant difference between groups (electronic newsletter and video) and incorrect answers on the post mission questionnaire from the training, $F(1, 29) = .03, p = .86, \eta^2 = .001$ (see Table 12). This suggests that all group members in the electronic newsletter and video groups acquired and retrieved similar amounts of information pertaining to the case examples presented during training.

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1 The $p$ value using Fisher’s exact test was calculated instead of the chi-square value because 18 cells have an expected count less than 5. The minimum expected count is .28 (Heiman, 1996; Siegel, 1956).
5.5.2 *Mean Minimum Altitude Descended for Group*

The main aim of this research was to examine whether different levels of cognitive involvement during a case-based training exercise would subsequently impact the risk-management behaviour during a test scenario. Therefore, a three by two between groups factorial ANOVA was used to determine whether differences existed between the mean minimum altitude descended for each of the three groups (newsletter, video and flight) across similarity. Since it was hypothesised that the risk-taking propensity amongst pilots would vary as a result of the training group, and not the memory or ability of the pilots to recall similar experiences or case examples during the flight in the second session, the response to a question regarding the similarity of the test scenario to previous experiences was included as a second variable in the analysis (see Appendix A-Post Mission Questionnaire, question 5 regarding similarity). The results revealed a main effect for group \( F(2, 45) = 3.40, p = .04, \eta^2 = .131 \) (see Table 13). There was no main effect for similarity and no interaction between group and similarity. Employing Fisher’s Least Significant Difference (LSD)\(^2\) post-hoc test, it was determined that the difference lay between the electronic newsletter and the flight \( (p = .041) \). There was no significant difference evident between video and flight \( (p = .088) \). The mean minimum altitude\(^3\) to which the participants descended in each group was 423 feet \( (SD = 232) \) for the electronic newsletter.

\(^2\) Seaman, Levin and Serlin (1991) conducted a study investigating the differences among Multiple Comparison Procedures (MCPs) in relation to Type 1 errors and power characteristics of various MCPs. In total twenty-three different MCPs were examined and the results were presented based on the MCPs employed to examine differences among three experimental groups \( (K=3) \) or the MCPs employed to examine difference among experimental groups greater than three \( (k>3) \). The results revealed that the most powerful MCPs used for experimental groups consisting of three groups only, were Fisher’s Least Significant Difference (LSD) and Newman-Keuls (NK). These two MCPs best controlled for the nominal alpha and the probability of making a Type 1 error (Seaman et al., 1991). In contrast, the results revealed that when there were more than three experimental groups, Fisher’s LSD and NK procedures were classified as unacceptable as they were said to fail in adequately controlling for Type 1 errors and the nominal alpha level (Hayter, 1986; Seaman et al., 1991).
newsletter group, 479 feet (SD = 297) for the video group and 657 feet (SD = 378) for the flight group. In comparing the mean minimum altitudes descended across the groups, the results suggest that participants who experienced a training task where they were cognitively active, maintained a higher average altitude than those participants who were cognitively inactive during training in the week preceding the test task.

5.5.3 *Pilots' Orientation towards Risk*

In an attempt to examine pilots’ orientation towards risk whilst flying over the oil tanker, data pertaining to each pilot’s flight path (altitude, latitude and longitude) were graphed using the interactive graph feature in SPSS 11 (see Appendix A). A pilot’s flight path over the oil tanker has significant implications for risk management due to the terrain surrounding the oil tanker. Since the oil tanker was located inside Botany Bay, flying north of the tanker would ensure that the pilot remained over water, whilst flying south of the oil tanker would ensure that the pilot remained over land. In the case of an engine failure and at low altitude, there is a greater likelihood of successfully landing the aircraft if circuits were performed south of the oil tanker rather than north of the oil tanker. Therefore, pilots were divided into three groups on the basis of their behaviour (zero number of circuits, 1-3 number of circuits, and 4-7 number of circuits) and a series of chi-square analyses were performed examining the relationship between the number of circuits and the flight path (overhead, north, and south of the oil tanker) (see Appendix A: Experiment 1 for chi-square analyses for descent beneath 500 feet and individual number of circuits). A subsequent chi-square

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\[ ^3 \]Data are actual rather than transformed for illustrative purpose. Transformed data for each group were 19.60 (6.46) for those pilots in the electronic newsletter group, 20.67 (7.37) for those pilots in the video group, and 24.67 (7.12) for those pilots in the simulated flight group.
analysis revealed a significant relationship between descent beneath 500 feet and number of circuits performed overhead the oil tanker $\chi^2(1, N = 51) = 6.55, p = .01$. These results suggest that those pilots who remained above 500 feet performed a greater number of circuits overhead the oil tanker, in comparison to those pilots who descended beneath 500 feet. In relation to descent beneath 500 feet and the number of circuits north of oil tanker, a chi-square analysis failed to reveal a significant relationship $\chi^2(2, N = 51) = 2.42, p = .30$; Fisher’s exact test, $p = .39^4$, and between descent beneath 500 feet and number of circuits south of oil tanker, $\chi^2(2, N = 51) = 1.44, p = .49$; Fisher’s exact test, $p = .76^5$. (see Table 3).

Table 3  
Circuit direction and number, distributed across whether participants descended beneath 500 while reading the number on the oil tanker.

<table>
<thead>
<tr>
<th>Circuit Direction</th>
<th>Descent below 500 feet</th>
<th>Number of circuits over oil tanker</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1-3</td>
</tr>
<tr>
<td>Overhead</td>
<td>Yes</td>
<td>-</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>-</td>
<td>20</td>
</tr>
<tr>
<td>North</td>
<td>Yes</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>South</td>
<td>Yes</td>
<td>1</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>2</td>
<td>20</td>
</tr>
</tbody>
</table>

5.6 Discussion

The results arising from the study revealed a significant difference between the groups in relation to their performance on a test flight as a result of the different

$^4$ The $p$ value using Fisher’s exact test was calculated instead of the chi-square value because 2 cells have an expected count less than 5. The minimum expected count is 1.29 (Heiman, 1996; Siegel, 1956).

$^5$ The $p$ value using Fisher’s exact test was calculated instead of the chi-square value because 4 cells have an expected count less than 5. The minimum expected count is .43 (Heiman, 1996; Siegel, 1956).
training regimes experienced in the preceding week. In particular, those pilots who flew the simulated flight in the training session remained at a higher altitude, on average, than those pilots who read the electronic newsletter or watched a video during the training session. The difference was evident between those pilots who were asked to read the electronic newsletter and those pilots who were asked to fly the simulated flight in the training session. No significant difference was evident between the video group and the other two groups. This result supports the second hypothesis, however not the first.

The first hypothesis predicted that participants who were cognitively active during the training phase (flight group), would be less likely to breach the VFR regulation (i.e., descend below 500 feet) than those participants who were cognitively inactive during the training phase (electronic newsletter and video group). A chi-square analysis failed to identify a significant relationship between descent beneath 500 feet and training group.

The second hypothesis predicted that participants who experience case-related example in first person (cognitively active) during the training phase (flight group) will remain at a higher altitude, on average, than those participants who experience case-related examples in third person (cognitively inactive) during the training phase (electronic newsletter and video group). In terms of pilots performance during the test flight, the average altitude to which the pilots in the electronic newsletter group descended was 423 feet (SD = 232), whereas pilots in the video group descended to an average altitude of 479 feet (SD = 297). Those pilots in the simulated flight training group descended to an average altitude of 657 feet (SD = 378).
While there are rules governing the minimum altitude to which a pilot can descend for safety-related reasons, upper limits on altitude restrictions are generally related to the aircraft being flown and are not prescribed by the regulatory authority. Therefore, remaining at a higher altitude whilst engaging in a low-flying task increases the number of options available in terms of finding a suitable place to land if a problem arises with the aeroplane during the course of the flight (thereby reducing the risk).

In an attempt to establish why participants descended below 500 feet, the frequency of pilots who descended beneath 500 feet was examined against their level of experience. The results failed to reveal a relationship between these two factors, suggesting that experience or a lack of experience was not necessarily an explanation for the results. Further, a comparison between the participants’ perception that they had descended below 500 feet and whether they actually descended below 500 feet, indicated that 69% of the participants were in full knowledge that they had breached 500 feet, while the remainder indicated that they had not descended beneath 500 feet. This indicates that the majority of participants were consciously aware of the altitude to which they descended.

Having established that the majority of the participants were conscious of their actions in descending below 500 feet, it was important to establish whether this was the result of the participants’ capacity to control the aircraft. During the test flight data were obtained relating to the aircraft roll. The results of a comparison between groups indicated that there was no difference between the groups in relation to their handling of the simulator as determined by the mean absolute roll of the aircraft.

For the participants who descended beneath 500 feet (29 participants in total), 38% (11 participants out of 29) indicated that they felt that the descent was necessary
to complete the task. For those participants who descended beneath the MSA, four participants successfully completed the task above 1,000 feet, while another 14 participants successfully completed the task above 500 feet. This suggests that the successful completion of the task was possible above the MSA of 500 feet.

As stated prior, the first hypothesis which predicted that participants who were cognitively active during the training phase (flight group), would be less likely to breach the VFR regulation (i.e., descend below 500 feet) than those participants who were cognitively inactive during the training phase (electronic newsletter and video group), was rejected. Support was found for the second hypothesis, however, which predicted that those participants who were cognitively active during the training phase (flight group) would remain at a higher altitude, on average, than those participants who were cognitively inactive during the training phase (electronic newsletter and video group).

There are three possible reasons that might explain the outcomes of the experiment and why the results only partially supported the hypotheses. These are; (1) Similarity between case examples and test example, (2) Pilots’ perception that they are better than the norm, and (3) Active participation in training helps facilitate the acquisition of knowledge. All three possible reasons are discussed in section 5.7.

5.7 Implications of Not Obtaining a Significant Result

While the chi-square analysis failed to identify a significant relationship between the groups, in relation to the frequency with which they descended beneath 500 feet, the results do suggest that a trend may be evident. In particular, the majority of participants in both the electronic newsletter group (71%) and the video group
(65%) descended beneath 500 feet, while only a minority of participants in the flight group (40%) descended beneath 500 feet. This suggests that the training experienced may have had some impact on the participants’ performance, especially within the flight group. Harris (1989) raises an important point when conducting research in an applied setting when safety is involved. He suggests that simply because a significant value is not obtained, one should not negate the potential implications of these results in improving safety. In the case of the current study, the results revealed no significant difference between the groups based on the frequency with which the regulations were breached, although in relation to the mean minimum altitude descended across groups, a significant result was obtained. Therefore, the results in relation to the breach of the 500 feet rule should not necessarily be disregarded.

5.7.1 Similarity of Case Examples

Although the general performance of the participants in the electronic newsletter and video group, in terms of altitude descended during the test flight was consistent with the hypothesis, the results were not consistent with previous empirical research. The theoretical perspective of case-based reasoning is based on the notion that an individual who experiences repeated exposure to a particular operational environment will acquire and retain information that is specific to that domain in the form of cases or examples (Kirsner et al., 1997). When individuals experience a similar problem to that experienced in the case examples, they may apply and modify a problem-solving strategy based on previously encountered problems, or they may categorically match the current situation with ones that they have previously experienced and solve it along similar lines (Leake, 1996). In theory, this approach appears to have a sound basis, however, there is little empirical evidence to validate
these assertions. While the current study did not explicitly test case-based training *per se*, employing a training method that relies solely on the presentation of case examples appears to have little value in preventing violations of low-flying regulations. The results from the current study suggest that additional research is required to further explore the potential of case-based training. Specifically, future research should examine the importance of feedback, the notion of repeated exposure, and the concept of the transfer of training.

While most skill acquisition theories are based on the notion of repeated exposure, it is difficult to determine the optimal level of repetition to improve performance. While no differences appeared evident between the two groups (electronic newsletter and video) exposed to the three case-related examples during training, in terms of the number of incorrect answers recorded directly following training, the extent to which this information was applied in the following week suggests that additional case examples may be required to foster or facilitate a sufficiently powerful memory trace.

The success of case-based training is also based on the premise that a degree of transfer of learning will occur between the case examples and the operational environment. However, this transfer is dependent upon the perceived similarity between the case examples and those experienced within the operational environment.

One explanation for the results from the current study may relate to the participants’ failure to perceive the link between the cases presented and the experimental task that they were performing. Gick and Holyoak (1987) have argued that success in the transfer of training is dependent upon both the perceived and the actual similarities between training and the performance domain. Therefore,
participants must perceive a similarity between the cases that they observed and their required performance (Woods, 1988; Rockwell & McCoy, 1988).

Further evidence relating to the significance of transfer in training can be drawn from Kraiger et al., (1995) who conducted an experiment into the transfer of training in computer programming. Specifically, they suggested that there must be some perceived similarity between the training and the type of performance required. They evaluated the pre-test/post-test difference and the relationship between training and performance on a task after a 12 week period. There were a total of 11 participants and the training covered five specific domains relating to computer programming. The results indicated that 10 of the 11 participants performed better on the post-test than the pre-test, which was interpreted as evidence to suggest that the participants were able to organise the information taught in a manner consistent with experts in their field. However, there was no transfer of training evident. Kraiger et al. (1995) explained these findings on the basis that the participants had not developed an understanding of the function of a particular computer programme. While the training appeared to concentrate on the development of the computer programme, it did not provide an understanding of the specific functions and performance of the programme. This evidence suggests that successful transfer of training is dependent upon both the perception of, and the actual similarities with, the performance domain (Gick & Holyoak, 1987).

The perception of similarities between the training material and the operational environment is presumed to be dependent upon the trainee’s ability to abstractly generalise concepts from training, and their ability to apply the information taught within the operational environment (Kraiger et al., 1995). On the basis of this evidence, it appears that the case-based training specifically employed in the present
study may have provided information that was perceived as abstractly unrelated to the low-flying exercise presented in the simulation.

The fact that the case examples were related to low-flying accidents may not have been sufficient to draw a link between them and the test flight. Although each case example was characterised by a pilot inadvertently descending beneath 500 feet as a result of a task they were undertaking, there was no case example which involved specifically an oil tanker and a task that required the pilot-in-command to report a number on the tanker. Therefore, there was no example provided during the training that matched the test scenario specifically, or that may have been perceived as a sufficient match.

One final point of note concerning the concept of similarity relates to the resulting behaviour from the exposure to the case examples. Specifically, the three case examples provided in the current study depicted situations where pilots breached the minimum safe altitude through the course of performing a specific task and were subsequently involved in an accident. In the test flight, the expected actions of the pilots were considerably different to those of the pilots in the case examples. Therefore, the case examples could be interpreted as models of behaviour that should be avoided, rather than models of appropriate actions. While these case examples provide pilots with information of what not to do, there is little, if any information from these case examples informing pilots of the appropriate behaviour. In fact, depending upon what each pilot perceives as the priority with the test flight, (i.e., complete task, arrive safe, conserve fuel, remain above the MSA) providing that they did not crash the aircraft, exposure to the case examples may be perceived as relatively successful.
The above view, in which participants might have perceived the exposure to the case examples as relatively successful is consistent with Kirsner et al., (1997) who examined fourth year medical students using a case-based learning programme that was designed to facilitate the acquisition of diagnostic skills in relation to patients who had suffered a stroke. The students were provided with information about the typical symptoms experienced by stroke patients and were then provided the opportunity to apply this information. A clear distinction between the current study and the study conducted by Kirsner et al. (1997) is that Kirsner et al. provided information about the appropriate behaviour, whereas the current study provided information about inappropriate behaviour and the appropriate behaviour was implied, rather than explicit. Therefore, future research needs to address this issue of similarity with case examples to effectively design training programmes and/or initiatives that provide reliable results, prior to their endorsement.

5.7.2 Better than the Norm

Another possible explanation that might provide insight into the participants’ behaviour in the electronic newsletter and video groups, is that these two training groups may not have been able to relate to the case examples because they perceived the pilots’ behaviour in the case examples as inferior to their own. The case examples to which they were exposed provided information about pilots who flew their aircraft in a manner that may have been portrayed as dangerous and/or irresponsible by the participants and, therefore, they may have been unable to relate to the information. Research conducted in the automotive industry examining similar behavioural characteristics to that shown by the pilots in the case examples suggests that individuals generally perceive their handling ability and behaviour as superior to the
norm (Berger & Persinger, 1980; Anderson, 1978). As a result, Brown and Groeger (1988) suggest that training programmes which focus on providing information about specific behaviours and objective dangers relating to a particular activity have little effect on the subsequent behaviour of the recipient. Brown and Groeger (1988) attribute this lack of success to the identification of the potential hazards, rather than responding to the potential risk.

Anderson (1978) suggests that exposing individuals to factual information about accident involvement and traffic hazards may actually be counter-intuitive for those concerned. This information may serve individual biases that accidents occur to others and not to themselves. This, in turn, may fuel self-fulfilling prophecies that an individual is a safer and more skilful driver than most others on the road. Support for this perspective can be derived from Berger and Persinger (1980) who contend that it is not the fact that some motorists do not consider driving to be dangerous, but that they do not consider the danger to personally apply to them. In the case of the current study, providing pilots with information about other pilots’ behaviour may have a similar effect to providing motorists with objective risk information. DeJoy (1992) further examines this notion of danger and personal liability and suggests that if training intervention strategies are to be successful, they need to personalise the risk involved in the task.

The current study appears to provide some support for DeJoy (1992), where those participants who were passively involved in the training breached the MSA more frequently than those pilots who experienced active involvement in the training task. Although future research is needed to investigate this notion of active involvement more thoroughly, the current study has utilised what might be considered active involvement, although this was coupled with performance appraisal.
5.7.3 Active Participation in Training Helps Facilitate the Acquisition of Knowledge

The results from the current study provided support for the second hypothesis, that those pilots who were cognitively active during the training would descend to a higher mean minimum altitude than those pilots who were cognitively inactive during the training. These results provide some support for the notion that being cognitively active during training facilitates the acquisition of knowledge, thereby making it more accessible and more thoroughly learnt (Kolodner, 1997; DeJoy, 1992).

The current study adopted a training regime consistent with that prescribed by Williams et al. (2002), in so far as explicit feedback followed performance during the flight phase. Specifically, pilots in the flight group received positive or negative feedback concerning their performance in relation to the altitude to which they descended during the training task. This feedback explicitly mentioned whether pilots breached the MSA regulation and descended beneath 500 feet or not. During the test flight in the following week, pilots appeared to adopt a behaviour that was less risky and remained, on average, at a significantly higher altitude than the average altitude descended in the other two groups. However, this outcome may have been a product of demand characteristics. On the basis of the results, it can be inferred that active participation in a training task, where feedback concerning performance is provided, has a positive impact on performance during a test flight. It does not distinguish between the provision of feedback and cognitive activity in relation to performance. This issue is examined in Experiment 2 in Chapter 6; in addition to a discussion concerning the limitations of both Experiment 1 and 2.

An extension of Experiment 1 was performed which examined in more detail, participants’ performance on a low-flying task after a delay of six months. Since, only
twelve out of the 51 participants who assisted with Experiment 1 were available for the extended experiment, the results were too small to be of utility and therefore, are not reported.
Chapter 6: Experiment 2-Cognitive Involvement and Risk Management

The following chapter extends the research conducted in Experiment 1 (Chapter 5) and examines, in greater detail, the relationship between different levels of cognitive involvement during a training task, and pilots’ risk-management performance during a subsequent test task. In addition, this chapter also examines the impact of feedback and memory on risk-management performance.

6.1 Improving Performance through Direct Involvement

Risk management is critical to successful performance in the aviation environment and pilots are expected to develop risk management skills as part of their training. Within the aviation industry, traditional training programmes do not specifically focus on teaching pilots the skills necessary to successfully manage risk. They generally incorporate risk management training into generic training programmes, often in the form of accident statistics and warnings. The expectation in exposing pilots to such data, is that, the presentation of this information will positively influence future behaviour. Such training programmes have appeared to experience only limited success (Molesworth et al., 2003). DeJoy (1992) suggests that, in order to overcome this problem, training programmes need to directly demonstrate an individual’s limits and capabilities. Typically, this requires cognitive involvement in the performance of a task.

Gregerson (1993) examined the potential benefits of actively involving inexperienced motorists in a driving task. Specifically, Gregerson (1993) examined a driving training technique where an instructor, seated beside an inexperienced motorist, provided a running verbal commentary about his/her driving performance.
The feedback provided by the instructor was in response to the behaviour of the inexperienced motorist which was viewed by the instructor as suboptimal (Gregerson, 1993). The results indicated an improvement in performance and highlights the benefits of providing direct feedback and actively involving individuals in the performance of a task.

Employing a similar technique to Gregerson (1993), Regan et al. (1998) employed a computer-based simulation where individuals obtained direct experience through active participation without the potential consequences associated with the real-life activity. Regan et al. (1998) divided sixty probationary licensed drivers into three different groups: A near miss group (avoidance), a mediated instruction group, and a control group. According to Regan et al. (1998), the principle behind the avoidance group is that providing individuals with a frightening encounter should facilitate the development of a set of general characteristics surrounding the situation. These characteristics are said to facilitate the recall of information surrounding the situation. If a similar situation is experienced and, if these characteristics are sufficiently uncomfortable, the individual will tend to avoid the situation in the future. In contrast, the mediated instruction group is based on the notion that learning can be moderated by external influences such as an instructor.

Regan et al. (1998) provided participants with training in the first week followed directly by a test drive. They were retested one week later. During training, the mediated instruction group worked through a multimedia exercise. The exercise provided instructions as to how to improve their driving technique, including effective scanning while driving, keeping ahead of the vehicle, and safe decision-making about traffic hazards. In contrast, the near-miss group and the control group watched a video that contained general information about driving. Following the computer based
instruction or the video, all three groups undertook a ‘treatment’ drive in the simulator. During this simulated drive, the near-miss group experienced a near miss situation where a car quickly reversed down a driveway, appearing to reverse into the path of the participant. In fact, the car stopped prior to the end of the driveway. In the case of the mediated instruction group, the driveway appeared further in the distance, providing the participant with sufficient time to exercise the risk perception skills that they had acquired in the training. In the case of the control group, they simply saw a stationary car parked in a driveway.

Following the treatment ‘drive’, all the participants viewed a video replay of their drive. During the video, the mediated instruction group was asked to verbalise what they had seen in the driving environment, in addition to their own driving and the actions of other drivers. In contrast, the control group simply viewed the video replay of their drive without any verbal input, while the near-miss group viewed the video replay of their drive, in addition to completing a self-analysis sheet which required them to rate their performance. Following the training, all of the participants undertook two simulated test drives. The first test drive occurred directly after the training (immediate condition) and the second test drive occurred one week later (delayed condition). Both test drives were similar in context to the baseline drive.

The results from the two simulated test drives indicated that the performance of the motorists in the near miss group and the control group did not improve post-training in either the immediate condition or the delay condition. In contrast, the performance of the participants in the mediated instruction group improved in both sessions.

The outcome of Regan et al. (1998) was interpreted along similar lines to Gregerson (1993). In both studies, it was concluded that a training method that
actively involved the participants in the task improved their performance on a subsequent test task. A closer examination of the results from both studies highlights the benefits of actively involving participants during training. In particular, those participants who were actively involved during the training performed at a superior level than the participants who were less involved during the training.

Although both Gregerson (1993) and Regan et al. (1998) yielded favourable results in terms of drivers’ performance, the level of cognitive involvement associated with the two training methods differed. As discussed in Chapter 2, cognitive involvement relates to whether individuals are immersed psychologically in an environment and make a decision/s or judgement/s about a situation/position. Individuals who are considered cognitively active during training, are fully immersed in the training environment and participate in decision/s or judgement/s about a situation or position that, if actioned, can have a direct impact on the outcome. Cognitively inactivity reflects a state where individuals are not involved in any decision/s or judgment/s about the situation or position.

In analysing the results from Gregerson (1993) and Regan et al. (1998) and those obtained from the first experiment (Chapter 5), there appears to be a strong indication to the effect that those participants who might be considered cognitively active during training perform at a superior level during a subsequent test task, in comparison to those participants who might be considered more cognitively inactive during training. Moreover, the results from the first experiment indicate that those participants who were cognitively inactive during training (i.e., either read an electronic newsletter or watched a video) descended to a lower mean minimum altitude than those participants who were cognitively active (i.e., flew simulator and received feedback) during training. Experiment 2 extends the previous research and
examines in greater detail, how different levels of cognitive involvement during a training task impact individuals’ risk management performance during a subsequent test task. Specifically, ‘Experiment 2 compares the performance of pilots who act as the pilot-in-command (cognitively active) during training, and those pilots who act as co-pilots (cognitively inactive) during training on a subsequent low-flying test task’.

A pilot-in-command takes responsibility for the aircraft and any passengers on board. As part of this role, they actively make decisions and/or judgements about the safe operation of the aircraft. In contrast, a co-pilot is essentially the ‘second in charge’, and while they have distinct responsibilities, their role is primarily a support role for the pilot-in-command. Therefore, the current study intends to examine whether differences between the levels of cognitive involvement associated with acting in the role of either a pilot-in-command or a co-pilot during a training task impact individuals’ risk management performance during a subsequent test task. A second aim of the current research is to examine the impact of feedback on individuals’ performance following training.

6.2 Effects of Feedback and Memory on Risk Management Performance

The impact of feedback on individuals’ performance following training is significant, as the provision of feedback provides individuals with the opportunity to learn by enabling them to reflect on the events that occurred during training (Javaux, 2002). Feedback may be positive or negative and may be presented in many different forms, such as verbal, physical and/or monetary. It may also be provided by numerous different sources, including superiors, subordinates, colleagues, friends, and family, while at the same time, it may also result from personal reflection/s (Ohlsson, 1996).
Lyons et al. (1998) contend that the effectiveness of feedback is contingent on the timing, its relevance, and whether or not it is embedded within the learning experience. Provided that feedback is immediate, relevant and embedded in the learning experience, it is likely to enhance the long-term viability of the information being learnt (Lyons et al., 1998).

While Goodman, Wood, and Hendrickx (2004) acknowledge the importance of timing and feedback relevance in improving individuals’ performance, they also argue that the specificity of feedback plays an equally important role. According to Kopelman (1986), specific feedback that informs an individual of the distance to the performance criterion and suggests the best method to achieve the goal leads to greater improvements in performance. However, Goodman et al. (2004) suggest that providing specific feedback is not always beneficial. While increasing the level of specificity of feedback improves future performance on the same task, it may reduce the extent to which an individual will explore the effects of different options when trying to solve a similar problem. Frese et al. (1991) attribute the results to the fact that highly specific feedback reduces the number of errors committed during practice. While mitigating errors in the operational environment is an overriding goal of training, it is equally important to provide individuals with the knowledge and skills to effectively manage or correct a broad range of errors and poor performance that they may experience. In effect, errors provide individuals with opportunities to learn (Frese et al., 1991). Within a training context, errors create an opportunity to learn what to do when things go wrong. By decreasing the opportunity to experience errors during training, it potentially decreases the extent to which an individual will learn how to correct their own erroneous behaviour or actions (Goodman et al., 2004).
In addition to the specificity of feedback, Goodman (1990) proposes that the frequency and timing of feedback is also crucial to the learning experience. While feedback that is frequent and immediate has proven beneficial in the short-term, it appears to undermine the extent to which information will transfer from one task to another. In contrast, according to Schmidt (1991), less frequent and delayed feedback over multiple trials leads to poorer performance, but facilitates greater learning. This relationship between delayed feedback and greater learning is said to occur as a result of individuals employing greater use of their cognitive resources in an attempt to improve their performance (Schmidt, 1991). Evidence to support these claims is derived from the research conducted by Goodman et al. (2004). Goodman et al. divided 161 participants into four groups. The four groups varied as a result of feedback specificity. The participants were first asked to complete a training session followed two days later by a test task. During training, the participants were asked to complete an 18-trial practice decision-making task, while during the test task they were asked to complete a six trial testing phase. The results revealed that increasing the specificity of feedback positively affected practice performance, but did not endure over time or task modification. Further, the results also indicated that feedback specificity negatively affected levels of exploration during practice (Goodman et al., 2004). These results were interpreted as support for the proposition that increasing the level of feedback can negatively impact creative problem solving and may reduce the generalisation of the information acquired during training. As a result, if improvements through the use of feedback are desired, the content of the feedback should be specifically designed to ensure that it is informative, but does not lead the individual to one specific conclusion.
While Goodman et al. (2004), Goodman and Wood (2004), Frese et al. (1991), Kopelman (1986), and Schmidt (1991), highlight the benefits associated with limiting the specificity of feedback, Molesworth and Wiggins (2004) discuss how feedback is highly dependent on an individual’s memory. Specifically, if individuals are unable to recall the feedback, then improvements in future behaviour/s are less likely to occur.

In the case of analogical transfer, where it is proposed that problem solving can be enhanced through the transfer of knowledge from one domain to another (Holyoak, 1984), the success of such transfer can be enhanced through the effective use of feedback. According to Holyoak (1984), the process of analogical transfer occurs in four basic steps. Firstly; (a) Individuals must construct mental representations of the source and the target; (b) they must then select what they perceive as an appropriate source to the target; (c) they must map the source to the target and, finally, (d) they must generate a solution of best fit to the target (Holyoak, 1984). Holyoak and Koh (1987) describe the second stage of this process, the selection of a source analogy, as the least understood amongst the four stages, which has also been described as the stage which is most influenced by effective feedback. It appears that the selection of a source analogy is least understood because there is little knowledge as to how individuals select a source analogue from their potentially large knowledge base (Holyoak & Koh, 1987).

The generation of a source analogue involves selecting an analogue from memory and perceiving the relationship between it and the target analogue. While it is commonly agreed by researchers that it is impossible to encode one's experience in a way that will guarantee retrieval at a later date, there are methods that individuals can employ to facilitate the retrieval of information (Carbonell, 1983; Kolodner, 1987; Holyoak & Koh, 1987). Carbonell (1983) suggests that the retrieval of analogies can
be improved if individuals organise their metaphorical database by similarities. Such similarities may be based on the components in the problem, the goals of the problem, and/or the constraints experienced.

Evidence to support the benefits associated with organising information in databases is derived from the research conducted between novices and experts. As discussed in Chapter 2, experts perceive situations holistically, which entails multiple characteristics (Benda & Hoyos, 1983; Milech et al., 1989). Such a holistic perception, where multiple characteristics are assessed, stems from the ability to organise and if need be, reorganise knowledge in memory, based on different schemata and scripts. According to Carbonell (1983), it is how these schemata and scripts are organised that facilitates their retrieval.

The process of information retrieval from memory is generally considered in relation to the recall of explicit information (Schab, 1991). However, more often than not, to facilitate the explicit recall of information, researchers or examiners tend to increase the degree of elaboration about the material being examined to positively influence the accuracy of the information recalled (Schab, 1991). In contrast to the explicit recall of information from memory, individuals may also implicitly recall information from memory (Blaxton, 1989). The distinction between explicit and implicit memory retrieval is based on whether or not an individual attempts encoding deliberately (Schab, 1991). In the case of explicit memory, individuals attempt to deliberately encode information in memory. In the case of implicit memory, information is encoded in the absence of a deliberate strategy. To facilitate the recall of information implicitly, Schab (1991) proposes using different modalities to present the information. In the case where analogical transfer is employed to facilitate transfer between a base analogue and a target analogue, emphasis needs to be placed on the
degree to which information is elaborated on, to facilitate the explicit recall of information from memory (Schab, 1991; Blaxton, 1989).

In summary, it is evident that providing feedback, which is both timely and appropriate to the task at hand, is likely to be beneficial in improving future performance. Further, it is also important to restrict the specificity of the feedback to facilitate creative problem solving. However, a potential restriction in the effectiveness of this feedback is individuals’ memory for the information. While researchers agree that it is generally impossible to code information in a particular way that will guarantee retrieval, Schab (1991) suggests that, in order to mitigate the potential problem/s caused by individuals being unable to explicitly recall feedback at an appropriate time, emphasis needs to be placed on the degree to which information in case examples are elaborated upon. Therefore, Experiment 2 investigates the potential benefits of incorporating feedback (informative but not conclusive) into pilots’ risk management training and its impact on risk management behaviour. Specifically, Experiment 2 compares the performance of pilots who receive feedback (feedback group) in relation to their performance during training, and those pilots who do not receive feedback (no feedback group) during training on a subsequent low-flying test task.

6.3 Improving Pilots’ Risk Management Behaviour

It appears that, in the case of aviation, the problem is not that pilots do not perceive aviation as dangerous (Hunter, 2002), but rather that pilots do not perceive that the danger applies to them personally (Hunter, 2002; O’Hare & Smitheram, 1995). Pilots appear to possess an exaggerated sense of their own ability and
underestimate the degree of risk involved in various flying activities (Hunter, 2002). Therefore, to improve pilots’ risk management behaviour, it is proposed that training and intervention strategies need to directly demonstrate individuals’ limits in potential risky situations (DeJoy, 1992; Hunter, 2002).

The current study (Experiment 2) is designed to further examine the personalisation of risk and builds on the outcomes of Experiment 1. Specifically, it examines the relationship between feedback and different levels of cognitive involvement during training, in terms of their impact on pilots’ risk management behaviour. Pilots were divided into four groups and completed a simulated low-flying task, followed by a test flight in the following week. Data pertaining to the mean minimum altitude descend during the test flight were examined in relation to training group. Two hypotheses are proposed;

1. That pilots who are cognitively active (pilot-in-command) during a low-level training task will adopt more risk averse behaviour as measured by the minimum altitude descended during a subsequent test task, in comparison to those pilots who are cognitively inactive (co-pilot) during the training.

2. That pilots who receive feedback concerning their performance during a low-level training task will adopt more risk averse behaviour as measured by the minimum altitude descended during a subsequent test task, in comparison to those pilots who do not receive any feedback during the training.
In addition to the two hypotheses, two research questions are proposed,

1. Do general aviation pilots prefer one particular decision-making strategy to another in the process of assessing the minimum altitude in which to descend during a simulated low-flying task?

2. Does general aviation pilots' orientation towards risk while flying over the oil tanker differ depending on the altitude flown?

6.4 Method

6.4.1 Participants

Consistent with the first experiment, participants were recruited from the Bachelor of Aviation (Flying) degree at the University of Western Sydney and from the various flying schools located at Bankstown airport. Forty participants were recruited for the study, and were randomly divided into four groups. All of the participants were naïve as to the purpose of the research (see Table 4).

Table 4
Frequency of participants distributed across training group and information relating to performance.

<table>
<thead>
<tr>
<th>Training group</th>
<th>Information relating to performance</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feedback</td>
<td>No feedback</td>
</tr>
<tr>
<td>Single Crew</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Multi-Crew</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>
Table 5 outlines the demographic features and the median experience of the participants, distributed across the four groups. Similar to Experiment 1, it was expected that the data pertaining to the total hours flying experience and the total hours of low-level flying experience would be positively skewed, a Kruskal-Wallis nonparametric test was used to determine whether differences existed between the three groups on the basis of flying experience. With alpha set at .05, the results of a Kruskal-Wallis chi-square approximation, corrected for ties, failed to reveal any statistically significant differences between groups in terms of the total hours flying experience \( \chi^2(3, N = 40) = 1.43, p = .70 \) and the total hours low-level flying \( \chi^2(3, N = 40) = 3.45, p = .33 \). As a result, it can be concluded that the four groups (single crew/feedback, single crew/no feedback, multi-crew/feedback, and multi-crew/no feedback) were not significantly different in terms of their median total hours flight experience and their total low-level flying experience.
Table 5
Demographics and median experience of participants, distributed across exposure to low-level flying experience.

<table>
<thead>
<tr>
<th>Training group</th>
<th>Mean Age (SD)</th>
<th>Median total hours flying experience (range)</th>
<th>Median total hours low-level flying (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (Single crew/ Feedback)</td>
<td>32.30 (18.6)</td>
<td>138 (6580)</td>
<td>.75 (300)</td>
</tr>
<tr>
<td>Group 2 (Single crew/ No feedback)</td>
<td>37.60 (18.6)</td>
<td>210 (6888)</td>
<td>0 (100)</td>
</tr>
<tr>
<td>Group 3 (Multi-crew/ Feedback)</td>
<td>33.20 (15.4)</td>
<td>110 (467)</td>
<td>2 (15)</td>
</tr>
<tr>
<td>Group 4 (Multi-crew/ No feedback)</td>
<td>26.10 (12.4)</td>
<td>137 (919)</td>
<td>1 (20)</td>
</tr>
<tr>
<td>Total</td>
<td>32.30 (16.3)</td>
<td>138 (6894)</td>
<td>.50 (300)</td>
</tr>
</tbody>
</table>

6.5 Design

The study was designed to examine the extent to which feedback during a simulated low-flying training task impacts pilot performance during a subsequent test flight scenario. However, it was also designed to examine the impact of different levels of cognitive involvement during training on pilot performance. The study comprised a three-way (cognitive involvement x condition x similarity) between-groups factorial ANOVA, with two levels of cognitive involvement (pilot-in-command and co-pilot), two levels of condition (feedback and no feedback), and two levels of similarity (ability to recall similar experience/s during test flight and unable to recall similar experience/s during test flight). Similarity was included as the third
independent variable, since it was important to test risk-taking propensity as a function of the training group (i.e., pilot-in-command or co-pilot), and not the memory or ability of the pilots to recall similar experience/s or case example/s during the test flight (this variable was also dichotomous, further excluding this variable from featuring as a covariate). The dependent variable for the study was the mean minimum altitude descended during the test flight. Consistent with the test task in Experiment 1, the participants in the current experiment were asked to track from Bankstown aerodrome to an oil tanker in Botany Bay and read a number located on the deck of the oil tanker. The number located on the deck of the oil tanker had been deliberately manipulated so that it was legible above 500 feet, thereby removing any requirement to violate the minimum safe altitude and descend beneath 500 feet. Additional dependent variables included the frequency with which participants descended beneath 500 feet, the time spent beneath 500 feet, the level of control exercised over the aircraft, and pilot’s subjective orientation towards risk. For all statistical procedures, an alpha level of .05 was set.

6.6 Materials

The materials were consistent with the first experiment, with only two exceptions. Two seventeen inch Liquid Crystal Display (LCD) monitors were included that were positioned on either side of the existing twenty-one inch CRT monitor, as illustrated in Figure 4 and a Matrox Parhelia 256 High Fidelity Graphics Card was used (see Materials section from Experiment 1 for comprehensive listing). In total, the three monitors provided a 160-degree view for the pilots. The lower portion of the centre monitor displayed the basic instrument functions of a Cessna
172, including the airspeed indicator, altimeter, vertical speed gauge, artificial horizon, turn and slip indicator, and directional gyroscope. In addition to these basic gauges, a radar altimeter, Revolutions Per Minute (RPM) gauge, and a fuel gauge were displayed on the right side of the console. On the upper portion of the centre monitor, and on both of the two LCD monitors, pilots were provided with the type of scenery that was consistent with the information that would be perceived in an actual cockpit.

![Figure 4](image_url)

*Figure 4.* An illustration of the computer based flight simulator including the Cirrus Two Flight Console with the Beech Yoke

### 6.7 Procedure

All participants were informed verbally and through the information sheet that the experiment would consist of two sessions, each of which would be undertaken one week apart. The participants were asked to complete a consent form and a demographics form. In the first session, participants were either randomly divided into
pairs (multi-crew) or remained as single operators (single operation). All of the participants were provided with the same flight details, which consisted of a simulated flight on the computer-based flight simulator that departed from Williamtown, NSW Australia and tracked south (see Appendix C for all material and stimuli pertaining to Experiment 2). This flight was a direct reproduction of the training flight (south of Williamtown) in Experiment 1. In brief, the objective of the flight was to locate a house 10 nautical miles south of Williamtown and identify and note the number of motor vehicles that passed the house within a ten-minute period.

In the multi-crew group, participants were allocated randomly to the position of pilot or co-pilot for the training flight. Prior to departure, all of the participants were provided with a pre-flight briefing concerning the aim and objective of the flight and were asked to conduct the operation in accordance with the aviation rules and regulations. The pilots were also asked to operate the aircraft as they would in the normal operational environment. Finally, participants were informed that they did not need to make radio calls, they did not need airways clearance, and that there were no restricted areas active.

At the conclusion of the flight, depending upon the group to which the participants were randomly assigned, they either received feedback concerning their performance and/or were thanked for their participation. For those participants who received feedback, two different types of feedback (positive or negative) were provided consistent with Experiment 1 (see Experiment 1 for details relating to feedback). Finally, all participants were asked to complete a brief, short-answer questionnaire. The questionnaire asked each participant to state the number of motor vehicles that they were required to count during the flight. It also provided them with
an opportunity to reflect on the flight and highlight any key point/s or lesson/s learnt (see Appendix C).

In the second session, in the succeeding week, participants from all training groups conducted an identical, simulated flight as individuals. The participants were provided with a set of instructions prior to the flight that outlined the nature of the flight and the objective (see Appendix C). The test flight scenario used in Experiment 1 was identical to this experiment. The participants departed from Bankstown airport on runway 11 centre and then turned left onto a heading of 085 degrees and tracked direct to Sydney International airport where they then tracked 155 degrees direct to an oil tanker located in Botany Bay.

The participants were asked to read a three-digit number that was located on the deck of the oil tanker. After completing the task, the participants were asked to track back to Sydney International Airport and make a straight in approach for runway 34 left. The respective distances were 9.5 nautical miles between Bankstown airport and Sydney International, and 3.8 nautical miles between Sydney International and the oil tanker. The overall distance of the flight was 17.1 nautical miles. Fuel levels were manipulated so that the participants could spend a maximum of ten minutes over the oil tanker before they started to use their reserve fuel. The total fuel aboard the aircraft was 56lbs. Calculating the fuel consumption of a Cessna 172 at full throttle for the duration of the flight, plus the mandatory 45 minutes of reserves, allowed for a total flight time of 66 minutes. On completion of the flight, the participants were asked to complete a final set of questions. Consistent with Experiment 1, the questionnaire was designed to examine participants’ perception of their performance on the task (number on oil tanker), as well as their ability to recall any similarities between the test flight and other flight/s undertaken, including simulation/s, and the
decision-making strategy employed throughout the task (see Appendix C). They were also asked to read the same pre-flight briefing as had occurred in the first week.

6.8 Results

The data obtained from X-Plane were transferred directly from the output file of X-Plane to Statistical Package for the Social Sciences (SPSS), version 11.5. This process was made possible through a template within SPSS which directly transformed the data (see Appendix C).

The main objective of the present study was to examine the altitude to which the participants descended over the oil tanker. Therefore, consistent with Experiment 1, a five nautical mile boundary was determined around the oil tanker and it was assumed that, within this five nautical mile boundary, the behaviour of the pilot would be oriented towards the task (reading the number located on the deck of the oil tanker during the 10 minute period) (see Experiment 1 for exact location of oil tanker and exclusion boundary).

Consistent with the application of parametric statistics, the data were tested for normality and homogeneity of variance. As in Experiment 1, the results revealed that the data pertaining to the mean minimum altitude to which pilots descended over the oil tanker were significantly non-normal. Specifically, the data were positively skewed with a positive kurtosis (leptokurtic) that was significantly different from zero across all groups ($p < .001$). Consistent with Experiment 1, these skewed data (floor effect) may be explained in relation to the lower limit imposed by the Minimum Safe Altitude (MSA) as per low-flying regulations to which the pilots could legally descend (i.e., 500 feet above ground).
To ensure that the data were consistent with the application of parametric statistics, the data pertaining to the mean minimum altitude descended were transformed using a square root transformation as prescribed by Tabachnick and Fidell (2001). A subsequent multivariate analysis revealed that the transformed data were normally distributed with both the skewness and kurtosis non-significantly different from zero across all groups (i.e., $z < 3.29$, $p > .001$) (Tabachnick & Fidell, 2001).

### 6.8.1 Frequency of Pilots Descending Beneath 500 Feet

The minimum altitude to which each pilot descended was examined in relation to the VFR low-flying regulations. In total, 46% of participants who flew the aircraft during training (pilot-in-command) descended beneath 500 feet in the second week, while 86% of the participants who were co-pilots in the training flight descended beneath 500 feet. However, a chi-square analysis failed to identify a significant relationship between descent beneath 500 feet and the training group to which the participants had been assigned $\chi^2(1, N = 40) = 3.754$, $p = .06$; Fisher’s exact test, $p = .095^6$. For those participants who descended beneath 500 feet, the mean time spent beneath this altitude was 88 seconds (SD = 82).

Having established the proportion of participants who descended beneath 500 feet during the exercise and the average time spent below 500 feet, the data were examined to determine whether the participants were aware of the altitude to which they descended. This is significant, since it indicates whether the participants were aware of their behaviour throughout the exercise. A subsequent Pearson’s product-

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6 The $p$ value using Fisher’s exact test was calculated instead of the chi-square value because 2 cells have an expected count less than 5. The minimum expected count is 3.33 (Heiman, 1996; Siegel, 1956).
moment correlation identified a significant positive correlation, \( r(38) = .88, p < .01 \) between the actual altitude to which the participants descended and the perception of the altitude to which they descended. As a result, it can be concluded that the participants were, to some extent, aware of the altitude to which they descended during the exercise, and that a descent below 500 feet was not necessarily due to a lack of awareness of the operational conditions.

In justifying their descent beneath 500 feet, 14% of the participants who descended beneath 500 feet claimed that their descent was due to the sensitivity of the flight controls. To examine if a difference existed between groups relating to the sensitivity of the flight controls, a univariate analysis of variance was employed. The results failed to reveal a significant difference between the pilots flying the aircraft in the first week and their handling characteristics (due to the sensitivity of the controls) \( F(1, 38) = 4.02, p = .06, \eta^2 = .096 \) (see Table 15). This suggests that all group members exercised similar levels of control over the aircraft.

Although the reasons given by the participants for the descent beneath 500 feet varied amongst the 21 participants, a majority (57%) acknowledged that they had violated the low-flying regulations, while 19% were undecided as to whether they had violated the regulations or not, and the remainder (24%) felt that they had not violated the regulations.

To examine if one decision-making strategy was used more frequently than another in determining the minimum altitude to which to descend the response to the question relating to the specific decision-making strategy employed were examined. The results revealed that 29% of the participants recalled previous situations that they had experienced when making a decision, 33% considered the pros and cons of the situation, 19% used rules to assist with their decision, 5% recalled previous examples
that they had read or heard about, 10% based their decision on a model, and the
remaining 5% indicated that they knew immediately whether it was appropriate or not
to proceed. However, a chi-square analysis failed to identify a statistically significant
relationship between the strategies used to determine the minimum altitude to which
to descend and the training group to which pilots were assigned $\chi^2(5, N = 21) = 7.88,$
$p = .16; \text{Fisher’s exact test, } p = 7.54^7$. Therefore, the results indicate that no one
decision-making strategy was selected amongst those pilots who descended beneath
500 feet.

6.8.2 *Mean Minimum Altitude Descended for Group*

The primary aim of the present study was to examine whether different levels
of cognitive involvement during a training exercise would impact pilots’ risk
management behaviour during a subsequent test scenario. A three-way (cognitive
involvement x condition x similarity) between-groups factorial ANOVA was used to
determine whether differences existed between the mean minimum altitude descended
for participants who flew the aircraft in the first week (pilot-in-command or co-pilot),
across similarity. Similarity referred to participants’ ability to recall any similar
experience/s (simulation or actual flight) to the test flight (dichotomous variable). The
results revealed a main effect for group (pilot-in-command or co-pilot) $F(1, 32) =
8.15, p = .008, \eta^2 = .203$ (see Table 16), whereby pilots who were actively operating
the aircraft during training remained a higher minimum altitude than those pilots who
acted as co-pilots during the training.

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7 The *p value* using Fisher’s exact test was calculated instead of the chi-square value because 11 cells
have an expected count less than 5. The minimum expected count is .29 (Heiman, 1996; Siegel, 1956).
However, there was no main effect for condition (feedback/no feedback) or for similarity. This suggests that, pilots’ performance during the test flight was not impacted by the presence or lack of explicit feedback during training or their ability to recall a similar flight experience during the test flight. The mean minimum altitude\(^8\) to which the participants descended in each group was 541 feet (SD = 306) for those pilots who flew the simulated flight during training, and 234 feet (SD = 269) for those pilots who were co-pilots during the training. In comparing the mean minimum altitudes to which the pilot’s descended across the groups, the results suggest that participants who experienced a training task where they were cognitively active (pilot in command), maintained a significantly higher average altitude than those participants who were cognitively inactive (co-pilots) during training in a subsequent test task.

The second aim of the study was to examine whether an interaction was evident between feedback and similarity. The results of the initial analyses revealed an interaction between condition (feedback/no feedback) and similarity \(F(1, 32) = 5.38, p = .27, \eta^2 = .144\) (see Table 16). This indicates that those pilots who received feedback during the training and who were able to recall a similar experience/s during the test flight remained at a statistically significant higher altitude\(^9\), on average (581 feet (SD = 259)), than those pilots who received feedback, but were unable to recall

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\(^8\) Data are actual rather than transformed for illustrative purpose. Transformed data for each group were 22.32 (6.70) for pilots who flew the simulated flight during training and, 12.36 (9.78) for those pilots who were co-pilots during training.

\(^9\) Data are actual rather than transformed for illustrative purpose. Transformed data for each group were 23.57 (5.25) for those pilots who received feedback and were able to recall similar experience/s, 15.40 (10.26) for those pilots who received feedback but were unable to recall any similar experience/s, 15.80 (9.01) for those pilots who did not receive feedback but were able to recall similar experience/s, and 21.57 (8.35) for those pilots who did not receive feedback and were unable to recall any similar experience/s.
any similar experience/s during the test flight (325 feet (SD = 311)). In comparison, those pilots who did not receive feedback during the training but were able to recall a similar experience (415 feet (SD = 277)) descended, on average, to an altitude lower than those pilots who did not receive feedback and were unable to recall any similar experience/s during the test flight (528 feet (SD = 419)) (see Figure 5). These results indicate an effect in which feedback and the ability to recall similar experiences was associated with more risk averse behaviour during testing.

Figure 5. Interaction between mean minimum altitude descend, ability to recall similar experience/s and feedback

To determine whether differences in pilots’ performance were evident as a result of the type of feedback (i.e., positive or negative) that pilots received at the conclusion of the training flight, data from only those pilots who received feedback were analysed. The results of a univariate analysis with feedback (positive or negative) as the independent variable and the mean minimum altitude descended
during the test flight as the dependent variable, revealed a statistically significant difference $F(1, 18) = 5.40, p = .03, \eta^2 = .231$ (see Table 17). The mean minimum altitude to which the participants descended in each group was 353 feet (SD = 238) for those pilots who received positive feedback, and 627 (SD = 285) for those participants who received negative feedback following the training flight. In comparing the mean minimum altitudes to which the pilots descended across groups, the results suggest that participants who experienced negative feedback as a result of their performance during training, maintained a significantly higher mean minimum altitude than those participants who received positive feedback during the training, in a subsequent test task.

To determine whether a relationship existed between feedback (feedback or no feedback) and similarity (recall similar flight/s or unable to recall similar flight/s), a two-way chi-square analysis was performed. However, the results failed to identify a statistically significant relationship between feedback and similarity $\chi^2(1, N = 40) = 1.67, p = .20$. Therefore, those pilots who received feedback following the training flight were no more likely to recall any similarities between the test flight and any other flight, including simulated flights, than those pilots who were not provided with feedback following the training flight.

Finally, to determine whether those participants who were unable to recall a similar experience actually learnt what was intended during the training flight, as determined by their ability to generate a rule or one main point following training pertaining to low-level flying, a two-way chi-square analysis (similarity and rule generation) was performed. However, the results failed to identify a statistically significant relationship between similarity and ability to generate a rule or main point derived from the training $\chi^2(1, N = 40) = 1.11, p = .29$. This result suggests that
irrespective of whether pilots perceived the test flight as similar to any other experienced flight, there were no differences in their ability to generate a rule derived from the training flight. This result has significant implications, as any differences evident were not related to differences in encoding the information from training.

6.8.3 Pilot’s Orientation towards Risk

To examine pilots’ orientation towards risk while flying over the oil tanker, data pertaining to each pilot’s flight path (altitude, latitude and longitude) were graphed using the interactive graph feature in SPSS 11.5 (see Appendix C). This is significant, as discussed in Experiment 1 because the direction of the pilots’ flight path is, in part, a reflection of their orientation towards risk (see Experiment 1 for full explanation). Consistent with Experiment 1, pilots’ performance was divided into three groups (zero number of circuits, 1-3 number of circuits, and 4-7 number of circuits) and a series of chi-square analyses were performed examining the relationship between the number of circuits and the flight path (overhead, north, and south of the oil tanker) (see Appendix C: Experiment 2 for chi-square analyses for descent beneath 500 feet and individual number of circuits). A subsequent chi-square analysis failed to identify a significant relationship between descent beneath 500 feet and the number of circuits performed overhead the oil tanker $\chi^2(1, N = 40) = .85, p = .36$; Fisher’s exact test, $p = .53$, and descent beneath 500 feet and the number of circuits north of the oil tanker $\chi^2(2, N = 40) = 1.55, p = .46$; Fisher’s exact test, $p = .54^{10}$. Finally, a one-way chi-square analysis failed to reveal a significant difference between descent beneath 500 feet and the number of circuits south of the oil tanker
\chi^2(1, N = 40) = 1.00, p = .75 (a one-way chi-square analysis was employed since all pilots completed between one and three circuits south of the oil tanker). These results suggest that the flight path of the aircraft was relatively consistent between those pilots who descended beneath 500 feet and the pilots who remained above this altitude during the test flight. As no statistically significant difference was observed between the two groups in relation to the descent beneath 500 feet and the number of circuits overhead, north or south of the oil tanker, it might be concluded that all pilots exercised a similar level of risk management behaviour in terms of their choice of flight path during the test flight (see Table 6).

Table 6
*Circuit direction and number, distributed across whether participants descended beneath 500 while reading the number on the oil tanker.*

<table>
<thead>
<tr>
<th>Circuit Direction</th>
<th>Descent below 500 feet</th>
<th>Number of circuits over oil tanker</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1-3</td>
</tr>
<tr>
<td>Overhead</td>
<td>Yes</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>North</td>
<td>Yes</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>South</td>
<td>Yes</td>
<td>-</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>-</td>
<td>19</td>
</tr>
</tbody>
</table>

The p value using Fisher's exact test was calculated instead of the chi-square value because 4 cells have an expected count less than 5. The minimum expected count is 3.33 (Heiman, 1996; Siegel, 1956).
6.9 Discussion

On the basis of previous research, Experiment 2 was designed to test the extent to which cognitive involvement in training, and the provision of feedback improved risk management performance amongst pilots. Forty participants were involved in the study and, in the first week, they were divided into groups so that some pilots flew in pairs during training, while others flew as single pilots. Following training, half of the participants received feedback concerning their performance. During a test flight in the following week, those pilots who were cognitively active during training displayed more risk averse behaviour, as measured by the mean minimum altitude descended, in comparison to those pilots who were simply co-pilots (cognitively inactive).

In relation to the hypotheses, the results from Experiment 2 supported the first hypothesis, but not the second. The first hypothesis predicted that those pilots, who were cognitively active (pilot-in-command) during the training task would adopt more risk averse behaviour as measured by the mean minimum altitude descended, in comparison to those pilots who were cognitively inactive (co-pilot) during the training. The second hypothesis predicted that those pilots, who received feedback concerning their performance during training, would adopt more risk averse behaviour as measured by the mean minimum altitude descended during the task, in comparison to those pilots who do not receive feedback during training.

The results relating to the second hypothesis revealed that the provision of feedback during training only appeared to be beneficial when pilots were able to recall similarities between the test flight and other flight/s that they had experienced. A closer examination of the results relating to the type of feedback pilots received (i.e.,
positive and negative) revealed that pilots who received negative feedback tended to adopt a behaviour that could be described as more risk averse than those pilots who received positive feedback. While the results clearly indicate the benefits of feedback, specifically negative feedback in the current context, an examination of the relationship between similarity and rule generation suggests that an individual’s ability to encode information from the training flight had no impact on whether they were able to recall a similar experience or not. This has significant implications for the transfer of learning, as it suggests that a participant’s ability to appropriately match the relevant analogue to the target, rather than encoding the information taught during training, plays an important role in facilitating transfer. Alternatively the results may simply be interpreted as support for the notion of cognitive involvement, where being actively involved in the task, facilitates the acquisition of task-related knowledge. To investigate these issues in terms of transfer of training, two specific areas need to be considered: Selecting a source analogy, and the abstract nature of the similarities between the two test tasks.

6.9.1 Selecting a Source Analogy

If a person is confronted with a problem, it is often the case that he/she will attempt to solve the problem by drawing on an analogy where the solution has been established previously (Holyoak & Koh, 1987). To facilitate the development of analogies, the literature relating to analogical transfer suggests that knowledge gained through activities where individuals have a personal motivation or interest in the task, is learnt more deeply, and/or is more useable than knowledge gained through textbooks or memorisation (Kolodner, 1997). However, in such situations, an
important prerequisite for the development or acquisition of knowledge, is knowing when one needs to learn. Kolodner (1987) suggests that students need to reflect on appropriate experiences to extract and articulate what they have learnt. Such reflections, although not empirically tested, are said to facilitate the development of examples which, in turn, may be used to make useful analogical inferences.

As discussed at the start of this chapter, Holyoak (1984) identified four basic steps that must be performed systematically before analogies can be used to derive solutions. The least understood of these steps is the second stage: The selection of a source analogue (Holyoak & Koh, 1987). This stage generally involves selecting a source analogue from memory and understanding the relationship between it and the target analogue. While researchers agree that it is impossible to encode one's experience in order to guarantee retrieval at a later date, there are certain methods that can be employed in order to facilitate the retrieval of information (Carbonell, 1983; Holyoak & Koh, 1987; Kolodner, 1987). One such method that was previously discussed involved coding and/or organising individuals' analogies based on a database, sorted by similarities (Carbonell, 1983). Another method to facilitate individuals' recall of information was proposed by Schab (1991), which involved elaborating on the material being examined. While both suggestions have merit, in an applied setting, the degree to which one can provide detailed information about an analogue imposes significant restrictions.

While the present study found evidence to support the use of analogical transfer as a training method, it also identified potential limiting factors. Prior to prescribing such a training approach, additional research is required to further investigate the precise role of recognition/memory in these findings. In view of the current literature relating to feedback and the explicit recall of information from
memory, it appears that greater emphasis needs to be placed on the detail of the
information presented (i.e., key points of example) and the different media (i.e., with
an emphasis on personalising the experience) that are used to present this information,
to ensure that the information is salient.

6.9.2 The Abstract Nature of Similarities between Tasks

The differences evident in pilots’ performance in relation to their ability to
recall similarities between the test flight and other flights undertaken, may relate to
the abstract nature of the similarities between the training and test tasks. During the
training task, participants were asked to identify and note the number of motor
vehicles that passed a house over a ten-minute period. However, in the test task, the
participants were asked to read a number located on the deck of an oil tanker.
Although both of these tasks have similarities from a surface perspective, (i.e.,
involved low-flying, flying the same aircraft (Cessna 172), similar holding patterns
(circling) and a spotting task) and a structural perspective (risk management
behaviour), the similarities may not have been sufficiently evident to the participants.

In a review of the literature pertaining to analogical transfer, Reeves and
Weisberg (1994) examined the distinction between two problems based on their
structure. The structure in each problem could be characterised on the basis of the
hierarchical representation of the concrete details of each problem, to an abstract
description of the solution employed. The structure of a problem can be decomposed
into two key components. The first component encompasses the surface elements,
which are described as the features that classify and characterise the problem (Reeves
& Weisberg, 1994). Gentner (1989) refers to surface elements as both the entities
which represent individual objects, and the attributes of such objects or variables.
Surface elements may best be described by referring to the ‘Fortress’ story which was used in an experiment to examine transfer of learning by Gick and Holyoak (1980).

The Fortress was the title of a story analogy used to describe how a dictator ruled a small country town from a strong fortress. The fortress was situated in the middle of a country surrounded by farms and villages. A great general arose and raised an army that was situated on the country’s border and planned to capture the fortress, in turn overthrowing the dictator and freeing the country’s people. The roads which radiated from the fortress, like spokes on a wheel were lined with mines to prevent large bodies of men using them to attack the fortress. The mines were strategically placed to permit only small bodies of men to pass safely. If large bodies of men were to use these roads, the mines would detonate, rendering the roads impassable and destroying many villages and the people which lined the roads. This was said to make a direct attack on the fortress appear impossible. The story then describes how the great general divided his army into small groups to overcome the mines and attack the fortress at full strength (Gick & Holyoak, 1980). In such an analogy, the surface elements, as described by Gentner (1989) and Reeves and Weisberg (1994), are ‘fortress’, ‘army’, ‘mines’, and ‘multiple roads’.

In contrast to the surface elements, abstract or structural features/details provide deep structural meaning (Reeves & Weisberg, 1994). Often, these abstract or structural details are not as obvious as the surface elements. They generally include descriptions of the solution/s that do not necessarily have to be tied with the content. In fact, Reeves and Weisberg argue that similarities between the two problems can exist at any level (abstract or surface), and that the content of a true analogy, (i.e., the analogy of an atom and the solar system) is considered to be related to the situations which have the abstract elements in common.
Gick and Holyoak’s (1980) fortress analogy story was paired with a story titled ‘Tumor’, originally written by Dunker (1945) to determine whether the participants could use the solution stated in the fortress story to derive a solution for the problem in the Tumor story. The Tumor problem describes a doctor who is faced with a patient suffering from a cancerous tumour. If the patient does not undergo an operation, he/she will die. However, the intensity of the ray that needs to be used to destroy the tumour will also destroy the healthy tissue that the ray must pass through (Gick & Holyoak, 1980). The question at the conclusion of the Tumor problem asks readers what procedure they can suggest to destroy the tumour without destroying any healthy tissue. The abstract or structural detail in common to both the Fortress and Tumor story is the simultaneous convergence of force to achieve the desired goal. Specifically, with the Tumor story this involved using multiple rays from a number of different directions all converging on one single point.

In the case of the current experiment, while it might be argued that the surface elements (i.e., both flights involved a low-level spotting task, flying a Cessna 172, and conducting holding patterns), and the structural feature (risk management behaviour) of both the training and the test flight were similar, the similarities may not have been as obvious to the participants. Therefore, future research needs to examine the extent to which information will generalise from one training task to another and on what basis this occurs (issues addressed in Experiment 3).

6.9.3 Limitations of the Study

Consistent with research conducted in the automotive industry (Regan et al., 1998; Gregerson, 1993) and the sporting domain (Williams et al., 2002), the current experiment has positively identified the benefits of employing a training programme
where the participants are cognitively active during training. While the results obtained from the current experiment specifically relate to a training programme involving low-level flying, the extent to which generalisations about these results can be made within both the aviation industry and other domains remain untested. The current experiment examined pilot performance in a controlled environment, where noise, lighting, seating, temperature, interruptions, and other operational conditions were controlled and/or eliminated. While the manipulation of these variables is beneficial from an experimental perspective, their overall impact on pilots’ performance remains unclear.

A second limiting factor that may, potentially, impact the results of the current study relates to the simulation. Although pilots were asked, on several occasions, to treat the simulated flight as they would in the operational environment, the fact that it was a simulation, and that the potential negative consequences associated with less than optimal performance are dissimilar to the operational environment, may have impacted the results. While this problem is not specifically limited to this study, it is important to accurately determine the extent to which this may have impacted the results.

A third limitation of the study relates to the fidelity of the simulation. Although a high quality simulation was employed which incorporated a full motion flight yoke plus rudders, it was evident from the post-mission questionnaire that the sensitivity of the controls and the feedback through the simulation caused some concern amongst the participants. While an examination of the data pertaining to the aircraft roll over a segment of the flight identified that there were no significant differences in pilots’ handling characteristics across groups, the fact that some participants noted that this was a factor, potentially highlights the negative impact it
may have had on their performance. Nevertheless, from an experimental perspective, it could be argued that performance across the groups was consistent in terms of the control of the aircraft.

The final limitation concerns the limited visibility experienced by the participants. In the normal operating environment, a general aviation pilot will experience, depending on aircraft type flown, between 300 to 360 degrees of visibility. The current experiment restricted pilots’ field of view to 160 degrees. While this field of view was adequate for straight and level flight where the pilots are required to look straight ahead, it restricts all other operations outside this arc. While it could be argued that all pilots experienced the same limitations relating to the field of view, it may have been the case that some pilots had a preference for visual cues outside this arc and, therefore, it is important to accurately determine the extent to which this may have impacted the results.

6.9.4 Future Research Direction

Experiment 1 and Experiment 2 have identified the benefits of providing cognitively active training in the development of risk management skills. While these results show promise for training programmes to improve pilots’ risk management behaviour, the results relating to the specific features that facilitate the transfer of this learning remain less clear. Therefore, Experiment 3 examines the extent to which information acquired during a low-flying training task transfers to a range of simulated flights that differ systematically. In addition, this study addresses the role of personality characteristics on risk propensity.
Chapter 7: Experiment 3-Generalisation under Varying Levels of Cognitive Load

The results from the two previous experiments suggest that, in comparison to pilots who are cognitively inactive during training, pilots who are cognitively active during a simulated, low-flying training task tend to adopt behaviour that might be described as more ‘risk averse’ during a test task one week later. The following chapter was designed to extend this research, and investigates the extent to which information obtained in one training context will generalise to other contexts under varying levels of cognitive load. Furthermore, since the issue of personality characteristics may potentially impact pilot performance (as discussed in Chapter 1), and since the current study has not investigated this to date, two personality scales: Zuckerman’s Sensation Seeking Scale and Hunter’s Risk Perception Scale 1 and 2, were incorporated as a manipulation check in the third experiment.

7.1 Transfer of Training

There are three prominent approaches relating to how individuals transfer information from one context to another: The Structure-Mapping Model, Pragmatic Schema Model, and the Exemplar Theories. A distinguishing feature between these three different perspectives is how each proposes that individuals map information from one situation to another. The mapping of information is a process where knowledge is transferred from one situation to another, based on similar characteristic between the two situations. This process is referred to as analogical transfer (Gick & Holyoak, 1983). According to the Structure-Mapping Model and the Pragmatic Schema Model, the process of mapping predominately occurs through the use of
formal or abstract rules (Cheng, Holyoak, Nisbett, & Oliver, 1986; Cheng & Holyoak, 1985). These formal or abstract rules are said to be based on the concrete similarities between situations and are derived from previous problem solving experience/s. When confronted with a new situation, individuals employ the use of formal or abstract rules to understand unfamiliar situations through comparisons with more familiar situations (Reeves & Weisberg, 1994). Holyoak (1985) contends that the development of these formal or abstract rules is derived from the solution required to solve the problem, which is embedded within the structure of the analogy.

An alternate perspective towards analogical transfer is embodied within exemplar theories, which contend that the surface or superficial features of a problem play an integral role in transfer, sometimes at the expense of the abstract principles (Reeves & Weisber, 1994; Catrambone, 1998). The surface features of an analogy are those features that, when changed, do not affect the solution procedure (Catrambone, 1998). Therefore, the surface features of an analogue have no necessary relevance to the solution problem. Catrambone (1998) explains this principle using an example relating to the velocity of objects hanging over a pulley. If there are two problems, then Newton’s Laws of physics will apply equally. The application of Newton’s Laws occurs irrespective of the different surface elements in each problem. However, if an individual categorises the two problems based on the surface elements (hanging object) and not the abstract/structural features (application of Newton’s Laws), then the effectiveness of each example in assisting to solve the abstract nature of the problem may, potentially, become redundant. This, in turn, reduces the likelihood of transfer between two situations.

Evidence to support the role of surface features in analogical transfer can be derived from Chen, Yanowitz, and Daehler (1995) who conducted two experiments to
determine the circumstances under which abstract features and surface features promote analogical problem solving. The study involved children between the ages of seven and eight who were allocated to one of four experimental groups or a control group, and were provided with a number of different riddles to solve. They were then asked to solve a number of additional problems using the riddles as a basis for the solution. The riddles differed amongst the experimental groups based on the extent to which the concrete and abstract details of the riddles were similar or dissimilar to the solution. The results revealed that the children who received the concrete analogies with the dissimilar surface feature performed at approximately the same level as the children in the control condition. However, those children who were given analogies that were similar in terms of the concrete features, tended to perform markedly better than the other children. These results were interpreted as support for the notion that surface features facilitate analogical transfer in at least some situations (Chen et al., 1995).

In explaining the significance of concrete features in facilitating transfer, Catrambone (1998) suggests that individuals often do not realise how seemingly different steps across various problems might be calculating the same thing. In the example relating to the application of Newton’s Laws, Catrambone claims that individuals will often tend to memorise equations, rather than learn the deeper, conceptual knowledge which is implicitly embedded in the problem. This perspective is consistent with the different approaches to learning; namely deep and surface approaches (Beishuizen & Stoutjesdijk, 1999; Vermetten, Lodewijks, & Vermunt, 2001).

Beishuizen and Stoutjesdijk (1999) posit that the differences between the surface and the deep approach to learning relate to the way that individuals orientate,
plan and organise information. Specifically, deep learners actively relate various parts of information to one another or to prior knowledge. This is achieved by organising the material in a predetermined fashion, to gain a greater insight into the subject matter. In contrast, surface learners appear to analyse material in a sequential approach, paying particular detail to factual information in an attempt to recall as much information as possible. This is reinforced through study strategies, such as rehearsal and memorisation (Beishuizen & Stoutjesdijk, 1999; Vermetten et al., 2001).

Using the surface learning approach, it would not be unreasonable to expect that an individual who attempts to solve the Newton’s Law problem proposed by Catrambone (1998), would attempt to solve a new problem along the lines of the previous example. If this procedure fails, the problem-solver will generally not know what to do (Catrambone, 1998). Therefore, while the abstract features of analogies may embody the solution, they are often overlooked by individuals in favour of the more obvious surface elements, primarily as a result of the individual memorising the problem, rather than learning the deeper, conceptual knowledge that is embedded within the problem.

The Structure-Mapping Model is based on the content of the semantic domains and the commonality between the base and target problems (Genter, 1983). Therefore, while a base and target problem may seem different, such as an electric battery and a reservoir in respect to size, construction, and application, it is what each item means (both store potential energy, and release energy to provide power) that will facilitate analogical transfer. According to the Structure-Mapping Model, the surface elements or objects that initiate the relation are said to be of lesser importance than the abstract feature of the analogies. While the similarities between the base and target analogies
can occur at both a semantic level and at a surface level, according to the Structure-Mapping Model, the instances with the greatest level of similarity will be selected for mapping to the target problem.

When a base analogue is sought, the target analogue is usually compared on the basis of both content and the pragmatic goals (Gentner, 1983). This selection principle is referred to as ‘systematicity’. Systematicity is based on the view that when true analogies share similar deep, structural features, they will be favoured over important object (surface elements) features (Gentner, 1983).

In the process of mapping one analogue to another, theorists who propose the Structure-Mapping Model posit that specific attributes relating to surface features of the objects are irrelevant, and are discarded during the mapping process (Gentner, 1983). These attributes are assumed to play no causal role in the solution and, therefore, are not necessary to be transferred to the target problem. Rather than the attributes of the objects, it is the predictive relationship of the higher-order relations (semantic or otherwise referred to as abstract or structural features) (i.e, problem, remedy) which need to match exactly to accomplish transfer. Therefore, the Structure-Mapping Model is predominately characterised by a hierarchy in which semantic (abstract/structural) features dominate over object features (surface elements) in analogical transfer (Revees & Weisber, 1994).

An inherent problem identified with the Structure-Mapping Model, where emphasis is placed on the semantic features to the exclusion of the surface elements, relates to those individuals who employ a surface approach to learning. As noted previously, surface learners analyse material in a sequential order, paying particular attention to factual information in an attempt to recall as much information as possible (Beishuizen & Stoutjesdijk, 1999; Vermetten et al., 2001). Surface learners reinforce
information acquired through strategies such as rehearsal and memorisation. Therefore, based on the Structure-Mapping Model, it would not be unreasonable to conclude that the Structure-Mapping Model may not sufficiently account for those individuals, in terms of their performance, who employ a surface approach to learning.

Support for the Structure-Mapping Model is evident through Gick and Holyoak, (1983). Gick and Holyoak (1983) employed the same principles as used in the Fortress and Tumor stories (see Chapter 6:), although the specific content of the analogies was changed (Dunker, 1945; Gick & Holyoak, 1980). In the case of Gick and Holyoak (1983), an analogue titled ‘Cord Problem’ described two cords hanging from a ceiling in a room that had to be tied together. Each cord was of a certain length that did not permit them to be tied together in the absence of any other material. In the room, there were additional objects such as a pole, clamps, pliers, extension cords, and a table and chairs, to assist with the task. The general solution that was prescribed was to tie objects to each cord and swing the objects in a pendulum fashion so that the cords could be brought together and then tied. The target story related to a ‘Birthday Party’, where two ribbons of a similar length to those in the cord problem were hanging from a ceiling which also had to be tied together. As with the cord problem, there were additional items in the room to facilitate the pendulum solution.

Gick and Holyoak’s study consisted of two experimental groups and one control group. The first experimental group was provided the opportunity to recall the cord problem prior to attempting to solve the Birthday Party problem. The second experimental group was provided the opportunity to summarise the cord problem prior to attempting the Birthday Party problem. For the purpose of analysing the results, the two experimental groups were combined (results from both groups were
similar and no statistically significant differences were observed between the two) and a statistically significant difference was observed between the experimental groups and the control group. The results were interpreted as support for analogical transfer, based on the abstract nature of the tasks.

The second theoretical approach that examines the relative predictive importance of abstract versus surface features is the Pragmatic Schema Model (Holyoak & Thagard, 1989). This model is similar to the Structure-Mapping Model in that selection and mapping between analogies is based predominately on the abstract, higher-level information (Revees & Weisber, 1994). However, the Pragmatic Schema Model differs from the Structure-Mapping Model in the definition of abstract elements and its greater emphasis on schema induction (abstract concept intended to be conveyed) as a method of facilitating problem solving (Revees & Weisber, 1994). According to the Pragmatic Schema Model, there are pragmatic, semantic and structural constraints which operate at different stages throughout the problem solving process (Holyoak & Thagard, 1989).

An examination of the theoretical basis of the Pragmatic Schema Model conducted by Gick and Holyoak (1983) indicated that transfer between analogies is best achieved if more than one analogy is used and a hint is provided that draws the sample analogue to the base analogue. In situations where transfer does not occur, Holyoak (1985) suggests that this may be a response to the constraints imposed by the pragmatic schema where the causal information relating to the abstract features in common between the analogies, may not be obvious. Equally, semantic constraints may hinder the transfer because the abstract similarities between the analogies may not be obvious. Finally, there may be problems with the transfer as a result of the
different underlying structures between the two analogies that hinder the transfer between the base and target problem (Revees & Weisberg, 1994; Holyoak, 1985).

In summary, according to the Pragmatic Schema Model, transfer occurs primarily due to the similar, semantic features that are common to both problems. However, in situations where the surface elements are also perceived as similar, transfer is greatly assisted by the overlap in these features. Ultimately, transfer is determined by matching both abstract and structural features (Holyoak, 1985; Holyoak & Koh, 1987).

The third class of theories concerning analogical transfer relate to Exemplar Theories, which are based on the assumption that both surface and abstract features play equal roles in analogical transfer. It is the individual who decides or gives more weight to what he/she considers the more salient of the features (i.e., surface elements or abstract features) in analogical transfer (Revees & Weisberg, 1994; Hintzman, 1986). The choice to use either surface elements or abstract features is automatic, and is dictated according to the way that the individual perceives both the base and target problems. Consistent with this perspective, Ross (1986) proposes a Reminding Theory, in which abstract information is favoured over content information, but both the abstract and surface features are used to map or recall information relating to problem examples.

While the Exemplar Theories are less prescriptive than the Structure-Mapping and the Pragmatic Schema Models, the three different theoretical perspectives all possess a degree of similarity. Specifically, the three different theoretical models all acknowledge the importance of both the surface elements and the abstract features in the process of analogical transfer. While the precise role through which each contributes to analogical transfer remains the subject of debate, employing the use of
surface elements to derive appropriate abstract information remains a critical part of these three theoretical perspectives.

In view of the research conducted in the field of analogical transfer, the current experiment (Experiment 3) will examine the extent to which information learnt from a base analogue will generalise to different target analogies. Extending the work of Gick and Holyoak (1983), where they employed the use of a hint condition in their experiments to facilitate the transfer between tasks, the current experiment will incorporate a ‘hint’ condition to examine whether this procedure further facilitates the extent to which information will generalise from one task to another. Since the research within this field is relatively conclusive in regards to the features that facilitate transfer between two tasks (i.e., surface and abstract features), the current experiment examines the utility of transfer under different cognitive loads.

7.2 Varying Levels of Cognitive Loads and Effective Transfer

The research conducted in the field of analogical transfer is predominately concerned with examining the extent to which information will transfer from one case example to another with similar characteristics. However, in many cases, both the base and target cases share not only similar surface and abstract features, but they also impose relatively similar cognitive loads or restrictions on the individual/s under examination. Moreover, while experiments have illustrated the effectiveness of analogical transfer (Gick & Holyoak, 1980; 1983; Holyoak & Koh, 1987; Catrambone, 1998; Chen et al., 1995), another factor may exist that dictates the successful transfer between tasks, which relates to the cognitive load imposed by both the base and target analogue.
Sweller (1988) describes cognitive load as the burden placed on working memory in the process of performing a task. Variations in cognitive load may result from the quantity of information, the design of a particular task, and/or the processing requirements of the task (Rose, Roberts, & Rose, 2004). When a task requires a high cognitive load, it consumes working memory. Working memory plays a crucial role in the process of decision-making, as it is where all information passes and is processed during the decision-making process (Tarmizi & Sweller, 1988). In situations that are novel, or where new information is introduced into a familiar task, the additional cognitive load imposed by such situations often restricts the residual resources available to effectively and accurately process information in the course of making an effective decision (Tarmizi & Sweller, 1988; Rose et al., 2004).

Tarmizi and Sweller (1988) illustrated the negative effects of increases in the cognitive load during a mathematics problem solving exercise. Thirty-three year nine students from the top mathematics class in a school participated in the experiment. The participants were randomly divided into three groups: Conventional, goal-free and guide-solution. Students in the conventional group were provided with problems with well-defined goals, while the goal-free group was provided with similar problems where no specific goals were stated. The final group was presented with problems with instructions concerning the use of particular theories to solve the problems. All of the students were asked to solve twelve problems according to their group instructions, and the results revealed that those participants in the goal-free group solved significantly more problems than the other two groups. These results indicated that the group with the least cognitive load performed at a superior level than the other two groups.
Overall, it is generally accepted that performance degrades during extreme levels of cognitive load (Paas, Renkl, & Sweller, 2004). Tiegan (1994) likens the effect of the relationship between performance and cognitive load to the Yerkes-Dodson’s inverted U, performance-arousal model. According to Tiegan, under conditions of both underload and overload, learning fails to occur. To facilitate the acquisition of information under these conditions, Wulf and Shea (2002) suggest that individuals should engage in continual practice, focusing on increasing or decreasing the information load during practice to facilitate an environment that is more conducive to learning.

An alternate approach to manipulating the demands of the task to facilitate a more conducive learning environment is proposed by the Cognitive Load Theory (CLT). According to the CLT, optimal learning occurs under situations that are best aligned with human cognitive architecture (Paas et al., 2004). CLT assumes that a cognitive architecture consists of working memory that is limited in capacity. The working memory can be divided into two independent subcomponents, which include a component for processing auditory/verbal information and a component for processing visual two or three-dimensional information (Paas et al., 2004). Cognitive Load Theory is based on the assumption that the, otherwise, limited capacity of working memory becomes unlimited when dealing with familiar material. This assumption is based on the proposition that when a decision or action is required that is familiar, the individual will utilise information stored in the form of schemata in long-term memory. As a result of employing schemata from long-term memory, behaviour is automated, thereby removing any need to process information in working memory (Paas et al., 2004).
According to Sweller, (1988) novices can be distinguished from experts based on the presence/absence of schemata. Experts are able to solve problems by identifying a solution or a formula to a problem based on their previous experience. Sweller (1988) refers to the process where an expert recognises a problem and draws on a previous problem from memory and its solution as a ‘cognitive structure’. The term 'cognitive structure' is commonly interchanged by Sweller with 'schemata'. He contends that schemata allow problem solvers to recognise a problem state as belonging to a specific category of a problem which, in turn, generally requires a particular solution. According to Sweller, novices do not possess schemata or cognitive structures and, therefore, when they encounter a problem, they are forced to solve problem through means-end analysis. Means-end analysis involves solving a problem by working backwards from the goal to solve the problem. An inherent problem associated with means-end analysis is that it requires a relatively large amount of cognitive processing capacity, which, more often than not, is not available (Sweller, 1988).

On the basis of the Cognitive Load Theory, to reduce or minimise the cognitive load imposed during problem solving, individuals need to increase their store of schemata in long-term memory. However, to increase the store of schemata, individuals need to first acquire information, which generally occurs through direct experience. One method of acquiring direct experience or specific knowledge is through training. Once individuals have acquired sufficient schemata, these then can be employed during the decision-making or the problem-solving process to free cognitive resources to deal with other situations or circumstances that may arise.

Sweller, Mawer, and Ward (1983) describe an example of experts implicitly recalling information from long-term memory in solving kinematic problems. The
process involved participants writing down basic formulas involving velocity, acceleration and time. Initially, participants wrote the formulas down to remind themselves of the equation, thereby, permitting them to work systematically through the process of problem solving by substituting the variables for the constants in the formula. However, once the individuals developed a greater understanding of the formula, they started to write the formula with the constants already substituted with the variables. Sweller et al. claim that this, in effect, illustrates that the formula was implicit in the problem solving process, rather than being explicitly recalled.

In view of the literature relating to the effects of varying levels of cognitive load on individuals’ performance and the CLT, if an individual experiences a new or novel situation that they do not perceive as similar to one previously experienced, they will more likely attempt to solve the problem through a means-end analysis. In doing so, they will use working memory resources, thereby reducing the residual cognitive resources available to manage or deal with other information that may need processing. As a result, it would be expected that decrement in performance would result.

In view of the literature concerning cognition and performance, Experiment 3 investigated the impact of cognitive load on the transfer of information amongst pilots during a low-flying task. Specifically, participants were asked to complete four test flights, three of which varied from a training flight that had been conducted one week prior to the test flights. The test flights differed systematically in terms of the cognitive load imposed, so that the first flight was a direct reproduction of the training flight (Traffic Report - no increase in cognitive load). The second flight (Freight Train) remained consistent with the training flight in examining pilots’ performance in relation to vertical separation, although the context of the flight changed (reading a
number on the side of a freight train) (minimal increase in cognitive load). The third flight (Cliff Face) differed from the training flight in terms of the context, (i.e., flight involving spotting a climber on a cliff face rather than noting the number of cars), and in terms of examining pilots’ performance (i.e., horizontal separation that pilots remained from a surface, in contrast to the vertical separation that pilots remained from a surface during the training flight) (moderate increase in cognitive load).

Finally, the fourth flight (Cooling Tower) varied from the training flight in terms of the context (i.e., flight involving spotting a protestor on a cooling tower opposed to noting the number of cars) and in terms of examining pilots’ performance (i.e., involved a combination of both the second and third test flights - vertical and horizontal separation pilots’ remained from a surface) (significant increase in cognitive load) (see Table 7).

Table 7
*Illustration of the changes between the four test flights in relation to the training flight.*

<table>
<thead>
<tr>
<th>Test Flight (differences in cognitive load from training)</th>
<th>Flight Characteristics</th>
<th>Increase in Cognitive Load from Training Flight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Report (Nil)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Freight Train (Minimal)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Cliff Face (Moderate)</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Cooling Tower (Significant)</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
7.3 Individual Differences

While the central aim of the third experiment was to examine the extent to which information learnt from a base analogy would generalise to different target analogies, it was also important to establish if there were any individual differences (as discussed in Chapter 1) in terms of risk perception between the three groups. While an experimental design that manipulated training should ensure that any result is the product of training and not individual differences, such procedures are never fail-safe, and therefore, two personality scales; Zuckerman's Sensation Seeking Scale and Hunter's Risk Perception Scales 1 and 2, were included as a manipulation check. Since all of the flights (training and test flights) involved maintaining minimum separation from either an object or the surface (ground), it was important to determine the impact of individual differences, in terms of pilots’ risk-orientated behaviour.

7.3.1 Zuckerman’s Sensation Seeking Scale

Zuckerman’s Sensation Seeking Scale (SSS) is designed primarily to examine individuals’ subjective appraisal of experiences or sensations that are derived from activities that are considered risky (Zuckerman, 1994). Zuckerman (1994) argues that risky activities do not only involve physical actions, but may also involve social, legal, and financial situations. Individuals who obtain a high score on Zuckerman’s Sensation Seeking Scale are said to reflect a personality type that is described as ‘adventurous’.

Zuckerman’s Sensation Seeking Scale consists of forty questions and examines four factors including: Thrill and Adventure Seeking (TAS), Experience Seeking (ES), Disinhibition (DIS), and Boredom Susceptibility (BS). There are ten
questions assigned to each factor. The questions relating to the Thrill and Adventure Seeking factor are primarily designed to examine individuals’ desire or pursuit to engage in sports or other activities that involve the sensations of speed or defiance of gravity (i.e., parachuting, scuba diving, or skiing). The questions relating to the Experience Seeking factor are primarily designed to encompass factors relating to individuals’ desire to seek novel or new sensations or experiences, and include arousing music, art, and travel. The questions relating to Disinhibition seek to examine individuals’ desire for engaging in social activities like parties, social drinking and sex. The questions relating to the final factor, Boredom Susceptibility, are designed to examine individual intolerance for experiences that are repetitious, such as routine work, and for people who are considered boring (Zuckerman, 1994).

To determine whether the Sensation Seeking Scale was internally consistent, Zuckerman, (1994) examined the internal reliability for the scale as a whole and, on each of the four subscales. The internal reliability of the total score on the Sensation Seeking Scale ranged from .83 to .86, while the ranges of reliability for the subscales were: TAS, .77 to .82; ES, .61 to .67; DIS, .74 to .78; and BS, .56 to .65. In addition, the test-retest reliability over a three-week period for the Sensation Seeking Scale was .94. Finally, Ball, Farnhill, and Wangeman, (1984) examined the four items on the SSS using a large heterogeneous sample of Australian men and women to determine the reliability of these factors. The results from their research indicated a high degree of reliability of each factor structure with Australian males and females. As a result, it can be concluded that Zuckerman’s Sensation Seeking Scale is internally consistent and the four factors in the scale are reliable.
7.3.2 Hunter’s Risk Perception Scales

Using a different approach to Zuckerman, Hunter constructed two specific scales to examine individual differences, in risk perception amongst pilots. Hunter (2002) describes risk as ubiquitous and states that there is no human state short of death itself, which is free from risk (Hunter, 2002). Risk, as defined by Brown and Groeger (1988), involves a subjective assessment of the perceived negative consequences associated with an activity. Individuals’ perception of risk varies as a result of their previous experience and their knowledge and/or ability. Therefore, when an individual assesses the risk involved in an activity, he/she weighs both the probability of injury and the probability of encountering a hazard (Faber & Stewart, 2003).

Hunter’s first risk perception scale consists of 17 scenarios depicting aviation situations in which pilots are asked to rate the level of risk present in each situation. Hunter’s second risk perception scale consists of 26 sentences; seven describing non-aviation events/situations, while the remainder describe aviation situations, where the participants are asked to indicate the degree of risk involved in each situation if they were to encounter the situation the next day. Both scales require the respondents to rate the perceived level of risk in each statement/scenario on a scale between 0 and 100.

Hunter’s Risk Perception Scale 1 consists of three factors: Delayed Risk, Nominal Risk and Immediate High Risk. Hunter’s Risk Perception Scale 2 consists of five factors: General Flight Risk, High Flight Risk, Altitude Risk, Driving Risk and Everyday Risk. To determine whether both scales are internally consistent, Hunter (2003) examined the reliability coefficient alpha for both scales. The coefficient alpha for the Risk Perception Scale 1 was .845, and the coefficient alpha for the Risk
Perception Scale 2 was .937. Nunnally (1978) suggests that obtaining a coefficient alpha greater than 0.7 indicates that the test is reliable. Therefore, it can be concluded that both of Hunter’s risk perception scales are internally consistent.

A review of the results from both Experiment 1 and Experiment 2 of the present project identified a positive transfer from a base analogue, where pilots counted the number of motor vehicles which passed by a house over a ten minute period, to a target analogue which involved reading a number located on the deck of an oil tanker. In both the base and target analogies, the primary focus of each flight was the vertical separation from the terrain. Experiment 3 is designed to extend this research and examine, in greater detail, the extent to which the provision of training related to vertical separation resulted in a transfer of training to a test task where horizontal separation and a combination of both vertical and horizontal separation was the primary focus. In addition, to ensure that the results from the test flights accurately reflect, as much as possible, the different training conditions that the pilots received in the first week, Zuckerman’s Sensation Seeking Scale and Hunter’s Risk Perception Scales 1 and 2 were employed as manipulation checks to test for individual differences.

The participants in the present experiment were trained in week one and undertook four test flights in the following week in counterbalanced order. The experiment consisted of three groups, two experimental (‘hint’ and ‘no hint’) and one control group. During the training flight, participants in both experimental groups were asked to identify and memorise the number of motor vehicles which passed by a house located north of Mudgee aerodrome over a ten minute period. They received feedback in relation to their performance. The participants in the control group were asked to fly two circuits around Mudgee aerodrome. In the following week, all
participants were asked to complete four test flights presented in a counterbalanced order.

The first test flight was a replication of the training flight for the experimental groups from week one. This test flight was designed to replicate the same levels of cognitive constraints imposed on the pilots as they had experienced during the training (Traffic Report - no variation in cognitive load). The second test flight (Freight Train - minimal variation in cognitive load) required participants to report a number located on the side of a freight train (vertical separation). This test flight was designed to be consistent with the test flights that featured in Experiment 1 and 2, and contained one dimension of separation in respect to the cognitive load from the training flight (different surface features from the training task). This difference was based on the fact that all three flights (training flight, and the two test flights) required the participants to maintain a minimum vertical separation from the ground. The third test flight (Cliff Face - moderate variation in cognitive load) required participants to confirm reports of a stranded climber on a cliff face (different surface feature from the training flight) - horizontal separation (different orientation of task objective). As in the training flight, the third flight (Cliff Face) required the pilots to remain clear of a surface (cliff), although horizontal separation, rather than vertical separation was required. In addition, the surface features of the task differed from the training flight (resulting in two dimensions of separation). Finally, the fourth test flight (Cooling Tower - significant variation in cognitive load) required participants to confirm a report of a protestor on a cooling tower (both vertical and horizontal separation). This flight differed from the training flight in three-dimensions: The surface features of task, and vertical and horizontal separation. It was assumed that this flight would impose the greatest cognitive load on pilots (see 7.14 Cognitive Load and
Performance for Friedman chi-square repeated measure ANOVA for ranks testing this assumption).

In summary, the study was designed primarily to examine the extent to which knowledge obtained during a case-based training task would transfer to other flying tasks during a subsequent test scenario and establish the impact that cognitive load may have on the transfer of training. In addition, the study was also designed to examine the potential benefits and implications for training programmes when a ‘hint’ is provided that highlights the relationship between the training task and the subsequent test scenarios. Twelve hypotheses and four research questions were derived for the study. In relation to the analyses of the results, a series of analyses of covariance were employed in preference to a repeated measures design, due to the differences in the dependent variables of each flight. Moreover, since the data pertaining to three of the test flights were not normally distributed, separate and independent transformations (i.e., data pertaining to Traffic Report and the Cliff Face test flight required a square root transformation, while the data pertaining to Cooling Tower test flight required a logarithmic transformation) were required to ensure that the data remained consistent for parametric analyses (i.e., multivariate normality) (Tabachnick & Fidell, 2001). Finally, scores from Zuckerman’s Sensation Seeking Scale featured as the covariate (see results section below for full explanation relating to covariate).

7.3.3 Hypotheses pertaining to ‘No’ Variation in Cognitive Load

The Traffic Report test flight was specifically designed to examine pilots’ performance in terms of the minimum altitude to which they descended during a low-flying task. It was assumed that those pilots who remained at a higher mean minimum
altitude displayed a behaviour that was consistent with being more risk averse, in comparison to those pilots who descended to a lower mean minimum altitude during the same task. Specifically, it was hypothesised:

1. That participants in the ‘hint’ training group would adopt more risk averse behaviour, as measured by the mean minimum altitude descended during the ‘Traffic Report’ test flight in the second week, in comparison to the participants in the ‘no hint’ group;

2. That participants in the ‘hint’ training group would adopt more risk averse behaviour, as measured by the mean minimum altitude descended during the ‘Traffic Report’ test flight in the second week, in comparison to the participants in the control group;

3. That participants in the ‘no hint’ training group would adopt more risk averse behaviour, as measured by the mean minimum altitude descended during the ‘Traffic Report’ test flight in the second week, in comparison to the participants in the control group;

4. That participants in the ‘hint’ training group would be less likely to breach the low-flying regulations during the ‘Traffic Report’ test flight, in comparison to the participants in the ‘no hint’ group;

5. That participants in the ‘hint’ training group would be less likely to breach the low-flying regulations during the ‘Traffic Report’ test flight, in comparison to the participants in the control group;

6. That participants in the ‘no hint’ training group would be less likely to breach the low-flying regulations during the ‘Traffic Report’ test flight, in comparison to the participants in the control group.
7.3.4 Hypotheses pertaining to ‘Minimal’ Variation in Cognitive Load

The Freight Train test flight was specifically designed to examine pilots’ performance in terms of the minimum altitude to which they descended during a low-flying task. It was assumed that those pilots who remained at a higher mean minimum altitude displayed a behaviour that was consistent with being more risk averse, in comparison to those pilots who descended to a lower mean minimum altitude during the same task. Specifically, it was hypothesised:

1. That participants in the ‘hint’ training group would adopt more risk averse behaviour, as measured by the mean minimum altitude descended during the ‘Freight Train’ test flight in the second week, in comparison to the participants in the ‘no hint’ group;

2. That participants in the ‘hint’ training group would adopt more risk averse behaviour, as measured by the mean minimum altitude descended during the ‘Freight Train’ test flight in the second week, in comparison to the participants in the control group;

3. That participants in the ‘no hint’ training group would adopt more risk averse behaviour, as measured by the mean minimum altitude descended during the ‘Freight Train’ test flight in the second week, in comparison to the participants in the control group;

4. That participants in the ‘hint’ training group would be less likely to breach the low-flying regulations during the ‘Freight Train’ test flight, in comparison to the participants in the ‘no hint’ group;
5. That participants in the ‘hint’ training group would be less likely to breach the low-flying regulations during the ‘Freight Train’ test flight, in comparison to the participants in the control group;

6. That participants in the ‘no hint’ training group would be less likely to breach the low-flying regulations during the ‘Freight Train’ test flight, in comparison to the participants in the control group.

The four research questions were formulated on the basis of the literature relating to the effects of different cognitive loads on individuals performance. In particular, since both the Cliff Face (moderate variation in cognitive load) and the Cooling Tower (significant variation in cognitive load) test flights altered from the training flight in respect to both the cognitive load and the context of each flight, the extent to which these additional task requirements impacted pilots’ performance remains untested. Consequently, responses to the following research questions were sought:

1. Would any additional load, imposed by the demands of the task, influence pilots’ risk management behaviour, in terms of the minimum altitude to which pilots descend during the Cliff Face flight?

2. Would any additional load, imposed by the demands of the task, influence pilots’ behaviour in terms of the low-flying regulations during the Cliff Face flight?

3. Would any additional load, imposed by the demands of the task, influence pilots’ risk management behaviour, in terms of the minimum altitude to which pilots descend during the Cooling Tower flight?
4. Would any additional load, imposed by the demands of the task influence pilots’ behaviour in terms of the low-flying regulations during the Cooling Tower flight?

7.4 Method

7.4.1 Participants

Consistent with the first experiment, participants were recruited from the Bachelor of Aviation (Flying) degree at the University of Western Sydney and from the various flying schools located at Bankstown airport. Forty-five participants were recruited for the study and were randomly divided into three groups. They were reimbursed thirty dollars for travel-related expenses which was paid at the conclusion of the study in the second week. All the participants were naïve as to the purpose of the research.

Table 8 outlines the distribution of the participants across groups, the demographic features, and the median experience of the participants distributed across the three groups. Since it was expected that the data pertaining to the total hours of flying experience and the total hours of low-level flying experience would be positive skewed, a Kruskal-Wallis, nonparametric test was used to examine whether differences existed between the three groups based on flying experience. With alpha set at .05, the results of a Kruskal-Wallis chi-square approximation, corrected for ties, failed to reveal any statistically significant differences between groups in terms of the total hours flying experience $\chi^2(2, N = 45) = 1.01, p = .60$ and the total hours low-level flying $\chi^2(2, N = 45) = 2.37, p = .31$. As a result, it can be concluded that the three groups (‘hint’, ‘no hint’ and control) were not significantly different in terms of
the median total hours flight experience and the total low-level flying experience (see Table 8).

Table 8
*Distribution of participants, demographics and median experience of participants distributed across exposure to low-level flying experience.*

<table>
<thead>
<tr>
<th>Training Group</th>
<th>Participant Numbers</th>
<th>Mean Age (SD)</th>
<th>Median total hours flying experience (range)</th>
<th>Median total hours low-level flying (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 (Hint)</td>
<td>15</td>
<td>41.87 (16)</td>
<td>190 (7045)</td>
<td>0 (25)</td>
</tr>
<tr>
<td>Group 2 (No Hint)</td>
<td>15</td>
<td>39.20 (14)</td>
<td>165 (6874)</td>
<td>0 (100)</td>
</tr>
<tr>
<td>Group 3 (Control)</td>
<td>15</td>
<td>45.33 (13)</td>
<td>293 (2650)</td>
<td>1 (100)</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>42.13 (14)</td>
<td>210 (7045)</td>
<td>0 (100)</td>
</tr>
</tbody>
</table>

7.5 **Design**

The aim of the study was to examine the extent to which knowledge obtained during a case-based training task would transfer to other flying tasks during a subsequent test scenario and establish the impact that cognitive load may have on the transfer of training. Furthermore, the study was designed to examine the potential benefits and implications for training programmes when a ‘hint’ is provided that highlights the relationship between the training task and the subsequent test scenarios (see Table 9).
Table 9

*Summary table outlining both the training and various test flights distributed across groups.*

<table>
<thead>
<tr>
<th>Training Group</th>
<th>Training Flights</th>
<th>Test Flights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traffic Report</td>
<td>Traffic Report</td>
</tr>
<tr>
<td>Group 1 (Hint)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Group 2 (No Hint)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Group 3 (Control)</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

The study comprised one independent variable, with three levels (‘hint’, ‘no hint’ and control) and a series of dependent variables. Two of the scenarios examined the mean minimum altitude to which the participants descended, while the ‘Cliff Face’ scenario enabled an examination of horizontal separation as the dependent variable. The final flight, the ‘Cooling Tower’ scenario, examined a metric of both the horizontal separation and the vertical separation as the dependent variable. Additional dependent variables included the frequency with which participants descended beneath 500 feet, the time spent beneath 500 feet, the level of control exercised over the aircraft, and pilots’ subjective orientation towards risk. For all statistical tests, an alpha level of .05 was set.
7.6 Materials

The materials were consistent with Experiment 2, except in total, three seventeen inch LCD monitors were employed, as displayed in Figure 6 (see materials section of Experiment 2).

Figure 6. An illustration of the computer based flight simulator including the Cirrus Two Flight Console with the Beech Yoke

The visual information, although presented on three seventeen-inch LCD monitors rather than two seventeen inch LCD monitors and one CRT monitor, displayed exactly the same information as the participants were exposed to in Experiment 2 (see Experiment 2 for display information pertaining to simulation). In addition to the software and hardware listed above, Zuckerman’s Sensation Seeking Scale (SSS) and Hunter’s Risk Perception Scale 1 and 2 were employed in the study (see Appendix D: Experiment 3).
7.7 Procedure

All participants were informed verbally and through the information sheet that the experiment would consist of two sessions, each of which would be undertaken one week apart. The participants were asked to complete a consent form, a demographics form, Zuckerman’s Sensation Seeking Scale and Hunter’s Risk Perception Scales 1 and 2. In the first session, the participants were randomly divided into three groups (‘hint’, ‘no hint’ or control). The participants in the ‘hint’ and ‘no hint’ groups were provided with the same flight details, which consisted of a simulated flight on the computer-based flight simulator that departed from Mudgee aerodrome (YMDG), New South Wales Australia and tracked north (see Appendix D: Experiment 3 for all material relating to current experiment).

Consistent with the previous experiments, the participants were asked to identify and memorise the number of motor vehicles that passed by a house within a ten-minute period. Unlike previous experiments, the house was located four nautical miles north of Mudgee aerodrome. The location of the house was altered to accurately reflect on an aeronautical chart that had been used for the three other test flights. Prior to departure, all participants were provided with a pre-flight briefing concerning the aim and objective of the flight, and were asked to conduct the operation in accordance with aviation rules and regulations. The pilots were also asked to operate the aircraft as they would within the normal operational environment. Finally, participants were informed that they did not need to make radio calls and that they did not need airways clearance for the flight.

At the conclusion of the flight, both the participants in the ‘hint’ and ‘no hint’ group received feedback concerning their performance. The feedback provided was
consistent with the feedback in the first two experiments (see Experiment 1 for details relating to feedback). Finally, all of the participants were asked to complete a brief, short-answer questionnaire. Consistent with Experiment 1 and 2, the questionnaire asked the participant to state the number of motor vehicles that they were asked to count during the flight, and was designed to provide them with an opportunity to reflect on the flight and the key point/s or lesson/s learnt (see Appendix D: Experiment 3).

The participants in the control group were provided with flight details that required them to perform two left hand circuits departing on runway 040 at Mudgee aerodrome (see Appendix D: Experiment 3). Mudgee aerodrome is located at an altitude of 1,545 feet above Mean Sea Level (MSL) and is surrounded by terrain that is approximately 2,000 feet above MSL. The first circuit required the participants to perform a touch-and-go, while the second circuit required participants to make a full-stop landing. Prior to departure, all of the participants were provided with a pre-flight briefing concerning the aims and objectives of the flight and were asked to conduct the operation in accordance with the aviation rules and regulations. The pilots were also asked to operate the aircraft as they would in the normal operational environment. Finally, participants were informed that they were not required to make radio calls throughout the flight.

In the second session, in the succeeding week, all of the participants conducted four simulated flights (Traffic Report, Freight Train, Cliff Face and Cooling Tower) in succession (see Table 10). The sequence in which the flights were presented was counterbalanced to minimise any learning effects. Further, since the four flights varied in terms of the cognitive load, a series of univariate analyses were performed to ensure that the presentation order of the flights did not impact performance (i.e.,
accumulative cognitive load). Consistent with expectations, a univariate analysis with the order in which the flights were presented as the independent variable and the mean minimum altitude or separation from object as the dependent variable, failed to reveal a statistically significant difference for the Traffic Report flight (no variation in cognitive load) $F(3, 41) = .84, p = .48, \eta^2 = .058$, for the Freight Train flight (minimal variation in cognitive load) $F(3, 41) = 2.19, p = .10, \eta^2 = .138$, for the Cliff Face flight (moderate variation in cognitive load) $F(3, 41) = .67, p = .58, \eta^2 = .047$, and the Cooling Tower flight (significant variation in cognitive load) $F(3, 41) = 1.01, p = .40, \eta^2 = .069$ (see Table 19). These results suggest that, irrespective of the order in which the flights were presented, there was no impact on pilots’ performance as a result of the sequence in which the flights were presented.

Prior to each flight, participants were provided with a set of instructions that outlined the nature and objective of the flight. For those participants in the ‘hint’ and ‘no hint’ group, the training flight used in the first week (Traffic Report) was replicated in the second week and constituted one of the four flights. The hint that was provided to the participants in the ‘hint’ group, consisted of a one sentence statement that remained consistent throughout all four flights and appeared in the instructions on each flight and read, “Please note that the training flight undertaken in the first week is relevant to this flight and should be used to assist with the current task”.

Table 10

Summary of the four different test flights flown by participants during testing.

<table>
<thead>
<tr>
<th>Test Flight</th>
<th>Departure Point</th>
<th>Track</th>
<th>Aircraft</th>
<th>Time Constraint</th>
<th>Flight Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Report</td>
<td>YMDG</td>
<td>040</td>
<td>Cessna 172</td>
<td>10 minutes</td>
<td>Identify and memorise traffic frequency</td>
</tr>
<tr>
<td>Freight Train</td>
<td>YMDG</td>
<td>345</td>
<td>Cessna 172</td>
<td>10 minutes</td>
<td>Identify and memorise train identification</td>
</tr>
<tr>
<td>Cliff Face</td>
<td>YMDG</td>
<td>345</td>
<td>Cessna 172</td>
<td>10 minutes</td>
<td>Investigate unconfirmed reports of stranded climber</td>
</tr>
<tr>
<td>Cooling Tower</td>
<td>YMDG</td>
<td>345</td>
<td>Cessna 172</td>
<td>10 minutes</td>
<td>Investigate unconfirmed reports of protestor</td>
</tr>
</tbody>
</table>

The scenario titled ‘Freight Train’ (see Table 10) was specifically designed to reflect a scenario consistent with the tanker scenario employed in the first two experiments. The ‘Freight Train’ scenario required the participants to depart from Mudgee aerodrome on runway 040 and track 345 degrees for approximately 6.5 nautical miles where they were asked to positively identify a 23 carriage freight train and report the call-sign of the freight train (see Appendix D: Experiment 3). The participants were provided with a maximum of twenty minutes to complete the task, allowing for five minutes flight time from Mudgee aerodrome to the freight train, a maximum of ten minutes to locate the number on the side of the carriages, and another five minutes to track back to Mudgee aerodrome.

The scenario titled ‘Cliff Face’ (see Table 10) required the participants to depart from Mudgee aerodrome on runway 040 and track 345 degrees for approximately 6.5 nautical miles where they were asked to investigate unconfirmed reports of a stranded climber/bush walker on a cliff face (see Appendix D: Experiment 3). The height of the cliff face was 1,316 feet AGL while the surrounding terrain was
reported at 2,000 feet above MSL. The unconfirmed report stated that a bush walker had been sighted at an altitude of approximately 1,000 feet AGL. The participants were provided with a maximum of 20 minutes to complete the task, allowing for five minutes to track from Mudgee aerodrome to the cliff face, a maximum of ten minutes to investigate the unconfirmed reports, and another five minutes to track back to Mudgee aerodrome.

The scenario titled ‘Cooling Tower’ (see Table 10) required the participants to depart from Mudgee aerodrome on runway 040 and track 345 degrees for approximately 6.5 nautical miles where they were asked to investigate unconfirmed reports of a protestor abseiling down a newly opened cooling tower (see Appendix D: Experiment 3). The height of the cooling tower was 700 feet AGL, and the exact location of the protestor was reported as ‘not known’. The terrain surrounding the cooling tower was reported at 2,000 feet above MSL. The participants were provided with a maximum of twenty minutes to complete the task, allowing for five minutes to track from Mudgee aerodrome to the cooling tower, a maximum of ten minutes to investigate the unconfirmed reports, and another five minutes to track back to Mudgee aerodrome.

Prior to each flight, the participants were provided with the same pre-flight briefing as had occurred during the first week. On completion of each flight, the participants were asked to complete a brief set of questions, specifically relating to each flight. Finally, at the conclusion of the fourth flight and accompanying questions, the participants were provided with a final questionnaire that was designed to examine whether participants linked the general concepts and principles associated with the four flights (see Appendix D: Experiment 3).
Consistent with the previous experiments, the four flights in the current study were specifically designed so that the pilots could complete the tasks associated with each flight without violating the low-flying rules. There is, in essence, two parts to the Low-Flying Regulations (CAR 157) pertaining to flight over non-populated areas. Firstly, as stated previously, a pilot must not fly over any non-populated area at an altitude lower than 500 feet. Secondly, an aircraft must not be flown at a height lower than 500 feet above the highest point of the terrain, and any object on it, in a radius of 600 meters.

7.8 Results

7.8.1 Zuckerman’s Sensation Seeking Scale

Prior to analysing the results of each test flight in relation to the main dependent variable, it was important to establish first that the results being examined reflected the training that pilots had received in the first week and were not due to any differences in pilots’ desire for sensation seeking experiences. Therefore, a univariate Analysis of Variance (ANOVA) was employed to determine whether differences existed between the mean score on Zuckerman’s Sensation Seeking Scale with the training groups as an independent variable. The ANOVA test assumptions were found to be satisfactory, and the results revealed a statistically significant difference between groups for the mean scores on the Sensation Seeking Scale $F(2, 42) = 3.28, p = .04, \eta^2 = .135$ (see Table 20). Employing Fisher’s Least Significant Difference $^{11}$ (LSD) post hoc test, it was determined that the only significant difference was between the ‘hint’ and the ‘no hint’ group ($p = .014$). In particular, a higher test score on Zuckerman’s

$^{11}$ See Footnote number two, justifying the use of Fisher’s LSD.
Sensation Seeking Scale was achieved by the ‘hint’ group in comparison to the ‘no hint’ group. This result has potentially important implications for the current study, as those pilots who scored higher on the SSS would be expected to display behaviour that is inherently less risk averse.

To examine whether participants’ scores on Zuckerman’s SSS were related to their risk-taking behaviour, a Pearson product-moment correlation was performed between scores on the sensation seeking scale and the minimum altitude to which the pilots descended during the training flight. In establishing the minimum altitude to which the participants descended over the house during training, the area around the house was isolated. The exact position of the house was –32.53739 degrees latitude and 149.65179 degrees longitude. Therefore, a five nautical mile boundary was determined around the house and this boundary was set between -32.5497 and -32.5425 degrees latitude and between 149.6664 and 149.6336 degrees longitude. It was assumed that, within this five nautical mile boundary, the behaviour of the pilot would be oriented towards identifying and memorising the number of cars that passed by the house within the ten-minute time period.

Prior to analysing the data within the isolated region of the house, the data relating to the mean minimum altitude to which the pilots descended were tested for normality and homogeneity of variance. The results revealed that the data were normally distributed with both the skewness and kurtosis non-significantly different from zero (i.e., \( z < 3.29, p > .001 \)) (Tabachnick & Fidell, 2001). A subsequent Pearson product-moment correlation revealed a weak, positive relationship between scores on the Zuckerman’s Sensation Seeking Scale and the minimum altitude descended during training was significant, \( r(28) = .45, p < .05 \). This indicates that those pilots, who scored higher on the sensation seeking scale, remained at a higher
altitude than those pilots who scored less on the same scale. This may have occurred for a number of reasons, one of which may relate to a self-censoring behaviour by the pilots. In other words, pilots may have been aware of their high sensation seeking desire and, as a result, may have amended their behaviour to reduce any potential negative effects. To ensure that subsequent analyses for each of the four test flights examined potential differences in training and not simply individual differences, scores from Zuckerman’s Sensation Seeking Scale were included as a covariate in subsequent analyses.

7.8.2 Risk Perception

The main aim in employing Hunter’s Risk Perception Scales in the current study was to examine whether pilots’ perception of risk differed between the three training groups (‘hint’, ‘no hint’ and control). This is important, since the perception of risk may be related to pilot behaviour. To test this assertion, a series of univariate analyses of variances were used to determine whether differences existed between the mean score on each factor in both Risk Perception Scale 1, and Risk Perception Scale 2, with the training group as the independent variable.

In relation to Risk Perception Scale 1, the results of three univariate analyses of variances failed to reveal any statistically significant differences between groups and the mean scores for, Delayed Risk $F(2, 42) = .20, p = .20, \eta^2 = .009$, Nominal Risk $F(2, 42) = .81, p = .45, \eta^2 = .037$, and Immediate Risk $F(2, 42) = .11, p = .89, \eta^2 = .005$ (see Table 21). This indicates that the groups did not differ on their scores for the Risk Perception Scale 1.

In relation to Risk Perception Scale 2, the results of five univariate analyses of variances failed to reveal any statistically significant differences between groups in
terms of the General Flight Risk $F(2, 42) = .68, p = .51, \eta^2 = .031$, High Flight Risk $F(2, 42) = .76, p = .48, \eta^2 = .035$, Altitude Risk $F(2, 42) = .45, p = .64, \eta^2 = .021$, Driving Risk $F(2, 42) = .55, p = .58, \eta^2 = .025$, and Everyday Risk $F(2, 42) = .99, p = .38, \eta^2 = .045$ (see Table 21). These results indicate that there were no significant differences between the groups in terms of their scores on Risk Perception Scale 2. In combination with the preceding results, it can be concluded that the groups did not differ in terms of their perception of the risks involved in various activities.

7.9 Results from the Four Simulated Test Flights

The main aim of the current study was to extend the research findings from the first two experiments and examine the extent to which information acquired during a training scenario would transfer/generalise to other scenarios that varied systematically from the initial training in terms of the surface features and the cognitive load. Since the results from the first two experiments reflected favourably on the value of cognitively active training and feedback, the current study sought to incorporate these features and further examine the benefits of providing a ‘hint’ as to the similarities between test task and the training. The hint consisted of a one-sentence statement that appeared in the instructions of each of the four flights and read, “Please note that the training flight undertaken in the first week is relevant to this flight and should be used to assist with the current task”.

During the training flight, emphasis was placed on the vertical separation during the course of the exercise, while the test flights examined the extent to which this information generalised to situations involving vertical separation (Freight Train),
horizontal separation (Cliff Face) and a combination of horizontal and vertical separation (Cooling Tower).

Since the primary aim of this study was to examine the extent to which information generalises from a task involving vertical separation to one that involves horizontal separation, the experimental design consisted of a series of analyses of covariance. Further, to examine whether the training that the pilots received in the first week was applied in the subsequent testing phase, one of the four counterbalanced test flights was a direct replication of the training flight.

The data obtained from each of the four test flights from X-Plane were transferred directly from the output file of X-Plane to the Statistical Package for the Social Sciences (SPSS), version 11.5. This process was made possible through a template within SPSS, which directly transformed the data (see Appendix A).

7.10 Analysis of Data Relating to ‘Traffic’ Test Flight

To establish whether the training that pilots received in the first week was applied in the following week during the testing phase, the data pertaining to the ‘Traffic Flight’ were analysed initially. This analysis is significant, since it is a direct replication of the training flight, and, therefore, transfer would be expected to occur. However, prior to analysis, it was necessary to determine the minimum altitude to which the participants descended over the house while completing the task. To identify the minimum altitude to which pilots descended, the area around the house was isolated. The exact position of the house was –32.53739 degrees latitude and 149.65179 degrees longitude. A five nautical mile boundary was determined around the house and this boundary was set between -32.5497 and -32.5425 degrees latitude.
and between 149.6664 and 149.6336 degrees longitude. It was assumed that, within this five nautical mile boundary, the behaviour of the pilot would be oriented towards identifying and memorising the number of cars that passed by the house within the ten-minute time period.

Prior to analysis, the data relating to the mean minimum altitude to which the pilots descended were tested for normality and homogeneity of variance. The results revealed that this data were positively skewed with a positive kurtosis (leptokurtic) that was significantly different from zero ($p < .001$).

Consistent with the results of the previous experiments, skewed data might have been expected, since it would be reasonable to assume that pilots would descend to an altitude somewhere in the vicinity of the MSA as per VFR regulations. Therefore, the MSA imposed a lower limit (floor effect) to which the pilots could legally descend (i.e., 500 feet above ground).

To ensure that the data were consistent with the application of parametric statistics, the data pertaining to the mean minimum altitude descended were transformed using a square root transformation as prescribed by Tabachnick and Fidell (2001). A subsequent multivariate analysis revealed that the transformed data were normally distributed with both the skewness and kurtosis non-significantly different from zero (i.e., $z < 3.29, p > .001$) (Tabachnick & Fidell, 2001).

### 7.10.1 Frequency of Pilots Descending Beneath 500 Feet

The minimum altitude to which each pilot descended was examined in relation to the VFR low-flying regulations. The VFR low-flying regulations prescribe that, over non-populated areas, pilots must not fly lower than 500 feet above ground level. In total, 20% of participants in the ‘hint’ group descended beneath 500 feet during the
‘Traffic Report’ test flight, while in each of the ‘no hint’ group and control groups, 40% of the participants descended beneath 500 feet during the same test flight. However, a chi-square analysis failed to identify a significant relationship between descent beneath 500 feet (Traffic Report scenario) and the training group to which the participants had been assigned $\chi^2(2, N = 45) = 2.52, p = .28$. For those participants who descended beneath 500 feet, the mean duration spent beneath this altitude was 20 seconds (SD = 49). This result suggests that, for the pilots who descended beneath 500 feet, it was highly unlikely that the descent beneath this altitude resulted from a momentary lapse in concentration.

Having established the proportion of participants who descended beneath 500 feet during the exercise and the average time spent below 500 feet, the data were examined to determine whether the participants were aware of the altitude to which they had descended. A Pearson’s product-moment correlation identified a significant positive correlation, $r(43) = .776, p < .01$ between the actual altitude to which the participants descended and the perception of the altitude to which they descended. As a result, it can be concluded that the participants were, to some extent, aware of the altitude to which they had descended during the exercise, and that a descent below 500 feet was not necessarily due to a lack of awareness of the operational conditions.

To test the differences in pilots’ performance as a result of their ability to manipulate the flight controls, a one nautical mile segment of the flight was analysed to determine whether there was a statistical significant difference between groups based on their ability to physically manage the aircraft. Data pertaining to the lateral position of the aircraft, relative to the horizon (roll), was analysed between a distance of two and three nautical miles from Mudgee aerodrome. However, a univariate analysis failed to reveal a significant difference between groups in terms of pilots’
handling characteristics during the Traffic Report flight in the test week $F(2, 42) = .21, \ p = .81, \ \eta^2 = .010$ (see Table 22). This suggests that all group members exercised a similar level of control over the aircraft and that any differences that might arise were unlikely to be due to an inability to exercise control over the flight path of the aircraft.

7.10.2 Mean Minimum Altitude Descended for Group

The main aim of the Traffic Report flight was to examine whether the provision of a ‘hint’ concerning the relationship between the flight undertaken during training and the subsequent test flight would positively impact pilots’ risk management behaviour. However, it was also important to ensure that the results obtained reflect pilots’ performance as a result of the training in the preceding week and were not the outcome of individual differences. Since statistically significant differences were evident between training groups and scores on Zuckerman’s Sensation Seeking Scale, participants’ response on this scale was included as a covariate, thereby removing any source of error variance. Since it was also hypothesised that the risk-taking propensity amongst pilots would vary as a result of the pilots’ ability to recall similar experiences or case examples during the flight in the second session, only those data from pilots who could recall a similar experience in the second week were analysed (in total, 35 participants). Therefore, an Analysis of Covariance (ANCOVA) with training group as the independent variable, participant’s score on the SSS as a covariate and the mean minimum altitude descended during the Traffic Report test flight as the dependent variable, was employed to determine whether differences existed between the mean minimum altitude descended by participants, distributed across groups. The results revealed a main effect for group
Employing Fisher’s Least Significant Difference (LSD) post-hoc test, it was determined that the only difference lay between the ‘hint’ group and the control group ($p = .006$). The mean minimum altitude to which the participants descended in each group was 808 feet (SD = 445) for the pilots in the ‘hint’ group, 527 feet (SD = 95) for the pilots in the ‘no hint’ group, and 430 feet (SD = 206) for the pilots in the control group. In comparing the mean minimum altitude to which pilots descended across the groups, the results appear to suggest that employing a training programme where participants are cognitively active in the task and receive feedback, combined with a hint as to the similarities between the training task and the test task, yields superior results than training provided without a hint as to the similarities between training and test task.

### 7.11 Analysis of Data Relating to ‘Freight Train’ Test Flight

The main objective of the ‘Freight Train’ scenario flight was to examine participants’ ability to generalise information obtained in the training flight to other flights which were considered similar in nature, based on the surface features that were common (minimal variation in cognitive load). Therefore, the area around the freight train had to be isolated and the minimum altitude to which the pilots descended analysed. The exact position of the freight train was –32.52404 degrees latitude and 149.59381 degrees longitude. A five nautical mile boundary was determined around the freight train and this boundary was set between -32.53954 and

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12 See footnote number two, justifying the use of Fisher’s LSD.
13 Data are actual rather than transformed for illustrative purpose. Transformed data for each group were 27.69 (6.74) for the pilots in the hint group, 22.77 feet (2.13) for those pilots in the no hint group and, 20.08 (5.55) for those pilots in the control group.
-32.50476 degrees latitude and between 149.60674 and 149.56757 degrees longitude. It was assumed that, within this five nautical mile boundary, the behaviour of the pilot would be oriented towards locating the number on the side of the leading four carriages within the ten-minute time period.

Consistent with the application of parametric statistics and with all statistical procedures thus far (Experiment 1 and 2, and Traffic Report scenario), the data relating to the mean minimum altitude to which the pilots descended over the train were tested for normality and homogeneity of variance. The results revealed that the data pertaining to the mean minimum altitude was not significantly different from zero across all groups ($p < .001$) (Tabachnick & Fidell, 2001).

7.11.1 Frequency of Pilots Descending Beneath 500 Feet

The minimum altitude to which each pilot descended was examined in relation to the VFR low-flying regulations. The VFR low-flying regulations prescribe that over non-populated areas, pilots must not fly lower than 500 feet above ground level. In total, 47% of participants in both the ‘hint’ and ‘no hint’ group descended beneath 500 feet during the Freight Train test flight, while 80% of the pilots in the control group descended beneath 500 feet during the Freight Train test flight. However, a chi-square analysis failed to identify a statistically significant relationship between descent beneath 500 feet (Freight Train scenario) and the training group to which the participants had been assigned $\chi^2(2, N = 45) = 4.55, p = .10$. For those participants who descended beneath 500 feet, the mean time spent beneath this altitude was 45 seconds ($SD = 68$). This result indicates that, for the pilots who descended beneath 500 feet, it was highly unlikely that the descent beneath this altitude resulted from a momentary lapse in concentration.
Having established the proportion of participants who descended beneath 500 feet during the exercise and the average time spent below 500 feet, the data were examined to determine whether the participants were aware of the altitude to which they descended. A subsequent Pearson’s product-moment correlation identified a significant positive correlation, \( r(43) = 0.486, p < 0.001 \) between the actual altitude to which the participants descended and the perception of the altitude to which they descended. As a result, it can be concluded that the participants were, to some extent, aware of the altitude to which they descended during the exercise, and that a descent below 500 feet was not necessarily due to a lack of awareness of the operational conditions.

For those participants who descended beneath 500 feet, 44% commented that it was necessary to complete the task, 8% attributed their descent beneath 500 feet due to the sensitivity of the controls, 36% thought that they had not descended beneath 500 feet, while the remaining 12% said that it was unintentional. For those participants who commented that they thought it was necessary to complete the task, the maximum altitude at which the task was performed was 903 feet, while the mean altitude for those participants who did not descend beneath 500 feet was 623 (SD = 108) feet.

7.11.2 Mean Minimum Altitude Descended for Group

The main aim of the Freight Train flight scenario was to examine whether the provision of a hint as to the relationship between the flight undertaken during training and the test flight would positively impact pilots’ risk management behaviour. However, consistent with the Traffic Report flight, it was important to ensure that the results obtained reflected pilots’ performance as a result of training and not the
outcome of individual differences. Therefore, participants’ score on Zuckerman’s Sensation Seeking Scale was included as a covariate. Since it was also hypothesised that the risk-taking propensity amongst pilots would vary as a result of the pilots’ ability to recall similar experiences or case examples during the flight in the second session, only data from those pilots who could recall a similar experience in the second week were analysed (in total, 34 participants). Therefore, an analysis of covariance, with training group as the independent variable, participant’s score on the SSS as a covariate and the mean minimum altitude descended during the Freight Train test flight as the dependent variable, was used to determine whether differences existed between the mean minimum altitude descended by participants, distributed across groups. However, the results failed to reveal a statistical significant difference for group (‘hint’, ‘no hint’ or control) \( F(2, 31) = .51, p = .60, \eta^2 = .032 \) (see Table 24). These results suggest that, irrespective of the training obtained in the preceding week, no statistical differences were evident in pilot performance when they undertook a task which differed in context (causing an increase in cognitive load) to the training task in the subsequent week.

7.12 Analysis of Data Relating to ‘Cliff Face’ Test Flight

The main objective of the ‘Cliff Face’ test flight was to examine the extent to which information obtained (relating to vertical separation) in the training flight would generalise to a test flight which varied systematically, in terms of both context and task requirement (horizontal separation) from the initial training flight (moderate variation in cognitive load). Therefore, the area in front of the cliff face had to be isolated and the minimum separation between participants’ flight path and the cliff
face calculated. The exact position of the cliff face was on the longitude meridian of 149.60681, and spanned the distance between the latitude meridians of -32.51954 and -32.51494. When participants flew west of the 149.60681 degrees longitude, it was assumed that their behaviour was orientated towards completing the task within the ten minute time period. Not all participants maintained the same altitude and, therefore, the data pertaining to the closest point that the participants flew to the cliff face was recalculated to ensure that valid comparisons could be made. For example, the data pertaining to the closest point to the cliff face is represented in degrees, while the Civil Aviation Safety Authority regulations refer to minimum horizontal separation in metres, while vertical separation is represented in feet. Therefore, in the situations where pilots maintained a minimum altitude greater than the height of the cliff face, the data pertaining to the closest point flown to the cliff face had to be recalculated from degrees to feet. Once this information was obtained, using Pythagoras Theorem, (minimum distance in feet away from cliff face and minimum altitude less height of cliff face), the closest point to the cliff face was calculated using the formula:

\[ C = \sqrt{(A - 1.316)^2 + (149.60681 - B) x 600,000}^2 \]

where, \( A \) is the altitude of the aircraft, \( B \) is the longitudinal position of the aircraft and, \( C \) is the minimum separation from cliff face. In those cases where the minimum separation from the cliff face was below the actual height of the cliff face, the longitudinal degrees were subtracted from the position of the cliff face and then calculated into feet, using the formula:

\[ C = (149.60681 - B) x 600,000 \]

where, \( B \) is the longitudinal position of the aircraft and, \( C \) is the minimum separation from cliff face (see Figure 7).
Prior to analysis, the resulting data from the calculations were tested for normality and homogeneity of variance. The data were found to be positively skewed with a positive kurtosis (leptokurtic) that was significantly different from zero ($p < .001$). Given the nature of the task, skewed data might have been expected, since it would be reasonable to assume that pilots would remain at a height and distance away from the cliff face somewhere in the vicinity of the low-flying regulations. Therefore, the vertical and horizontal limitations imposed a lower limit (floor effect) to which the pilots could legally descend (i.e., 500 feet above a height specified by the highest point of the terrain, within a radius of 600 meters).

To ensure that the data were consistent with the application of parametric statistics, the data pertaining to the mean minimum distance from the cliff face were transformed using a square root transformation as prescribed by Tabachnick and Fidell (2001). A subsequent multivariate analysis revealed that the transformed data
were normally distributed with both the skewness and kurtosis non-significantly different from zero (i.e., $z < 3.29, p > .001$) (Tabachnick & Fidell, 2001).

7.12.1 Frequency of Pilots Descending Beneath 500 Feet

The minimum altitude to which each pilot descended was examined in relation to the VFR low-flying regulations. The VFR low-flying regulations prescribe that pilots must remain 500 feet above a height specified by the highest point of the terrain, within a radius of 600 meters. In total, 27% of participants in the ‘hint’ group breached the low-flying regulations, 7% of the participants in the ‘no hint’ group breached the low-flying regulations, while 33% of the participants in the ‘control’ group breached the low-flying regulations during the ‘Cliff Face’ test flight. However, a chi-square analysis failed to identify a significant relationship between descent beneath 500 feet within a radius of 600 meters above the highest point of the terrain (Cliff Face scenario), and the training group to which the participants had been assigned $\chi^2(2, N = 45) = 3.34, p = .19$.

Having established the proportion of participants who breached the low-flying regulations, the data were examined to determine whether the participants were aware of their separation from the cliff face. A subsequent Pearson’s product-moment correlation failed to identify a significant positive correlation, $r(43) = .197, p > .05$ between participants’ actual separation from the cliff face and their perceived separation. As a result, it can be concluded that participants may have had difficulty in estimating their separation from the cliff face and that their performance during the exercise may not have accurately reflect their intended behaviour. Therefore, any conclusions drawn from the data should be interpreted with caution.
For those participants who descended beneath 500 feet within a 600 metre radius above the cliff face, 80% commented that this was necessary to complete the task, 10% attributed their descent beneath 500 feet due to the sensitivity of the controls, and 10% thought that they had not descended beneath 500 feet. For those participants who commented that descent beneath 500 feet within a 600 meter radius of the cliff face was necessary to complete the task, the average distance that those participants who did not violate the low-flying regulations remained from the cliff face was 4,305 feet (SD = 2,660).

### 7.12.2 Mean Minimum Separation from Cliff Face for Group

The main aim of the Cliff Face flight was to examine the extent to which information acquired during training would generalise to tasks that varied systematically from the training flight, based on differences in terms of the context and task requirements. Consistent with the previous analyses of covariance, the pilots’ score on Zuckerman’s Sensation Seeking Scale was included as a covariate and only data from those pilots who were able to recall similar experiences or case examples during the test flight were analysed (in total, 29 participants). However, the results of an analysis of covariance, with training group as the independent variable, participant’s score on the SSS as a covariate, and the square root of the minimum separation from the cliff face as the dependent variable, failed to reveal a statistically significant difference for group (‘hint’, ‘no hint’ or control) $F(2, 26) = .46, p = .64, \eta^2 = .034$ (see Table 25). In comparing the mean minimum altitudes descended across the groups, the results suggest that, irrespective of the training received in the preceding week, no statistically significant differences were evident in pilots’ performance when they undertook a task which differed in context and task
requirement (causing a moderate increase in cognitive load) to the training task in the subsequent week.

**7.12.3 Mean Minimum Altitude Descended across Group**

Since the training flight was primarily concerned with the minimum altitude to which pilots descended, the data from the Cliff Face flight pertaining to the mean minimum altitude to which pilots descended was also examined. Prior to analysis, all of the data were tested for normality and homogeneity of variance. The results revealed that the data pertaining to the mean minimum altitude to which pilots descended over the cliff face were not significantly different from zero ($p < .001$) (Tabachnick & Fidell, 2001).

Consistent with the previous analyses, pilot’s score on Zuckerman’s Sensation Seeking Scale was included as a covariate and, since it was hypothesised that the risk-taking propensity amongst pilots would vary as a result of the pilots’ ability to recall similar experiences or case examples during the flight in the second session, only data from those pilots who could recall a similar experience in the second week were analysed (in total, 29 participants). An analysis of covariance with training group (‘hint’, ‘no hint’ and control) as the independent variable, participant’s score on the SSS as the covariate and the mean minimum altitude participants descended as the dependent variable, was employed to determine whether differences existed between the mean minimum altitude descended for participants, distributed across groups. However, the results failed to reveal a statistically significant difference for group (‘hint’, ‘no hint’ or control) $F(2, 26) = .04, p = .96, \eta^2 = .003$ (see Table 26). This indicates that pilots’ risk management behaviour, as reflected in the minimum altitude
descended during the ‘Cliff Face’ test flight, did not alter as a result of the training that they had received in the preceding week.

7.13 Analysis of Data Relating to the ‘Cooling Tower’ Test Flight

The main objective of the Cooling Tower test flight was to examine the extent to which information would generalise between two flights, based on differences in terms of both context (i.e., specific features of flight) and task requirements (i.e., combination of both vertical and horizontal separation) (significant increase in cognitive load). The Cooling Tower flight required participants to investigate unconfirmed reports of a protestor on a cooling tower. Therefore, the area around the cooling tower had to be isolated and the minimum separation between participants’ flight path and the cooling tower was calculated. The exact position of the cooling tower was –32.49994 degrees latitude and 149.58775 degrees longitude. A five nautical mile boundary was determined around the cooling tower and this boundary was set to between -32.51476 and -32.48490 degrees latitude and between 149.59995 and 149.567653 degrees longitude. It was assumed that, within this five nautical mile boundary, the behaviour of the pilot would be oriented towards identifying the alleged protestor on the cooling tower within the ten-minute time period.

Since not all of the participants maintained the same altitude throughout the exercise, the closest point that the participants flew to the cooling tower had to be calculated. Specifically, the data pertaining to the closest point to the cooling tower is represented in degrees, while Civil Aviation Safety Authority regulations refer to minimum horizontal separation in metres and vertical separation represented in feet. Therefore, to ensure that the data remained consistent across comparisons, the data
relating to horizontal separation were calculated from degrees to metres and then to feet. Once this information was obtained, using Pythagoras Theorem, (minimum distance in feet away from the cooling tower and the minimum altitude less height of the cooling tower), the closest point to the cooling tower was calculated using the formula:

\[ B = (\text{Aircraft latitude} + \text{Aircraft longitude} - 117.08781) \times 600,000 \]

\[ C = \sqrt{(A - 700)^2 + B^2} \]

where, \( A \) is the altitude of the aircraft, \( B \) is the horizontal separation from cooling tower and, \( C \) is the minimum separation from cooling tower. In those cases where the minimum separation from the cooling tower was below the actual height of the structure, the longitudinal degrees of the closest point flown was subtracted from the cooling tower and transformed into feet using the formula:

\[ C = \text{absolute} (\text{Aircraft latitude} + \text{Aircraft longitude} - 117.08781) \times 600,000 \]

where, \( C \) is the minimum separation from cooling tower (see Figure 8).

*Figure 8.* Pictorial representation, illustrating how the data pertaining to pilots’ flight path was calculated depending on their altitude (AGL) during the Cooling Tower flight.
Prior to analysis, the resulting data from the calculations were tested for normality and homogeneity of variance. Specifically, the data were positively skewed with a positive kurtosis (leptokurtic) that was significantly different from zero across groups ($p < .001$). Given the nature of the task, skewed data might have been expected, since it would be reasonable to assume that pilots would remain at a height and distance away from the cooling tower somewhere in the vicinity of the requirements specified in the low-flying regulations. Therefore, the vertical and horizontal limitations imposed a lower limit (floor effect) to which the pilots could legally descend (i.e., 500 feet above a height specified by the highest point of the terrain, within a radius of 600 meters).

To ensure that the data were consistent with the application of parametric statistics, the data pertaining to the mean minimum distance from the cooling tower were transformed using a logarithmic transformation as prescribed by Tabachnick and Fidell (2001). A subsequent multivariate analysis revealed that the transformed data were normally distributed with both the skewness and kurtosis non-significantly different from zero (i.e., $z < 3.29, p > .001$) (Tabachnick & Fidell, 2001).

### 7.13.1 Frequency of Pilots Descending Beneath 500 Feet

The minimum altitude to which pilots descended was examined in relation to the VFR low-flying regulations. The VFR low-flying regulations prescribe that pilots must remain 500 feet above a height specified by the highest point of the terrain, within a radius of 600 meters. In total, 93% of participants in both the ‘hint’ and ‘no hint’ group breached the low-flying regulations, while 80% of the participants in the control group breached the low-flying regulations during the Cooling Tower test flight. However, a chi-square analysis failed to identify a significant relationship...
between descent beneath 500 feet within a radius of 600 meters above the highest point of the terrain (Cooling Tower scenario) and the training group to which the participants had been assigned \( \chi^2(2, N = 45) = 1.80, p = .41 \), Fisher’s exact test, \( p = 1.60 \).

Having established the proportion of participants who breached the low-flying regulations, the data were examined to determine whether the participants were aware of their separation from the cooling tower. A subsequent Pearson’s product-moment correlation failed to identify a significant positive correlation, \( r(43) = .017, p > .05 \) between participants’ actual separation from the cooling tower and their perceived separation. As a result, it can be concluded that participants may have had difficulty estimating their separation from the cooling tower and that their performance during the exercise may not have accurately reflected their intended behaviour. Therefore, any conclusions drawn from the data should be interpreted with caution.

For those participants who descended beneath 500 feet within a 600 metre radius above the cooling tower, 15% commented that it was necessary to complete the task, 78% thought that they had not descended beneath 500 feet, and 7% commented that their descent beneath 500 feet was unintentional. For those participants who commented that they thought it was necessary to complete the task, the average distance that participants who did not breach the low-flying regulations remained from the cooling tower was 843 feet (SD = 274).

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\(^{14}\) The \( p \) value using Fisher’s exact test was calculated instead of the chi-square value because 3 cells have an expected count less than 5. The minimum expected count is 1.67 (Heiman, 1996; Siegel, 1956).
7.13.2 Mean Minimum Separation from Cooling Tower for Group

The main objective of the Cooling Tower test flight was to examine the extent to which information would generalise between two flights, based on differences in terms of cognitive load. Therefore, an analysis of covariance was employed to determine whether differences existed between the mean minimum separation from the cooling tower, distributed across groups. Consistent with the previous analyses, participant’s score on Zuckerman’s Sensation Seeking Scale was included as a covariate and only data from those pilots who were able to recall similar experiences or case examples during the Cooling Tower test flight were analysed (in total, 29 participants). However, an analysis of covariance with training group as the independent variable, participant’s score on the SSS as a covariate and the mean minimum separation (log 10) away from the Cooling Tower as the dependent variable, failed to reveal a statistical significant difference for group (‘hint’, ‘no hint’ or control) $F(2, 27) = .96, p = .40, \eta^2 = .066$ (see Table 27). In comparing the mean minimum altitude descended across the groups, the results appear to suggest, that irrespective of the training obtained in the preceding week, no statistically significant differences were evident in pilot performance between the three groups.

7.13.3 Mean Minimum Altitude Descended Across Group

Since the training flight during the first week was primarily concerned with the minimum altitude to which pilots descended, it was considered necessary to examine the data pertaining to the Cooling Tower flight in terms of the altitude to which the pilots descended. Prior to analysis, the data were tested for normality and homogeneity of variance. The results revealed that the data pertaining to the mean minimum altitude to which pilots descended over the cooling tower was not
Consistent with the previous analyses, pilot’s score on Zuckerman’s Sensation Seeking Scale was included as a covariate and, since it was hypothesised that the risk-taking propensity amongst pilots would vary as a result of the pilots’ ability to recall similar experiences or case examples during the flight in the second session, only data from those pilots who could recall a similar experience in the second week were analysed (in total, 29 participants). An analysis of covariance with training group (‘hint’, ‘no hint’ and control) as the independent variable, participant’s score on the SSS as a covariance, and the mean minimum altitude to which the participants descended during the Cooling Tower test flight as the dependent variable, was employed to determine whether differences existed between the mean minimum altitude descended for participants, distributed across groups. However, the results failed to reveal a statistical significant difference for group (‘hint’, ‘no hint’ or control) $F(2, 27) = .34, p = .71, \eta^2 = .025$ (see Table 28). This indicates that pilots’ risk management behaviour, in relation to the mean minimum altitude flown during the Cooling Tower test flight did not alter significantly as a result of the training they had received in the preceding week.

7.14 Cognitive Load and Performance

It was assumed that the four test flights differed in terms of the cognitive load imposed on the pilots during the completion of the tasks. Pilots under increased cognitive load would be required to divide their attentional resources to manage the task demands. As a result of the division of attentional resources, it might be expected
that there would be relatively limited residual resources available to manage other aspects of the flight. This may, in turn, negatively impact pilot performance. To investigate the validity of this assumption, a Friedman chi-square repeated measure ANOVA for ranks was employed, with the minimum separation from the surfaces (i.e., ground or object) in rank-order as the independent variable. Friedman’s chi-square test for repeated measures was employed, since the data pertaining to each of the four test flights, in terms of the minimum separation participants remained from the surfaces were not homogeneous.

The results from the Friedman’s chi-square test for repeated measures revealed a statistically significant difference $\chi^2(3, N = 45) = 82.95, p = .0001$, between test flights in terms of the rank-order relating to the minimum separation that participants remained from each of the surfaces during the flights. Employing Nemenyi’s post hoc comparison procedure, with a calculated critical difference of .91, it was determined that the difference lay between the Traffic Report (no increase in cognitive load) and the Cliff Face (moderate increase in cognitive load) scenarios; between the Traffic Report (no increase in cognitive load) and the Cooling Tower (significant increase in cognitive load) scenarios; between the Freight Train (minimal increase in cognitive load) and the Cliff Face (moderate increase in cognitive load); and between the Cliff Face (moderate increase in cognitive load) and the Cooling Tower (significant increase in cognitive load). Therefore, it can be concluded that if the four flights were ranked, the Cooling Tower flight (significant increase in cognitive load) would be ranked first in terms of the minimum separation that they remained from the surface, followed by the Freight Train (minimal increase in cognitive load), Traffic Flight (no increase in cognitive load) and then the Cliff Face (moderate increase in cognitive load). Therefore, participants flew closer to the Cooling Tower (significant increase in
cognitive load) than any other structure, which is consistent with the cognitive demands imposed by the task. In contrast, the participants’ separation from terrain was greatest during the Cliff Face test flight (moderate increase in cognitive load), suggesting that participants may have found this test flight, the least demanding from the perspective of cognitive load.

An alternate explanation that may account for the differences in the mean separation that participants remained from surfaces relates to the lack of instrumentation that might have provided pilots with information pertaining to horizontal separation. Since the Cliff Face test flight was the only flight that required horizontal separation alone, it would not be unreasonable to assume that since no instrument was present in the aircraft that provided a clear indication of the horizontal separation from surfaces, pilots might err on the side of caution and, as a result, increase their horizontal separation from terrain.

7.15 Discussion

The current experiment was primarily concerned with examining the extent to which analogical transfer would occur from information learnt in one situation to performance in another situation. A secondary, although no less important issue was the impact that cognitive load may have on the transfer of information. To investigate these issues, forty-five pilots were divided into three groups: Two experimental groups (‘hint’, and ‘no hint’) and one control group, and the three groups completed a simulated training flight on a flight simulator, followed one week later by four test flights. Three of the four test flights in the second week varied from the training flight, while the fourth test flight was a direct reproduction of the training flight. Data
pertaining to the mean minimum altitude (Traffic Report and Freight Train) and the minimum separation that participants remained from surfaces (Cliff Face and Cooling Tower) were analysed using a series of analyses of covariance. As stated previously, analyses of covariance were employed in preference to a repeated measures design, as a result of the different transformations (i.e., data pertaining to the Train test flight normally distributed, data pertaining to the Traffic Report and the Cliff Face test flight not normally distributed, requiring square root transformation, and the data pertaining to the Cliff Face test flight not normally distributed, requiring a log 10 transformation) that were performed to satisfy the requirements for multivariate procedures (Tabachnick & Fidell, 2001). In addition, since statistically significant differences were evident between training groups and scores on Zuckerman’s Sensation Seeking Scale, participants’ responses on this scale were included as a covariate to remove any source of error variance. Finally, Friedman’s chi-square test for repeated measures was employed as a manipulation check to determine whether differences existed in terms of the cognitive load imposed by the four test flights.

A review of the empirical literature relating to analogical transfer indicated that the transfer of information from one analogue to another might result if both analogies share similar characteristics. While theorists remain divided about the precise role that different features of an analogue facilitate transfer, a more central aim to this research is the potential benefit in providing a hint as to the similarities between analogies. According to Gick and Holyoak (1983), providing a hint as to the similarities between two analogies increases the likelihood of transfer. On the basis of this evidence, the current study was designed to investigate the benefits of providing a hint concerning the similarities between two tasks to facilitate the transfer between the tasks.
In addition to an examination of the utility of providing a hint, the current study was designed to examine the extent to which information acquired during a training task would generalise to a subsequent test task, based on differences in the cognitive load between the two tasks. The empirical literature relating to cognition and performance suggests that post-exposure to an event or situation, an individual will store information pertaining to the event in the form of a case example in long-term memory. When that individual is subsequently exposed to an event that they perceive as the same or similar, they will draw on the example stored in long-term memory to assist with solving the current situation. As a result of drawing upon the information directly from long-term memory, the processing capacity of working memory remains at its peak, providing the maximum residual resources available to process other information as required (Sweller, 1988; Rose et al., 2004; Fraidin, 2004). However, Sweller (1988) suggests that any alteration from the original event or situation, may add to the cognitive load, thereby potentially impacting performance.

With this in mind, the current study sought to examine the extent to which information would generalise from one flight to another, based on differences in terms of the cognitive load between the tasks. Specifically, during the training task, emphasis was placed on the vertical separation, while during the test tasks, the emphasis was shifted to either the horizontal separation participants remained from a surface or a combination of both horizontal and vertical separation.

Prior to discussing the results from each of the four test flights, a review of the results from Zuckerman’s Sensation Seeking Scale identified that the three different training groups (‘hint’, ‘no hint’ and control) differed in terms of their score on the SSS. A post-hoc test following a univariate analysis of variance revealed a higher score on Zuckerman’s SSS for the ‘hint’ group in comparison to the ‘no hint’ group.
To determine whether participants’ score on Zuckerman’s SSS was correlated with their behaviour, a Pearson’s product-moment correlation was performed between participants’ scores on the sensation seeking scale and the mean minimum altitude to which they descended during the training flight in the first week. The results revealed a weak positive correlation, indicating that the pilots who scored higher on the sensation seeking scale remained at a higher altitude in comparison to those pilots who scored lower on the same scale. As a result of this relationship, scores on Zuckerman’s SSS were included as a covariate in all subsequent analyses performed between the training groups to remove any source of error variance.

In addition to Zuckerman’s SSS, the results from Hunter’s Risk Perception Scales were examined across groups to determine whether any differences were evident. The results of a series of univariate analyses of variances between groups and each factor on the Risk Perception Scales failed to reveal any statistically significant difference between the three training groups. This suggests that no differences were evident in participants’ perception of risk across the three different training groups (‘hint’, ‘no hint’ and control).

A total of twelve hypotheses (six hypotheses for each of the Traffic Report and the Freight Train test flights) and four research questions (two research questions for each of the Cliff Face and the Cooling Tower test flights) were derived for the current experiment. The results supported only one (hypothesis number two from the Traffic Report scenario - no variation in cognitive load) out of the twelve hypotheses. This hypothesis predicted that, in comparison to the participants in the control group, participants in the ‘hint’ training group would adopt more risk averse behaviour, as measured by the mean minimum altitude descended during the ‘Traffic Report’ test flight in the second week. The Traffic Report test flight was a direct replication of the
training flight in the first week. The mean minimum altitude to which the participants in the ‘hint’ group descended during the Traffic Report test flight was 808 feet (SD = 445), in comparison to the pilots in the control group who descended to a mean minimum altitude of 430 feet (SD = 206).

The remaining eleven hypotheses and the four research questions can be divided into two categories to facilitate interpretation. The first category concerns improving pilots’ risk management behaviour. This category embodies differences in pilots’ performance in relation to the mean minimum altitude to which they descended. The second category concerns itself with reducing violations and, in turn, ultimately reducing errors and accidents. This category relates to breaches of the low-flying regulations between groups. For the Traffic Report and the Freight Train test flights, it was predicted that a difference would be evident between the three training groups, based on the mean minimum altitude to which the participants descended. It was also predicted that a difference would be evident between the three training groups, based on breaches of the low-flying regulations. Similarly, the four research questions explored potential differences between the training groups in terms of both the mean minimum altitude descended, and breaches in the low-flying regulations with the Cooling Tower and the Cliff Face test flights. No differences were evident between the three groups on any of the four test flights in relation to breaches of the low-flying regulations. The only statistically significant difference was observed during the Traffic Report test flight between the ‘hint’ group and the control group, where the ‘hint’ group remained at a higher altitude, on average, than the control group. While the results pertaining to the mean minimum separation that participants maintained during the Cliff Face test flight were not statistically significant, they may be explained in relation to the cognitive load of the task.
The results of Friedman’s chi-square test for repeated measures indicated that participants remained further away from the cliff face, than any other surface during the four test flights. If it assumed that the difficulty of the flight, as measured by the median distance from the surface or objects, is related to the cognitive load imposed by the task, then it might be argued in relation to the Cliff Face scenario, that participants might have had cognitive resources available to them that were not available in other scenarios. As a result, a greater level of transfer might have been expected in relation to this scenario. The fact that this did not occur, raises a number of questions pertaining to both the nature of the scenarios and the nature of transfer itself.

The nature of the scenarios comes under further scrutiny when the data are considered in relation to the ‘Traffic Report’ and ‘Freight Train’ test flights. The former was designed as a direct reproduction of the training flight, while the latter was designed to be consistent with the oil tanker flight that featured in experiments one and two. In the Oil Tanker and the Freight Train flights, participants were asked to identify a number located on an object, where emphasis was placed on vertical separation. As a result, participants’ performance on the Freight Train flight was expected to be similar to the level of performance that occurred in the Oil Tanker flight. In fact, the results from the Freight Train test flight appear to contradict the results from the first two experiments. There are two possible reasons for this outcome, the first of which is the possibility that the two scenarios are similar, but different representations of the tasks. Secondly, it might be the case that pilots are naturally more risk averse when flying over water than when flying over land.
7.15.1 Similar but Different Representation of the Tasks

In experiments one and two, participants trained by counting the number of motor vehicles which passed by a house during a ten-minute period. In the second week, pilots were asked to read a number located on the deck of an oil tanker. In the third experiment, although the training scenario was consistent with the previous experiment, the testing phase involved participants reading a number located on the side of the leading four carriages of a freight train. Although both the surface elements (i.e., involved low-flying, flying the same aircraft (Cessna 172), similar holding patterns (circling) and a spotting task) and the abstract features (risk management behaviour) of each task remained identical, the finer surface details of the tasks differed. For example, the number that was located on the deck of the oil tanker was depicted horizontally, where the number appeared vertically on the side of the freight train. In addition, the number located on the oil tanker was presented in turquoise on a grey background, while the number on the freight train was present in white with a red background. Although the orientation of the numbers differed, the size of the numbers in all of these studies was matched.

While it could be argued that the differences that existed between the two flights were simply differences in stimuli, the fact that no transfer occurred between the training flight and the Freight Train flight in Experiment 3, while transfer was evident between a similar training flight and the oil tanker flight in experiments one and two, suggests that the differences in the context of the flights may have had an impact on the results. While support for this claim will vary as a result of the different theoretical perspectives (Gick & Holyoak, 1983; Revees & Weisberg, 1994; Catrambone & Holyoak, 1989; Bassok & Holyoak, 1993; Sweller, 1988), additional research is required to exclude the orientation of the number as a significant factor in
the outcome. This research should specifically address the impact of different colours (i.e., background and foreground) on individuals’ performance as well as the impact the placement of the number on the object (i.e., vertical and horizontal) has on individual performance.

7.15.2 Pilots Naturally more Risk Averse when Flying Over Water

Another explanation for the differences that are evident between the results from both Experiment 1 and 2 and the results from Experiment 3 relates to the pilots’ natural instinct to adopt varying levels of risk management in response to the demands of the task. For example, it would be reasonable to assume that, when flying over water, pilots would adopt more risk averse behaviour in comparison to operations over land. Such changes in behaviour may be explained as pilots maximising their options in the event of an engine failure and/or the aircraft becoming unserviceable. While an empirical review of the aviation literature failed to find any evidence to support this assertion, evidence may be derived from the results of Experiment 1 where, during the training flight in week one, half of the pilots in the flight group were asked to identify and memorise the number of fishing trawlers at Tanilba Bay, and remained at a higher altitude, on average, in comparison to those pilots who were asked to identify and memorise the number of motor vehicles that passed by a house south of Williamtown.

Although the differences relating to pilots’ performance when counting fishing trawlers at Tanilba Bay in Experiment 1 were not statistically significant, there was a trend evident which appears to suggest that pilots’ risk management behaviour is contingent on the situation at hand. Consistent with this view, Mayhew, Donelson,
Beirness, and Simpson (1986) examined different risk management behaviour in the automotive industry and identified a relationship between the task demands and situations. Mayhew et al. (1986) tested the widely held belief that young drivers are more willing to drink alcohol and then drive a motor vehicle. In fact, they found that while teenagers and young adults frequently consume alcohol and, sometimes in large quantities, young adults are less likely to drive after drinking than their older counterparts. Nevertheless, there appears to be a small minority of the younger population who are complacent with drinking and driving. However, they tend to be over-represented in accident involvement. For the most part, the majority of younger drivers successfully manage drinking alcohol and the temptation of driving.

Braithwaite (2001) refers to the acceptability of risk as being directly related to the perceived level of control. Moreover, Braithwaite claims that if individuals have a greater level of perceived control over the situation, they will engage in behaviour that is inherently more risky. Alternatively, if they perceive that they have minimal control over a situation, they will exercise greater caution with their decisions. Examining the results from the current series of experiments with this notion in mind, the plausibility of the explanation becomes more feasible, that pilots flying over water adopt more risk averse behaviour to increase the number of options available in the event of a problem arising.

7.15.3 Cognitive Load Imposes Restrictions on Pilots’ Performance

In an attempt to examine why transfer between the base and target analogies was not evident in the current experiment, the following section examines the results in terms of the literature pertaining to cognition and performance. While the Traffic
Report and the Freight Train flights primarily examined pilots’ performance in relation to the vertical separation, the Cooling Tower flight potentially added additional constraints on the pilots, in terms of cognitive load, since there was a requirement to monitor both the horizontal and the vertical separation of the aircraft.

An examination of the data from Friedman’s chi-square test for repeated measures pertaining to the four test flights revealed that pilots flew closer to the cooling tower than they did to the ground when completing the traffic report test flight. This result was interpreted as support for the premise that the change in dimension from the vertical to the combination of the horizontal and the vertical (Cooling Tower flight) increased the cognitive load on the participants, thereby resulting in a reduction in performance. As a result of the increased cognitive load imposed by the tasks, participants’ ability to devote sufficient resources to process the additional information was presumed to have been limited.

Cognitive empiricists have established that individuals have a limited working memory capacity (Sweller, 1988; Rose et al., 2004; Fraidin, 2004). Moreover, Tarmizi and Sweller (1988) suggest that, under conditions of increased cognitive load, where individuals are exposed to new information, additional information, and/or when time constraints are imposed, often there are insufficient cognitive resources available to adequately process this information. As a result, individuals tend to manage their limited attentional resources by dividing their attention between multiple sources of information. Fraidin (2004) posits that this, in turn, further adds to the cognitive load which further hinders the performance.

Evidence to support the relationship between decrements in cognitive load and performance is provided by Rose, Roberts, and Rose, (2004) who examined performance where participants were asked to analyse financial data under varied
information and levels of cognitive load. The results revealed that, as information or cognitive load increases, individuals’ ability to perform decreases. These results coincide with Fraidin (2004) who examined both group and individuals’ performance under varying cognitive loads. Fraidin indicates that when cognitive load increases, impairments in decision-making ability tend to result.

Sweller (1988) explains the reduction in performance resulting from an increase in cognitive load as a product of the constraints of working memory. According to Sweller, in situations where new or unfamiliar information is encountered, working memory does not have the residual capacity to process this information in parallel with any other information. In contrast, in situations that are perceived as familiar, a participant would have developed schemata encompassing information pertaining to the situation. When he/she experiences the same or a similar situation and this situation is recognised, they apply the solution derived from the schema directly from their long-term memory. In such situations, Paas et al. (2004) contend that individuals process schemata automatically or unconsciously, thereby removing any limitations on the working memory.

The relationship between the use of schemata and a limited-capacity working memory provides a relatively plausible explanation of the results from the current experiment. For example, in the current experiment while only data from those participants who were able to recall similarities between the test flight and other flights experienced including simulation/s were analysed, it is not clear if they actually recognised the similarities between the training flight and the cooling tower flight or between the cooling tower flight and another experience. According to the cognitive empiricists, if any differences existed between the two experiences, then an increase in cognitive load on working memory would be expected. Under such
conditions, due to the increased constraints on working memory as a result of processing the new information, decrements in performance would not be uncommon.

7.15.4 Limitations of the Study

While the current experiment has tested the extent to which information taught in a low-flying training scenario will generalise to a broader range of flight operations, the extent to which conclusions may be drawn from this research remains limited. The current experiment focused on examining pilots’ performance in a simulated environment. Such environments control for, and eliminate as much as possible, noise, interruptions, turbulence, temperature, seating and other environmental factors that are present under normal operating conditions. From an experimental perspective, controlling these variables allows the researcher to closely examine the main objective of the research (training method). However, from an applied perspective, the actual impact of other variables and/or their interaction/s remains unclear.

As discussed in Experiment 2, another factor that may potentially limit the generalisation of the results, relates to the fidelity of the simulation (see 6.9.3, ‘Limitations of the Study’ for discussion on fidelity of simulation) and the restricted visibility experienced by the participants in the simulator (see 6.9.3, ‘Limitations of the Study’ for discussion on visibility limitations of simulator).

7.15.5 Future Research

Thus far, the results from the current experiment have indicated that, in order to improve pilots’ risk management behaviour on a low-flying task, pilots need to be
cognitively active in the training task where they personally experience the risks involved. They also need to be provided with feedback during training in relation to their performance on the training task. Since pilots’ performance also improves as a result of recognising the similarity between two tasks, sufficient emphasis needs to be placed on the training tasks to make them more memorable. In addition, to facilitate the link between training and the base task, there is some evidence from both the current experiment and research conducted by Gick and Holyoak (1980; 1983) that providing a hint as to the similarities between the two tasks further facilitates transfer during training. Finally, there is some evidence from Experiment 3 to suggest that the extent to which information will generalise beyond training is contingent on both the situation or task being familiar to the participant and the residual cognitive resources required to process information pertaining to the situation or task.

While the results from the current experimental sequence (Experiment 1, 2 and 3) indicate what is necessary to improve pilots’ risk averse behaviour during a simulated low-flying task, the extent to which information experienced in one situation will generalise to another remains less clear. The results from both Experiment 1 and 2 indicate a positive transfer between two tasks, while the results from Experiment 3 appear less conclusive. Interpreting these results in terms of the literature, it appears that there may be a discrepancy present between the surface elements (underlying structure) or the abstract features (pragmatic or semantic constraints) of the two different analogies (training task in week one to any one of the three test flights in the second week which differed from the initial training flight), or that pilots’ risk management behaviour is a reflection of the situational demands (objective of the task). For example, the results from the training flight in the first
An alternate view to both the potential problems caused by different surface features between analogies or the situational demands of the task/s, relates to the cognitive load imposed by the task. While both the Traffic Report and the Freight Train flights primarily constituted an identification task where pilots were cognitively engaged in maintaining the required vertical separation, the context of each task changed (i.e., cars passing by a house, in contrast to a number located on a train). While it was expected that transfer would occur between the two flights based on the results of the first two experiments, according to the cognitive theorist, transfer between these two flights (Traffic Report and the Freight Train) was not guaranteed as a result of the potential increase in cognitive load caused by the contextual changes between the two flights. Furthermore, according to this theoretical perspective, the results from the Cooling Tower test flight would be expected to be similar to the results from the Traffic Report and the Freight Train flights. Such results might have been anticipated, based on the potential increase in cognitive load resulting from differences in the context and the task requirements of each flight. Specifically, during the Cooling Tower test flight, pilots not only had to perform an identification task and monitor their vertical separation, but they also had to contend with a third factor, their horizontal separation.

While theories relating to analogical transfer examine the degree to which information transfers between two tasks that are relatively similar in nature and under similar conditions (i.e., cognitive load), the results from Experiment 3 raise concerns about the effectiveness of transfer between tasks when the tasks are not perceived as similar or where additional cognitive loads are imposed on individuals. As a result,
future research needs to examine the potential impact resulting from problems associated with the underlying structures of analogies, the constraints imposed by pragmatic and semantic schemata, the situational demands of the task, and the effects of varying levels of cognitive loads in relation to analogical transfer. Specifically, future research is required to examine, in greater detail, the precise factors of the training and the test environment that influences the transfer of training between tasks. At the same time, future research is required to examine, in greater detail, differences in pilots’ risk management behaviour as a result of the demands of the task. Finally, additional research also needs to be directed at examining the impact of varying cognitive loads on individuals’ performance. Examining the impact of these three factors (factors that facilitate transfer, demand characteristics and cognitive load) on transfer can be achieved by systematically altering different variables relating to each of these factors on the training case, and examine the degree of transfer in relation to performance on a test case.
Chapter 8: General Discussion

The aim of this series of studies was to examine different training methods to improve pilots’ risk management behaviour during low-level flight operations. The impetus for the research was evidence to suggest that pilots may not necessarily develop these skills as part of their training. Indeed, contemporary aviation training programmes do not necessarily target risk management as a distinct skill. Rather, it is assumed that risk management skills are acquired through interaction with the environment and through knowledge of factual information relating to the statistical frequency of accidents and/or incidents (e.g. Helicopter Association International (HAI) & Federal Aviation Administration (FAA), 1999).

The assumption within the aviation industry that risk management skills are acquired through interaction with the environment is not dissimilar to those made within the automotive industry. Furthermore, DeJoy (1992) contends that while most individuals, specifically motorist possess a relatively accurate perception of the risks associated with specific activities, they also tend to perceive that the aggregate estimates of risk do not necessarily apply to them personally (DeJoy, 1992). In fact, with some individuals, providing factual information about others’ involvement in accidents, such as occurs in aviation, may simply confirm an expectation that an individual is safer, better, and more skilful than the average operator (Brown, 1987).

In the automotive industry and in certain sporting domains, there is evidence to suggest that, rather than providing aggregate estimates of events, providing personalised experiences that are meaningful to an individual best facilitates the acquisition of risk management skills (Regan et al., 1998; Williams et al., 2002; Gregerson, 1993). However, the success of this approach appears dependent upon
active participation in the performance of the task, where the participant must engage
cognitively with the activities, and must receive feedback concerning the
appropriateness of various responses.

8.1 General Aviation Pilots

Within the aviation industry, general aviation pilots appear over-represented in
the accident statistics. Indeed, pilots within the general aviation industry are eight
times more likely to be involved in a fatal accident than their commercial counterparts
(Wiegmann & Taneja, 2003). In addition, while the International Civil Aviation
Organisation and the Civil Aviation Safety Authority govern both the commercial and
the general aviation industry in Australia, the commercial airlines impose additional
regulations on pilots to standardise behaviours in a further attempt to reduce
accidents. By contrast, the implementation of standard operating procedures is not as
easily achieved in general aviation due to the diversity of flight activities, varying
levels of pilots’ experience, and the number of different types of aircraft involved.
While the introduction of rules and regulations is designed to standardise behaviour,
general aviation pilots do not necessarily comply with these rules. In fact, violations
of rules and regulations have been reported as high as fifty-four percent within the
aviation industry (Helmreich et al., 2001), while Mason (1997) contends a less
conservative figure, and reports that across all industries, violations of rules and
procedures contribute to approximately 70% of all accidents.

Reason (1997) distinguished errors from violations based on the fact that
violations are committed intentionally, while an error is generally performed
unintentionally. Defences are erected to prevent either a violation or an error resulting
in a system failure. While violations are reported to have the least consequences (Klinect et al., 1999), often those who commit a violation are more susceptible to committing an error. In fact, Reason (1997) contends that a violation paired with an error often results in negative consequences.

Schuman et al. (1967) and Panek et al. (1978) suggest that there are certain individuals who are more willing to commit violations than others. These individuals are generally unrealistically optimistic about future events. They generally perceive situations as less risky or perceive themselves as relatively less vulnerable to negative outcomes (Ulleberg, 2002). Hunter (2002) suggests that these individuals may also possess an inaccurate perception of the risks involved in an activity, and that this stems from either differences in their experience/qualification, and/or as a result of their personality.

While aviation is perceived as a relatively high-risk industry (Janic, 2000), the individuals involved within this industry do not differ significantly from the general population in terms of their propensity towards risk-taking behaviour or in terms of their desire for sensation-seeking activities (O’Hare, 1990). Although Hunter (2002) has identified that pilots with greater levels of experience perceive situations with which they are more familiar as less risky than those situations with which they are less familiar, he also identified that those pilots with the least experience in a particular situation, also perceive these situations as less risky. While it is not surprising that a negative correlation exists between experience in a given situation and risk perception, a more concerning issue relates to those individuals who have less experience, but nonetheless, still perceive the situation as less risky. Hunter (2002) posits that such a combination of experience and risk perception, potentially increases an individual’s vulnerability to negative outcomes.
Often, within both the aviation industry and the automotive industry, there is a perception that it is the younger individuals who hold these inaccurate perceptions of the risks involved in activities. However, both O’Hare (1990) and Mayhew et al. (1986) have found that accident involvement is not regulated by age. In fact, in relation to drinking and driving, Mayhew et al. (1986) identified that younger motorists have a better understanding of the problems and consequences associated with drinking and driving than their older counterparts. Nevertheless, it appears that there is a small minority of the younger population who are complacent about drinking and then driving, and who are subsequently over-represented in accidents.

8.2 General Aviation Pilots and Violations

In relation to the operation of an aircraft, pilots are similar to other individuals who experience both intrinsic and extrinsic motivation to satisfy particular goals. In responding to this motivation, pilots may commit errors and/or violations. While improving knowledge, skills and defences may mitigate the potential for error (Reason, 1997), preventing pilots from committing violations is more complex. Pilots who intentionally violate rules and regulations, do so to improve the efficiency of their performance. Therefore, they develop a more effective and/or more efficient way of performing activities. This may involve the creative use of working around the very defences erected by system designers to prevent system failures.

An inherent problem associated with the commission of a violation, is that it may lead to a successful outcome (Wright, 1981). The positive outcomes associated with committing a violation, may reinforce maladaptive behaviours (Molesworth &
Wiggins, 2004). Wright (1981) suggests that, if left un-policed, the maladaptive behaviour may increase to a point where it is near impossible to rectify the situation.

Within the general aviation industry, pilots’ behaviour is seldom observed or policed by the governing bodies. In fact, there is a strong tendency within the industry to acquire knowledge through general observation or discussion with other aviation personnel (Moore, 1991; Walter, 2000). Therefore, it may be the case that behaviour is influenced by other pilots and that violations may be perpetuated through this process.

8.3 Multi-Modal Reasoning

Traditional training programmes within aviation tend to emphasise a rule-based reasoning approach. This approach primarily concerns itself with the provision of rules and/or regulations to govern pilot behaviour. An inherent problem with this approach is that individuals are forced to acquire domain knowledge by reference to rules and general principles, rather than through personal experience (Kirsner et al., 1997). Both rules and general principles lack a certain richness in information, which is often required to facilitate higher-level cognitive learning.

An alternate approach to production-based learning is case-based learning. Case-based learning concerns itself with providing individuals with case examples for them to comprehend, retrieve and apply at a later date. Such an approach makes numerous assumptions about the information acquisition process of individuals. For example, it is assumed that an individual is able to store and retrieve information from memory and adapt, apply and/or modify the information as necessary to solve a current problem or predicament. While case-based learning is highly contingent on
these factors, it nonetheless appears to be the optimal choice over production-based learning, as there is evidence to suggest that it facilitates ‘deeper’ learning (Brown, 1988; Hatano & Inagaki, 1991).

To overcome the potential limiting factors (i.e., individuals’ information processing ability, memory and cognitive ability) that may hinder the effectiveness of case-based learning, Kolodner (1997) and DeJoy (1992) suggest that individuals should be actively involved in the case example/s. As a result, individuals are more motivated (Hatano & Inagaki, 1991) to perform the task and are more likely to develop the motivation to learn (Goodnow, 1988). In such situations, case example/s have a greater level of significance due to the physical and cognitive motivation and involvement of the individual.

8.4 Training in Order to Improve Individuals’ Risk Management Behaviour

Over the past decade, automotive industry researchers have successfully tested the potential benefits of adopting a training approach where individuals are actively involved in the task to improve motorists’ risk management behaviour. Using case-based training, the approach moves away from the more traditional approaches where motorists are provided with factual information concerning the likelihood of being involved in an accident. Instead, the training system focuses on the accurate perception of the risks associated with an activity.

Risk perception is the subjective assessment of the possibility of injury or loss of life in relation to encountering a hazard (Hunter, 2002). It is differentiated from risk tolerance that incorporates the amount of risk that individuals are willing to accept in the pursuit of a goal (Hunter, 2002). Both risk perception and risk tolerance
are two factors that significantly impact an individuals’ decision-making (Hunter, 2002). Ultimately, inaccurate risk perception may cause a pilot to ignore or misinterpret external cues concerning an immediate hazard and the decision required to effectively avoid the hazard. By contrast, a high level of risk tolerance may lead to a course of action which unnecessarily exposes pilots to potential hazard/s. Hunter (2002) has concluded that risk perception and risk tolerance are two distinctively different constructs, such that the former represents a cognitive skill that may be learnt, while the latter might be regarded as a personality trait. Consistent with this view, Hunter suggests that the most effective method to improve existing pilot performance is to target risk perception.

According to Lowrance, (1980) and Slovic et al. (1979), when individuals assess the potential risk/s involved in a situation, they generally assess the potential risk based on two variables: a) The likelihood of injury; and b) the severity of the potential consequences. There is much debate amongst theorists over which variable takes precedence, although within the general aviation industry, where the rate of fatalities is five times greater than within the automotive industry, assessing each situation based on the severity of the potential consequences may prove inconsequential. Equally as difficult within the general aviation industry is the ability to assess the probabilistic nature of sustaining an injury. To achieve such a feat, individuals would be required to systematically distinguish between relatively small probabilities such as, 1/100,000 and 1/1,000,000 in addition to the demands of the task being undertaken (Desauliniers, 1991).

Within the aviation industry, there is some evidence to suggest that pilots moderate the likelihood of injury and the severity of the potential consequences, for more subjective measures, such as their ability (Hunter, 2002). To reduce the
discrepancy between individuals’ actual and perceived ability, training programmes need to actively demonstrate individuals’ limits (DeJoy, 1992). This requires a level of cognitive activity during training. Cognitive activity is characterised by deliberate engagement in decisions or judgements. The broad aim of the current project was to assess the extent to which cognitive activity during training facilitates the acquisition of risk management skills amongst pilots.

8.5 Overview of Results

The results arising from the three studies that comprised the project appear to support the proposition that the level of cognitive activity during training impacts participants’ risk management behaviour on a test task involving low-flying activities. The first experiment was designed to compare the outcomes of a training programme where participants were cognitively active in a task coupled with feedback, with the outcomes of a training programme where participants were asked to read or watch a video (cognitively inactive/passive) containing three vignettes characterised by pilots breaching the low-flying regulations and, subsequently, being involved in a fatal accident. A low-flying task was employed to examine pilots’ risk management behaviour. The task was based on the assumption that pilots displaying a behaviour that could be described as more risk averse would remain at a higher altitude on average, than those pilots who were more inclined to engage in riskier behaviour. This assumption was based on the fact that remaining at a higher altitude whilst engaging in a low-flying task, increases the number of options available in terms of locating a suitable place to land if a problem arises with the aeroplane during the course of the flight. In total, 51 participants were recruited from the Aviation programme at the
University of Western Sydney and from various flying schools at Bankstown airport. Following training which either involved passive or active involvement, all pilots completed a low-flying task in the following week. The results indicated that those pilots who were engaged actively during training remained at a higher altitude, on average, during the test flight. However, despite these positive results, it was unclear whether the results of Experiment 1 were due to participants’ level of cognitive activity in the task or whether the effects observed were due to the feedback that they received.

The second study was designed to further investigate the results from the first experiment and determine the precise role of cognitive activity and feedback during training. Therefore, forty pilots were recruited and randomly assigned to either the position of pilot-in-command (cognitively active) or co-pilot (cognitively inactive) of which half received feedback as part of their training. In the second week, all participants flew the same test flight as those participants from the first experiment. The results indicated that those pilots who were cognitively active (pilot-in-command) during training, adopted more risk averse behaviour during the test flight, in comparison to those pilots who were cognitively inactive (co-pilot) during the training session. In relation to the effects of feedback, the results indicated that the provision of feedback only appeared beneficial when pilots were able to recall similarities between the test flight and other flights that they had experienced. This suggested that, to improve pilots’ risk management behaviour, sufficient emphasis needs to be placed on the information taught during training for it to be sufficiently memorable.

The third experiment sought to examine the extent to which information acquired during training would generalise to tasks that varied systematically from the training task in terms of cognitive load. In addition, the third experiment incorporated
a ‘hint’ condition. Forty-five pilots were randomly divided into three groups (‘hint’, ‘no hint’ and control) where the two experimental groups conducted a similar training flight to the participants in the first two experiments, while the control group flew circuits around Mudgee aerodrome. In the second week, all of the participants were exposed to four different test flights, three of which varied from the training flight, while the fourth flight was a direct reproduction of the training flight. Of the three test flights that varied from the training flight, the Freight Train test flight (minimal variation in cognitive load) was designed to examine participants’ performance in relation to vertical separation, the Cliff Face test flight (moderate variation in cognitive load) was designed to examine participants’ performance in relation to horizontal separation, while the Cooling Tower test flight (significant variation in cognitive load) was designed to examine participants’ performance in relation to a combination of vertical and horizontal separation. The presentation of the four test flights was counterbalanced to minimise any learning effect.

The results revealed a transfer of training effect that only extended to the test flight that was a direct reproduction of the experimental group training flight. In relation to the other three flights, no significant transfer of training effects were observed.

While the results from the third study failed to reveal a general transfer of training effect across tasks, in combination with the results from the preceding studies, there is evidence to suggest that pilots who are cognitively active in a training task and who receive feedback concerning their performance, are able to apply this information at a later date, albeit within a limited context.

Depicting the different training methods as a hierarchy, it appears evident that a training method, where the participants are cognitively inactive and receive no
feedback concerning their performance, is likely to be less effective in improving risk
management behaviour than a training method where the participants are cognitively
active, and receive feedback concerning their performance. Similarly, the provision of
a hint as to the similarities between the training task and test task appears to further
improve performance. However, while these results highlight the potential advantages
associated with cognitively active training, the extent to which the information learnt
during training will generalise appears to be limited, at least in the context of a low-
fly
ing activity.

8.6 Generalisations beyond Training

The results from the third experiment appear to support, in part, the
assumption that each of the scenarios represented a systematic variation from the
initial training task. This was evident from the comparisons between the mean
minimum separation between the aircraft and the surface during each of the flights.
The fact that there was no difference between groups in relation to improvements in
performance, suggests that the transition from the training task to each of three test
tasks during study three was too great to enable the transfer of training.

As discussed in Chapter 7:, depending upon the theoretical perspective, the
effective transfer from one situation to another is contingent on either the surface
(Reeves & Weisberg, 1994; Gentner, 1989) and/or the abstract features (Gick &
Holyoak, 1980) of a task, or the similarities between the two tasks in terms of the
cognitive load. However, it also appears that there may be other factors that determine
the transfer of training, such as the breadth of the experience that the participant
brings to the training task. Indeed, it may have been the case there was simply
insufficient knowledge amongst participants to perceive the similarities between the training and test flights, to apply the information from one context to another. This is a matter for further research.

8.6.1 Limitations of the Studies

Unlike training programmes that incorporate the general nature of accidents and their frequency, the current training programme specifically focused on one task. Therefore, while these results are positive and a step forward in improving pilots’ risk management behaviour, it is important to acknowledge that the context of this research was limited to a low-flying activity.

In addition to the specific nature of the task, the current research involved pilots flying a simulated flight on a computer-based flight simulator. In all of the experiments, the participants completed the research in an air-conditioned office where noise, interruptions, turbulence, temperature, seating and other environmental factors were controlled. Further, while all pilots were asked to conduct the simulated flights as they would within the normal operating environment, the fact that pilots were sitting in the comfort of an air-conditioned office, and removed from the potential of serious injury, may have created an environment that may have impacted their responses. Finally, while not unlike other research conducted in a simulator, the extent to which the research findings may be applied within the operational environment remains untested. Nonetheless, in light of these potential limitations, the results from the current experimental sequence suggest that cognitive activity during training may be a useful approach in targeting the development of non-technical skills amongst pilots.
While it is acknowledged that the extent to which the results from the current study may be applied to the operation environment remains untested, research examining the utility of computer-based simulation has revealed encouraging results (Ortiz, 1994; Taylor et al., 1999; Pfeiffer, Horey, & Butrimas, 1991; Dohme, 1991). In one such aviation-related study, sixty college-based students were divided into two groups (experimental and control), with all students receiving the same instructions concerning how to perform an in-flight manoeuvre (Ortiz, 1994). Only the experimental group was provided the opportunity to practice on a computer-based simulator. Once the students in the experimental group were able to complete the flight manoeuvre on the computer-based simulator within 100 feet of the desired altitude, all of the participants were asked to perform the same manoeuvre in a real light aircraft. The results revealed statistically significant differences between groups in terms of their performance completing the flight manoeuvre. These results were interpreted as support for the effective transfer of training between simulation and the operational environment. While the current study is limited in terms of the extent to which the results transfer to the operational environment, the prognosis still remains encouraging. Nonetheless, additional research is required to accurately determine the validity of this assertion.

8.6.2 Theoretical Implications

An important theoretical implication arising from this research specifically relates to the empirical support that was derived for the application of case-based reasoning. Case-based reasoning, which is similar to analogical transfer and transfer of training, proposes that, to facilitate the development of problem solving skills,
individuals should be provided with case examples of problems and their solutions, which can be used as an analogue when they experience a similar problem in the future (Kolodner, 1997). However, it appears that merely providing individuals with case examples, where they are removed cognitively from the circumstances (i.e., reading or watching a video), may not result in improvements in performance. In fact, the results suggest that individuals need to be cognitively active during a training task if the information pertaining to the experience is to be retained and, subsequently, recalled at a later date.

In addition to ensure that individuals are cognitively active during training, the current research also established that the extent to which information will generalise from one analogue to another is relatively limited in the case of simulated low-flying activities.

Another theoretical limitation identified in the current study that potentially dictates the success of training activities relates to individuals’ ability to recognise and recall similarities between the training task and the test task. A recurring theme that was evident from the current line of research was that those participants who were able to recall similarities between the training and the test task tended to adopt a behaviour that was more risk averse than those participants who were unable to recall any similarities. This suggests that the effectiveness of training initiatives is dependent, in part, on individuals’ memory, and/or their ability to recognise and recall similarities between the case example/base task and the test/target task.

In summary, the provision of a case example during training will not necessarily facilitate problem solving when trainees experience a similar case or example in the future. It appears that the transfer of training between two tasks is
dependent on a number of factors, including the need for the individual to be sufficiently immersed cognitively in the task, and the memorability of the training.

8.6.3 Implications for the Aviation Industry

Currently, training programmes employed within the aviation industry to improve pilots’ risk management skills appear to focus on the assessment of risk, through identifying hazards and their expected occurrence (Hunter, 2002). However, such training programmes have experienced only limited success in terms of reducing the number of accidents caused by pilots taking unnecessary risks. The current research tested an alternative approach in which pilots are cognitively active during training and receive feedback concerning their performance. While the current study demonstrated the efficacy of this approach, the extent to which these results translate into improvements in risk averse behaviour in the operational environment remains untested.

A feature of the proposed training initiative that may hinder the adoption of the current training programme within the aviation industry is the requirement to train pilots individually. However, this disadvantage may be overcome through the development and implementation of a computer-based training programme.

8.6.4 Further Research

Despite the intense focus on safety within the aviation industry, general aviation pilots appear to actively engage in activities that are considered risky. Often when engaging in these activities, pilots violate a rule or regulation that has been specifically designed to reduce the potential dangers associated with the activity. In
many cases, the reasons for violating a rule or regulation relate to the fact that it is a more effective and more efficient means of operating.

The current philosophy to reduce the number of violations committed by pilots and to improve their risk management skills is to report statistical data and cases, and alert them to the dangers of their actions. The design of such programmes is based on the expectation that pilots will modify their behaviour based on the results of their less fortunate counterparts. While the intent of such training programmes is to improve pilots’ risk management behaviour, there is evidence to suggest that this does not always occur.

The present study proposes a different approach to risk management training amongst pilots. Although the results from the current study reflected favourably on a training programme which involved pilots cognitively in the performance of the task, the extent to which the results are generalisable remains unclear. Based on the empirical literature, it appears that transfer between tasks is contingent on individuals’ recognising the similarities between the tasks (see 4.4 Transfer of Learning). This, in turn, is said to influence the cognitive demands or resources available to process the information pertaining to the task. If individuals recognise a task as familiar, they will draw on information from long-term memory to assist with the task. As a result, they effectively bypass working memory and do not consume any of its resources (Sweller, 1988; Rose et al., 2004; Fraidin, 2004). In contrast, if an event or task is not perceived as familiar, individuals will process information pertaining to this task in working memory (Paas et al. 2004). Due to the limited capacity of working memory, individuals’ ability to process new or additional information remains restricted. While the results from the third experiment appear to provide some evidence to this theoretical perspective, there appears to be some contradiction with the results from
the first two experiments. Therefore, additional research is required to examine the relationship between cognitive load and transfer of training to develop a more comprehensive understanding of the relationship between the two.

8.7 Conclusion

The primary aim of this study was to examine the utility of different training methods to improve pilots’ risk management behaviour. Contemporary training programmes within aviation incorporate data relating to the frequency of accidents and/or incidents and provide accident examples to alert pilots to the potential dangers of various activities. Exposing pilots to such information is assumed to facilitate the development of risk management skills.

An empirical examination of the literature relating to risk management has established that, within the automotive industry, training programmes which employ an experiential approach, where motorists are provided with direct demonstrations of the limits in their driving skills, have resulted in positive results in reducing the number of automotive accidents. The success of such a training approach provides support for the role that unwarranted optimism plays in this problem (DeJoy, 1992). With these positive results in mind, the current study was designed to examine the utility of different training programmes to mitigate pilots’ willingness to engage in unwarranted risky behaviour/s.

The results of a series of three experiments revealed that engaging pilots in training where they were cognitively active and received feedback as to their low-flying performance, improved their risk management behaviour during a subsequent test task. In other words, it can be concluded from the current study that cognitive
involvement during training facilitates the development of risk management skills.

While the results from the current study are positive, in terms of improving pilots’ risk management behaviour, there were also a number of limitations associated with the study. Such limitations should not detract from the importance of providing pilots with training in which they receive a direct demonstration of the limits of their skills as a basis for improving their risk management behaviour.
References


*Transportation Research, 8, 427-432.*


*Reliability Engineering and System Safety, 75,* 115-119.


Appendix A: Experiment 1

This appendix contains the material and the stimuli that were developed in order to permit the conduct of Experiment 1. In addition, a sample of the data obtained from the experiment is provided.
Personal Computer Aviation Training Device (PCATD)
This study is being conducted as part of a PhD degree undertaken by Brett Molesworth at the School of Psychology, University of Western Sydney under the supervision of Dr Mark Wiggins. The aim of the study is to examine the influence of previous experience on various types of aeronautical decision-making.

This study comprises two parts, involving two sessions one week apart. The first session involves you completing a computer-based training task. You will read a series of accidents, and make comments about the causal factors involved. This task should take no more than 30 minutes. During the second session in the following week, you will be asked to ‘fly’ a flight simulator, as you would in the operational environment. This task should take no more than 30 minutes.

Please note that you are under no obligation to complete this study and you may withdraw at any time. Your participation in this study will have no bearing on your studies, either at the University of Western Sydney or elsewhere. In addition, any identifying features of your responses will be removed and individual results will be considered confidential.

In some cases, the exposure to aviation-based situations can evoke an undesired emotional response amongst participants. If you experience adverse emotional reactions at any time throughout this study, please advise the researcher, and the study will be concluded immediately.

We appreciate your participation in this study and if you have any questions, please do not hesitate to contact Brett Molesworth (University of Western Sydney) on:

Telephone (02) 9772 6717
Fax (02) 9772 6626
Email pardon@ozemail.com.au

NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (tel: 02 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
MARCS Human Factors and Performance Lab
Information Sheet (Group 2)

This study is being conducted as part of a PhD degree undertaken by Brett Molesworth at the School of Psychology, University of Western Sydney under the supervision of Dr Mark Wiggins. The aim of the study is to examine the influence of previous experience on various types of aeronautical decision-making.

This study comprises two parts, involving two sessions one week apart. The first session involves you watching a video where a series of accidents will be presented. At the conclusion of the video, you will be asked a short series of questions concerning the causal factors involved. This task should take no more than 30 minutes. During the second session in the week following, you will be asked to ‘fly’ a flight simulator, as you would in the operational environment. This task should take no more than 30 minutes.

Please note that you are under no obligation to complete this study and you may withdraw at any time. Your participation in this study will have no bearing on your studies, either at the University of Western Sydney or elsewhere. In addition, any identifying features of your responses will be removed and individual results will be considered confidential.

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MARCS Human Factors and Performance Lab
Information Sheet (Group 3)

This study is being conducted as part of a PhD degree undertaken by Brett Molesworth at the School of Psychology, University of Western Sydney under the supervision of Dr Mark Wiggins. The aim of the study is to examine the influence of previous experience on various types of aeronautical decision-making.

This study comprises two parts, involving two sessions one week apart. Both sessions of the study will involve flying a computer based flight simulator. In the first session, after the simulated flight, you will be asked to make comments about the certain aspects of your simulated flight. The whole exercise should take no more than 30 minutes. During the second session in the week following, you will also be asked to ‘fly’ a simulated flight. The second simulated flight will differ from the first sessions simulated flight. This also should take no more than 30 minutes.

Please note that you are under no obligation to complete this study and you may withdraw at any time. Your participation in this study will have no bearing on your studies, either at the University of Western Sydney or elsewhere. In addition, any identifying features of your responses will be removed and individual results will be considered confidential.

In some cases, the exposure to aviation-based situations can evoke an undesired emotional response amongst participants. If you experience adverse emotional reactions at any time throughout this study, please advise the researcher, and the study will be concluded immediately.

We appreciate your participation in this study and if you have any questions, please do not hesitate to contact Brett Molesworth (University of Western Sydney) on:

Telephone  (02) 9772 6717
Fax           (02) 9772 6626
Email        pardon@ozemail.com.au

NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (tel: 02 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
I have been asked to participate in the research “The Role of Case-Based Reasoning in Learning: An Analysis of Private Pilots” conducted by Brett Molesworth and Dr Mark Wiggins, and give my free consent by signing this form. I understand that:

1. The research project will be carried out as described in the information sheet, a copy of which I have retained. I have read and understood the Information Sheet and have had the opportunity to have all my questions answered to my satisfaction.

2. My consent to participate is voluntary and I may withdraw from the study at any time. I do not have to give a reason for the withdrawal of my consent.

Signature ...................................................   Date      /      / 2002

This research project has been approved by the University of Western Sydney Ethics Review Committee (Human Subjects). Any complaints or reservations about this research may be directed to the Ethics Committee through the Executive Officer, phone (02) 9772 6785. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.
If you wish to receive a summary of the overall results of this research, please supply your name and address below. A summary will be sent to you at this address on completion of the study.

Name: ___________________________________

Address: ___________________________________

_________________________________________
Demographic Information

Age: ____     Gender: Male: ☐ Female: ☐

Please indicate which of the following licences that you hold:

GFPT ☐
Private ☐
Commercial ☐
ATPL ☐

Please indicate which of the following ratings that you hold:

Instructor ☐
Instrument ☐

Have you ever conducted any low-level flight training?

Yes: ☐
No: ☐

Each of the following questions is related to your flying experience. Please estimate these figures as accurately as possible.

Number of hours (total) experience: 

Number of hours (total) as pilot in command: 

Number of hours (total) actual IFR experience: 

Number of cross-country hours experience (excluding training): 

Number of hours (total) during the previous 90 days: 

Number of cross-country hours during the previous 90 days: 

Number of times you have been forced to fly below 500ft AGL: 

Number of hours (total) low-level flying:
Have you ever been involved in an aircraft accident or incident involving low-level flying?

Yes: □
No: □

Do you know of anyone who has been involved in an accident or incident involving low-level flying?

Yes: □
No: □

Over the previous six months, how often have you used GPS as a primary source of navigation?

Never □ Rarely □ Sometimes □ Frequently □ Always □
Compact Disc

The following are contained on the compact disc (see back cover);

1. Computer Based Training Programme (electronic newsletter) - Compatible with Internet Explorer V5
2. Low Flying Videos (Low-Flying Case 1 and Low-Flying Case 2)
3. SPSS Template for Converting Data from X-Plane Output Files to SPSS Version 11 and 11.5.
4. X-Plane 6.21
5. Raw Data for all Experiments
Low-flying Case 1

Name: Fish Spotting Flight

Instructions: Please answer all the questions below by placing a tick (✓) in the appropriate circles

Question 1 Multiple Choice

Question: How many passengers were there?

- □ 0
- □ 1
- □ 2
- □ 3

Question 2 Multiple Choice

Question: The pilot had ___ degrees of flap extended prior to the accident?

- □ 0
- □ 10
- □ 15
- □ 20

Question 3 Multiple Choice

Question: Witnesses in the other airplanes report seeing the pilot of the Cessna fly at an altitude estimated between?

- □ 200 to 400 feet
- □ 300 to 400 feet
- □ 100 to 300 feet
- □ 200 to 300 feet
Question 4  Multiple Choice

Question: What type of fish was the pilot spotting for?

- [ ] Snapper
- [ ] Herring
- [ ] Tuna
- [ ] Shark
Name: Whale Watching Flight

Instructions: Please answer all the questions below by placing a tick (✓) in the appropriate circles

Question 1  Multiple Choice

**Question:** Where did the pilot depart from?

- [ ] Sydney Harbour
- [ ] Batemans Bay
- [ ] Jervis Bay
- [ ] Cronulla

Question 2  Multiple Choice

**Question:** What was the lowest altitude the male passenger could recall?

- [ ] 250 feet
- [ ] 350 feet
- [ ] 400 feet
- [ ] 450 feet

Question 3  Multiple Choice

**Question:** The quality of the water was reported to have been?

- [ ] Muddy
- [ ] Crystal clear
- [ ] Choppy and dangerous
- [ ] Calm
Question 4  Multiple Choice

Question: How many people were on board the plane?

☐ 1
☐ 2
☐ 3
☐ 4
Name: River Joy Flight

Instructions: Please answer all the questions below by placing a tick (✓) in the appropriate circles.

Question 1  Multiple Choice

Question: Up which river was the pilot taking passengers for a joy flight?

☐ Murray
☐ Georges River
☐ Hawkesbury
☐ Mississippi

Question 2  Multiple Choice

Question: At what height was the aircraft being flown up and down the river?

☐ 150 - 200 feet
☐ 100 - 150 feet
☐ 200 - 250 feet
☐ 250 - 300 feet

Question 3  Multiple Choice

Question: How many passengers were there?

☐ 0
☐ 1
☐ 2
☐ 3
Question 4  Multiple Choice

**Question:** Prior to the accident, what was the duration of the average flight?

- [ ] 10 minutes
- [ ] 15 Minutes
- [ ] 20 Minutes
- [ ] 25 Minutes
Comparison Questions

Instructions: Please answer the questions below.

Question 1: Short Answer

Reflect on any similarities you can find between the three aviation cases. List these similarities in the space provided.

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

Question 2: Short Answer

In the space provided, describe a general rule that may be applicable for all three cases.

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

Thank you for completing the questionnaire 😊
Low-flying Case 2

Name: Aerial Survey Flight

Instructions: Please answer all the questions below by placing a tick (✓) in the appropriate circles

Question 1  Multiple Choice

Question: How many passengers were there?

☐ 0
☐ 1
☐ 2
☐ 3

Question 2  Multiple Choice

Question: In what order did these events occur?

1. The aircraft struck the tree tops
2. The pilot flew over the pine plantation
3. The pilot flew over the wooded area

☐ 3, 2, 1
☐ 3, 1, 2
☐ 2, 3, 1

Question 3  Multiple Choice

Question: The horseback rider reported the pilot had flown

☐ Approx. 300 feet over the wooded area
☐ Approx. 350 feet over the wooded area
☐ Approx. 400 feet over the wooded area
☐ It wasn't stated
Question 4  Multiple Choice

**Question:** What was the probable cause of the accident concluded by the accident investigator?

- [ ] Fuel starvation
- [ ] Engine failure
- [ ] Failure to maintain sufficient altitude
- [ ] Intoxication
Name: Aerial Photographic Flight

Instructions: Please answer all the questions below by placing a tick (✓) in the appropriate circles

Question 1  Multiple Choice

Question: Where did the aircraft strike the ground?

☐ 90 feet right of the train
☐ 600 feet left of the train
☐ 90 feet left of the train
☐ 600 feet right of the train

Question 2  Multiple Choice

Question: What height did the pilot descend to above the train?

☐ 400 feet
☐ 300 feet
☐ 200 feet
☐ 100 feet

Question 3  Multiple Choice

Question: The aircraft flew into

☐ Two high-tensile steel wires
☐ Trees
☐ The train
☐ A steel electrical wire conductor
Question 4  Multiple Choice

Question: In what order did these events occur?

1. The pilot descended the aircraft to a height of 100 feet above the train
2. The pilot adjusted his flight speed
3. The pilot manoeuvred the plane over the train carriages

☐ 3, 2, 1
☐ 3, 1, 2
☐ 2, 3, 1
☐ 2, 1, 3
Name: Fire Patrol Flight

Instructions: Please answer all the questions below by placing a tick (✓) in the appropriate circles

Question 1  Multiple Choice

Question: Where did the pilot depart from?

☐ Katoomba
☐ Bankstown
☐ Camden
☐ Hoxton Park

Question 2  Multiple Choice

Question: At what height above the ground did witnesses report the aircraft was flying up the valley?

☐ 200 to 300 feet
☐ 300 to 400 feet
☐ 400 to 500 feet
☐ 500 to 600 feet

Question 3  Multiple Choice

Question: What did the crew possibly suspect was smoke from a forest fire?

☐ Dust from a rock slide
☐ A pollen flight
☐ Low hanging wispy clouds
☐ Dust from motorcycles
Question 4  Multiple Choice

**Question:** How many people were on board the plane?

- [ ] 1
- [ ] 2
- [ ] 3
- [ ] 4
Comparison Questions

Instructions: Please answer the questions below.

Question 1: Short Answer

Reflect on any similarities you can find between the three aviation cases. List these similarities in the space provided.

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

Question 2: Short Answer

In the space provided, describe a general rule that may be applicable for all three cases.

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

_______________________________________________________

Thank you for completing the questionnaire ☺
Trawler Mission (Williamtown North)

**Background:** You are an employee of a small aviation company that is the sole private operator based at Williamtown (RAAF base). The company has been contracted to monitor the number of fishing vessels within harbours and lakes surrounding Sydney. Your company has a reputation as being one of the few reliable and trustworthy organisations that appear to always get the job done.

**Task:** Your employer has received information that unusually large numbers of fishing trawlers have entered Port Stephens in search of prized fish, destined for overseas markets. You have been asked personally by your employer to fly over the lake and report the number of fishing trawlers located within the southwestern part of Port Stephens, also known as Tanilba Bay. There are numerous boats within the harbour and your task is to correctly identify the amount of fishing trawlers. A fishing trawler is distinguishable from other vessels due to its large boom that extends rearward, which is used to reel in the fishing nets. Due to fuel constraints, the duration of the flight will be approximately 20 minutes. It will take approximately 5 minutes to fly from Williamtown RAAF base to Tanilba Bay, leaving a maximum of 10 minutes to identify the number of fishing trawlers and 5 minutes to track back and land at Williamtown. Please note that there is no minimum requirement for the time spent identifying the number of fishing trawlers. As soon as you feel you have completed your task, or if you feel you are unable to complete the task, please return back to Williamtown. The track from Williamtown to Tanilba Bay is 050 degrees and approximately 6.5 nautical miles.

You will be provided with a VTC for Newcastle/Williamtown, a WAC/VTC ruler, flight protractor (airtour), marker and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
Flight Details
Williamtown, NSW

Aerodrome Reports

YWLM Williamtown
METAR YWLM CURRENT 27002KT //// 16/13 Q1020

Terminal Area Forecasts

YWLM Williamtown
TAF YWLM CURRENT 27002KT 9999 BKN CU 090
T 20 21 21 22 Q 1016 1018 1020 1020

Area Forecast

AREA 20 Current

OVERVIEW:
CLEAR SKYS, PATCHES INLAND.

SUBDIVISIONS:
NIL

WIND:
2000 5000 7000 10000 14000 18500
270/05 250/10 235/10 230/10 MS07 230/10 MS14 230/10 MS24

CLOUD:
FEW 9000

WEATHER:
CLEAR.

VISIBILITY:
>9999M

FREEZING LEVEL:
7000/9500

ICING:
MOD IN CU TOPS.

TURBULENCE:
MOD IN CU
AMD CRITICAL LOCATIONS: [CLOUD HEIGHTS ABOVE MEAN SEA LEVEL]

AMD MT VICTORIA: 9999 –SHRA BKN CU 5000
INTER 0211 4000 SHRA BKN ST 4000

MURRURUNDI: 9999 -SHRA BKN 3500
TEMPO 0011 4000 –SHRA BKN ST 3000
Traffic Report (Williamtown South)

Background: You are an employee of a small aviation company that specialises in monitoring traffic movements. Your company has a reputation as one of the few aviation transportation companies that always get the job done.

Task: Your employer has asked you monitor the traffic flow of cars that passes a house on a busy road south of Williamtown (RAAF base). Due to fuel constraints, the duration of the flight will be approximately 20 minutes. It will take approximately 5 minutes to fly from Williamtown to the house, leaving a maximum of 10 minutes to monitor the number of motor vehicles passing the house, allowing for another 5 minutes to return to Williamtown. Please note that the duration of time you are permitted identifying the volume of traffic is 10 minutes. As soon as you feel you have completed your task, or if you feel you are unable to complete the task, please return back to Williamtown. The track from Williamtown to the house is 180 degrees and approximately 4 nautical miles.

You will be provided with a VTC for Newcastle/Williamtown, a WAC/VTC ruler, flight protractor (airtour), marker and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
Flight Details

Williamtown, NSW

Aerodrome Reports

YWLM Williamtown
METAR YWLM CURRENT 27002KT //// 16/13 Q1020

Terminal Area Forecasts

YWLM Williamtown
TAF YWLM CURRENT 27002KT 9999 BKN CU 090
T 20 21 22 Q 1016 1018 1020 1020

Area Forecast

AREA 20 Current

OVERVIEW:
CLEAR SKYS, PATCHES INLAND.

SUBDIVISIONS:
NIL

WIND:
2000  5000  7000  10000  14000  18500
270/05  250/10  235/10  230/10  MS07  230/10 MS14  230/10 MS24

CLOUD:
FEW 9000

WEATHER:
CLEAR.

VISIBILITY:
>9999M

FREEZING LEVEL:
7000/9500

ICING:
MOD IN CU TOPS.

TURBULENCE:
MOD IN CU
AMD CRITICAL LOCATIONS: [CLOUD HEIGHTS ABOVE MEAN SEA LEVEL]

AMD MT VICTORIA: 9999 –SHRA BKN CU 5000
INTER 0211 4000 SHRA BKN ST 4000

MURRURUNDI: 9999 -SHRA BKN 3500
TEMPO 0011 4000 –SHRA BKN ST 3000
Reflection Questions

State the number which you were asked to read or report during your flight. ______

Briefly reflect on the flight that you have just flown, and write down any key points or lessons learnt.
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

In your own words, please summarise on one main point or rule that you could conclude or derive from your flight.
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

Thank you for completing the questionnaire ☺
Aerial Spotting Flight (Final Mission)

Background: You work for a small aviation company that specialises in aerial 'spotting' tasks using various aircraft. The general approach used by the company on any given task is to first send out a light plane. Should the pilot of the plane be unable to complete the task, a helicopter will be sent out to make a further attempt. Because helicopters are considerably more expensive to operate than light planes, the owner of the company encourages pilots of light planes to make every attempt to complete the task. In addition, the company has a reputation for never getting it wrong, so the accuracy of the information you gather is critical.

Task: An oil tanker is sitting in shallow water, just off the coast in Botany Bay. To locate the oil tanker, simply fly from Bankstown aerodrome tracking 097 degrees direct to Sydney International airport and turn onto a heading of 165, degrees tracking direct to the oil tanker. You do not need airways clearance for this flight and there will be no other traffic to contend with. Upon departing the oil tanker, you are permitted to fly direct to Sydney International airport and land. The oil tanker has a unique, 3 digit serial number painted on the main deck. The owner of the oil-tanker fleet wishes to know which of its vessels is coming this close to shore. Your task is to locate the oil tanker, and to identify the serial number. Due to fuel constraints, the duration of the flight will be approximately 20 min. It will take approximately 5 minutes to fly from Bankstown aerodrome to Sydney International airport and a further 2 minutes to track direct to the oil tanker. This leaves a maximum of 10 minutes to identify the number. Please note, that there is no minimum requirement for the time spent identifying the number. As soon as you feel you have completed the task, or if you feel you are unable to complete the task, please proceed to land back at Sydney airport.

You will be provided with a VTC for Sydney, 30cm ruler, flight protractor (airtour), marker and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
Flight Details

Bankstown, NSW

Aerodrome Report

BANKSTOWN YSBK
METAR YSBK CURRENT 13008KT /// 16/13 Q1020

Terminal Area Forecasts

BANKSTOWN YSBK
TAF YSBK CURRENT 13008KT 9999 BNK CU 090
T 18 21 21 22 Q 1016 1018 1020 1020

Area Forecast

AREA 20 CURRENT

OVERVIEW:
SCATTERED SHOWERS, ISOLATED SE OF BATHURST/COONABARABRAN
GRADUALLY CLEARING FROM THE W AFTER 14Z.ISOLATED
THUNDERSTORMS NE OF COONABARABRAN/MT VICTORIA
CONTRACTING TO SEA AFTER 14Z.AREAS BROKEN LOW CLOUD ABOUT
RANGES/SLOPES N OF ARMIDALE EXTENDING S TO MURRURUNDI BY
14Z.BROKEN STRATUS IN PRECIPITATION. AREAS FOG/MIST
DEVELOPING AFTER 11Z.

WIND:
2000  5000  7000  10000  14000  18500
VRB/15  VRB/15  VRB/15  330/15 MS04  340/20 MS10  340/30 MS20

CLOUD:
ISOL CB 3000/30000 NE OF COONABARABRAN/MT VICTORIA
CONTRACTING TO SEA AFTER 14Z AREAS BKN ST N OF ARMIDALE,
3000/5000 RANGES, 2000/3500 W SLOPES, EXTENDING S TO MURRURUNDI
AFTER 14Z. LOCALLY BKN ST IN SH/TS, 1000/3000 SEA/COAST,3000/5000
RANGES, 2000/4000 W SLOPES. AREAS BKN CU/SC 3000/10000 SEA/COAST,
5000/10000 RANGES, 4000/10000 W SLOPES WITH ISOL TOPS 15000 NE OF
COONABARABRAN/MT VICTORIA. AREAS BKN AC/AS ABOVE 10000
OVER SEA.

WEATHER:
SH.TS. FG/BR AFTER 11Z.
VISIBILITY:
0500 FG. 2000M BR.
3000M TS. 4000M SH.

FREEZING LEVEL:
7000/9500.

ICING:
MOD IN CU TOPS AND AC/AS.

TURBULENCE:
MOD IN CU AND AC.

CRITICAL LOCATIONS: [CLOUD HEIGHTS ABOVE MEAN SEA LEVEL]

MT VICTORIA: 9999 -SHRA BKN CU 5000
INTER 0517 4000 SHRA BKN ST 3700

MURRURUNDI: 9999 -SHRA BKN CU/SC 4500
INTER 0517 4000 SHRA BKN ST 3000
Post-Mission Questionnaire

1. Your task was to read the number located on the deck of the oil-tanker, please report that number as accurately as possible. ____________

2. Throughout the flight, what was the lowest altitude to which descended? _____ ft-AGL.

   2.1 If you think that you descended below 500ft, can you explain why this was the case?

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

3. As you were flying the mission, were you able to recall any of the Low-flying rules?

   Yes ( )    No ( )

   3.1 If Yes, what rules could you recall?

   ____________________________________________________________

   ____________________________________________________________

   ____________________________________________________________

4. At the lowest point of your flight, how low do you think in relation to minimum altitude specified by the low flight regulations?

   Well below   Slightly below   Right on   Slightly Above   Well above
5. At any point throughout the flight, were you able to recall any similarities between this flight and other experiences that you are familiar with?

Yes ( )   No ( )

5.1 If ‘Yes’, please explain the case(s) or example(s) you recalled and their similarities.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

5.2 If you answered ‘Yes’ to the previous question. Please indicate below the level of influence that you perceived these case(s) or example(s) had on your decision-making during the flight?

( ) No influence at all.

( ) Very little influence.

( ) Some influence.

( ) Moderate influence.

( ) Major influence.

6. Did the presence of the researcher influence your decision?

Yes ( )   No ( )

If YES, how?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
7. If you had the opportunity to ‘turn back time’ and re-fly the flight, is there anything that you would do differently?

8. Would you like to comment on any aspects of the experimental process good or bad? (e.g. how the experiment was conducted, time it took, use of flight simulator, researcher etc).

9. My actions throughout the flight did not jeopardise in anyway the safety of the aircraft.

10. My actions throughout the flight did not violate aviation regulations pertaining to low-flying.
11. Which of the following is most like the strategy that you employed to determine the minimum altitude to which you would descend. (Place one tick only in the box adjacent to the most appropriate statement).

I recall previous examples of situations in which I have made similar decisions, and I try and adapt these experiences. 

I tend to consider the pros and cons of each alternative and choose the strategy that is likely to lead to the most favourable outcome.

I tend to use a specific rule which specifies when I make a decision and how I make it.

I recall previous examples of situations that I have read / heard about, and I use this information as the basis for making a decision.

I have a model of the way in which decisions should be made, and I use this as the basis for making my own decisions.

I know immediately whether it is Ok or not.

Thank you for your time ☺
Table 11
Summary table of a one-way analysis of variance for Experiment 1, with training group as the independent variable and the mean absolute roll between 1 and 5 nautical miles as the dependent variable (Experiment 1).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>2</td>
<td>10.70</td>
<td>5.35</td>
<td>1.28</td>
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<tr>
<td>Error</td>
<td>48</td>
<td>199.88</td>
<td>4.16</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01

Table 12
Summary table of a one-way analysis of variance for Experiment 1, with training group (electronic newsletter and video) as the independent variable and the number of incorrect scores on the training post mission questionnaire as the dependent variable (Experiment 1).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>1</td>
<td>0.06</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td>Error</td>
<td>29</td>
<td>55.62</td>
<td>1.92</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01

Table 13
Summary table of the 3 x 2 (training group x similarity) between group factorial analysis of variance for the minimum altitude to which the pilots descended during the test flight (Experiment 1).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GROUP</td>
<td>2</td>
<td>326.86</td>
<td>163.43</td>
<td>3.40*</td>
</tr>
<tr>
<td>SIMILARI</td>
<td>1</td>
<td>46.92</td>
<td>46.92</td>
<td>.98</td>
</tr>
<tr>
<td>Interaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GROUP * SIMILARI</td>
<td>2</td>
<td>172.11</td>
<td>86.05</td>
<td>1.79</td>
</tr>
<tr>
<td>Error</td>
<td>45</td>
<td>2165.06</td>
<td>48.11</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01
Chi-Square Analyses for Descent Beneath 500 Feet and Number of Circuits

The following three chi-square analyses examine pilots’ performance in relation to their flight path (individual number of circuits) overhead, north, and south of the oil tanker. A subsequent chi-square analysis failed to identify a significant relationship between descent beneath 500 feet and number of circuits performed overhead the oil tanker $\chi^2(5, N = 51) = 9.01, p = .11$; Fisher’s exact test, $p = 8.20^{15}$, and descent beneath 500 feet and number of circuits north of the oil tanker $\chi^2(5, N = 51) = 3.06, p = .69$; Fisher’s exact test, $p = 2.81^{16}$. In relation to descent beneath 500 feet and number of circuits south of the oil tanker, a chi-square analysis revealed a significant correlation $\chi^2(5, N = 51) = 9.74, p = .04$; Fisher’s exact test, $p = 9.20^{17}$. These results suggest that those pilots who remained above 500 feet performed fewer circuits south of the oil tanker, in comparison to those pilots who descended beneath 500 feet. As noted previously (see 5.5.3), flying south of the oil tanker would ensure that the pilot remained over land, and in the case of an engine failure would increase the likelihood that the pilot would be able to successfully land the aircraft (see Table 14).

---

15 The $p$ value using Fisher’s exact test was calculated instead of the chi-square value because 8 cells have an expected count less than 5. The minimum expected count is 1.29 (Heiman, 1996; Siegel, 1956).

16 The $p$ value using Fisher’s exact test was calculated instead of the chi-square value because 6 cells have an expected count less than 5. The minimum expected count is .43 (Heiman, 1996; Siegel, 1956).

17 The $p$ value using Fisher’s exact test was calculated instead of the chi-square value because 6 cells have an expected count less than 5. The minimum expected count is .43 (Heiman, 1996; Siegel, 1956).
Table 14
Circuit direction and number, distributed across whether participants descended beneath 500 while reading the number on the oil tanker (Experiment 1).

<table>
<thead>
<tr>
<th>Circuit Direction</th>
<th>Descent below 500 feet</th>
<th>Number of circuits over oil tanker</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Overhead</td>
<td>Yes</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>North</td>
<td>Yes</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>South</td>
<td>Yes</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>2</td>
<td>14</td>
</tr>
</tbody>
</table>
Summary of Experiment

The Role of Case-Based Reasoning in Learning: An Analysis of Private Pilots

Dear

I would like to take this opportunity to thank you for participating in the research project titled ‘The Role of Case-Based Reasoning in Learning: An Analysis of Private Pilots’ conducted by Brett Molesworth and under the supervision of Dr Mark Wiggins.

In total, there were 51 participants who volunteered their time to assist with the research. The study is one of a series that is designed to examine the impact of previous experience on pilot performance during a simulated flight. Specifically, this study examined the difference and benefits of three case-based training methods. Participants were placed in a different training group, where either they watched a video, read an electronic newsletter or flew a simulated flight in the first week (training condition). During the second week, the pilots all flew the same flight scenario and performance was measured.

The objective of measuring the pilot performance was not to ascertain those pilots who would be considered superior, but to examine the impact of the training condition in the first week. During the data analyses, the experience of pilots was considered in relation to the total number of hours flown, and factored into their performance on the simulated flight in the second week.

The results reflected favourably on the training method where direct experience was received (simulated flight) in comparison to either the video or the newsletter groups. Although this study is in its infancy, the results support the idea that direct experience (in comparison to indirect experience) is most effective in terms of improving pilot performance, especially in terms of the management of risk. Such results are pleasing, but more research is needed before a more comprehensive conclusion can be drawn.

I would like to once again thank you for your time and stress how important your contributions are to improving the level of safety within the general aviation industry.

Regards,

Brett Molesworth
Appendix C: Experiment 2

This appendix contains all the material and the stimuli that were developed in order to permit the conduct of Experiment 2. In addition, a sample of the data obtained from this experiment is provided.
Personal Computer Aviation Training Device (PCATD)
MARCS Human Factors and Performance Lab
Information Sheet

Aviation Human Factors – Single-Crew Operation

This study is being conducted as part of a PhD degree undertaken by Brett Molesworth at the School of Psychology, University of Western Sydney under the supervision of Dr Mark Wiggins. The aim of the study is to examine the influence of previous experience on various types of aeronautical decision-making.

This study comprises two parts, involving two sessions one week apart. Both sessions of the study will involve flying a computer-based flight simulator. In the first session, after the simulated flight, you will be asked to make comments about the certain aspects of the simulated flight. The whole exercise should take no more than 30 minutes. During the second session in the week following, you will also be asked to ‘fly’ a simulated flight. The second simulated flight will differ from the first sessions simulated flight. This also should take no more than 30 minutes.

Please note that you are under no obligation to complete this study and you may withdraw at any time. Your participation in this study will have no bearing on your studies, either at the University of Western Sydney or elsewhere. In addition, any identifying features of your responses will be removed and individual results will be considered confidential.

In some cases, the exposure to aviation-based situations can evoke an undesired emotional response amongst participants. If you experience adverse emotional reactions at any time throughout this study, please advise the researcher, and the study will be concluded immediately.

We appreciate your participation in this study and if you have any questions, please do not hesitate to contact Brett Molesworth (University of Western Sydney) on:

<table>
<thead>
<tr>
<th>Telephone</th>
<th>(02) 9772 6717</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fax</td>
<td>(02) 9772 6626</td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:pardon@ozemail.com.au">pardon@ozemail.com.au</a></td>
</tr>
</tbody>
</table>
NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (tel: 02 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Aviation Human Factors – Multi-Crew Operation

This study is being conducted as part of a PhD degree undertaken by Brett Molesworth at the School of Psychology, University of Western Sydney under the supervision of Dr Mark Wiggins. The aim of the study is to examine the influence of previous experience on various types of aeronautical decision-making.

This study comprises two parts, involving two sessions one week apart. Both sessions of the study will involve flying a computer based flight simulator. In the first session you will be randomly paired with another pilot and, after the simulated flight, you will be asked to make comments about certain aspects of flight. The whole exercise should take no more than 30 minutes. During the second session in the week following, you will also be asked to ‘fly’ a simulated flight. The second simulated flight will differ from the first sessions simulated flight. This also should take no more than 30 minutes.

Please note that you are under no obligation to complete this study and you may withdraw at any time. Your participation in this study will have no bearing on your studies, either at the University of Western Sydney or elsewhere. In addition, any identifying features of your responses will be removed and individual results will be considered confidential.

In some cases, the exposure to aviation-based situations can evoke an undesired emotional response amongst participants. If you experience adverse emotional reactions at any time throughout this study, please advise the researcher, and the study will be concluded immediately.

We appreciate your participation in this study and if you have any questions, please do not hesitate to contact Brett Molesworth (University of Western Sydney) on:

- Telephone (02) 9772 6717
- Fax (02) 9772 6626
- Email pardon@ozemail.com.au
NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (tel: 02 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
MARCS Human Factors and Performance Lab
Consent Form

I have been asked to participate in the research “The Role of Experience and Prior Exposure in Learning: An Analysis of General Aviation Pilots” conducted by Brett Molesworth and Dr Mark Wiggins, and give my free consent by signing this form. I understand that:

The research project will be carried out as described in the information sheet, a copy of which I have retained. I have read and understood the Information Sheet and have had the opportunity to have all my questions answered to my satisfaction.

My consent to participate is voluntary and I may withdraw from the study at any time. I do not have to give a reason for the withdrawal of my consent.

Signature ...................................................   Date      /      / 2003

NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (tel: 02 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
If you wish to receive a summary of the overall results of this research, please supply your name and address below. A summary will be sent to you at this address on completion of the study.

Name:  ___________________________________

Address:  ___________________________________

___________________________________
Demographic Information

Age: ____

Gender:  Male: ☐  Female: ☐

Please indicate which of the following licences that you hold:

- GFPT ☐
- Private ☐
- Commercial ☐
- ATPL ☐

Please indicate which of the following ratings that you hold:

- Instructor ☐
- Instrument ☐

Have you ever conducted any low-level flight training?

Yes: ☐
No: ☐

Each of the following questions is related to your flying experience. Please estimate these figures as accurately as possible.

- Number of hours (total) experience: ☐
- Number of hours (total) as pilot in command: ☐
- Number of hours (total) actual IFR experience: ☐
- Number of cross-country hours experience (excluding training): ☐
- Number of cross-country hours experience during the previous 90 days: ☐
- Number of times you have been forced to fly below 500ft AGL: ☐
- Number of hours (total) low-level flying: ☐
Have you ever been involved in an aircraft accident or incident involving low-level flying?

Yes: □

No: □

Do you know of anyone who has been involved in an accident or incident involving low-level flying?

Yes: □

No: □

Over the previous six months, how often have you used GPS as a primary source of navigation?

Never □ Rarely □ Sometimes □ Frequently □ Always □
Reflection Questions

State the number which you were asked to read or report during your flight. ______

Briefly reflect on the flight that you have just flown, and write down any key points or lessons learnt.

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

In your own words, please summarise on one main point or rule that you could conclude or derive from your flight.

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

Thank you for completing the questionnaire ☺
**Aerial Spotting Flight**

*Background:* You work for a small aviation company that specialises in aerial 'spotting' tasks using various aircraft. The general approach used by the company on any given task is to first send out a light plane. Should the pilot of the plane be unable to complete the task, a helicopter will be sent out to make a further attempt. Because helicopters are considerably more expensive to operate than light planes, the owner of the company encourages pilots of light planes to make every attempt to complete the task. In addition, the company has a reputation for never getting it wrong, so the accuracy of the information you gather is critical.

*Task:* An oil tanker is sitting in shallow water, just off the coast in Botany Bay. To locate the oil tanker, simply fly from Bankstown aerodrome tracking 097 degrees direct to Sydney International airport and turn onto a heading of 165, degrees tracking direct to the oil tanker. You do not need airways clearance for this flight and there will be no other traffic to contend with. Upon departing the oil tanker, you are permitted to fly direct to Sydney International airport and land. The oil tanker has a unique, 3 digit serial number painted on the main deck. The owner of the oil-tanker fleet wishes to know which of its vessels is coming this close to shore. Your task is to locate the oil tanker, and to identify the serial number. Due to fuel constraints, the duration of the flight will be approximately 20 min. It will take approximately 5 minutes to fly from Bankstown aerodrome to Sydney International airport and a further 2 minutes to track direct to the oil tanker. This leaves a maximum of 10 minutes to identify the number. Please note, that there is no minimum requirement for the time spent identifying the number. As soon as you feel you have completed the task, or if you feel you are unable to complete the task, please proceed to land back at Sydney airport.

You will be provided with a VTC for Sydney, 30cm ruler, flight protractor (airtour), marker and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
Flight Details

Bankstown, NSW

Aerodrome Report

BANKSTOWN YSBK
METAR YSBK CURRENT 13008KT /// 16/13 Q1020

Terminal Area Forecasts

BANKSTOWN YSBK
TAF YSBK CURRENT 13008KT 9999 BNK CU 090
T 18 21 21 22 Q 1016 1018 1020 1020

Area Forecast

AREA 20 CURRENT

OVERVIEW:
SCATTERED SHOWERS, ISOLATED SE OF BATHURST/COONABARABRAN GRADUALLY CLEARING FROM THE W AFTER 14Z.ISOLATED THUNDERSTORMS NE OF COONABARABRAN/Mt VICTORIA CONTRACTING TO SEA AFTER 14Z.AREAS BROKEN LOW CLOUD ABOUT RANGES/SLOPES N OF ARMIDALE EXTENDING S TO MURRURUNDI BY 14Z.BROKEN STRATUS IN PRECIPITATION. AREAS FOG/MIST DEVELOPING AFTER 11Z.

WIND:
2000 5000 7000 10000 14000 18500
VRB/15 VRB/15 VRB/15 330/15 MS04 340/20 MS10 340/30 MS20

CLOUD:
ISOL CB 3000/30000 NE OF COONABARABRAN/Mt VICTORIA CONTRACTING TO SEA AFTER 14Z AREAS BKN ST N OF ARMIDALE, 3000/5000 RANGES, 2000/3500 W SLOPES, EXTENDING S TO MURRURUNDI AFTER 14Z. LOCALLY BKN ST IN SH/TS, 1000/3000 SEA/COAST,3000/5000 RANGES, 2000/4000 W SLOPES. AREAS BKN CU/SC 3000/10000 SEA/COAST, 5000/10000 RANGES, 4000/10000 W SLOPES WITH ISOL TOPS 15000 NE OF COONABARABRAN/Mt VICTORIA. AREAS BKN AC/AS ABOVE 10000 OVER SEA.

WEATHER:
SH.TS. FG/BR AFTER 11Z.
VISIBILITY:
0500 FG. 2000M BR.
3000M TS. 4000M SH.

FREEZING LEVEL:
7000/9500.

ICING:
MOD IN CU TOPS AND AC/AS.

TURBULENCE:
MOD IN CU AND AC.

CRITICAL LOCATIONS: [CLOUD HEIGHTS ABOVE MEAN SEA LEVEL]

MT VICTORIA: 9999 -SHRA BKN CU 5000
INTER 0517 4000 SHRA BKN ST 3700

MURRENDI: 9999 -SHRA BKN CU/SC 4500
INTER 0517 4000 SHRA BKN ST 3000
Post-Mission Questionnaire

1. Your task was to read the number located on the deck of the oil-tanker, please report that number as accurately as possible. _______________ 

2. Throughout the flight, what was the lowest altitude to which descended? _____ ft-AGL. 

2.2 If you think that you descended below 500ft, can you explain why this was the case? 

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

3. As you were flying the mission, were you able to recall any of the Low-flying rules? 

Yes ( ) No ( )

3.1 If Yes, what rules could you recall? 

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

4. At the lowest point of your flight, how low do you think in relation to minimum altitude specified by the low flight regulations? 

<table>
<thead>
<tr>
<th>Well below</th>
<th>Slightly below</th>
<th>Right on</th>
<th>Slightly Above</th>
<th>Well above</th>
</tr>
</thead>
</table>
5. At any point throughout the flight, were you able to recall any similarities between this flight and other experiences that you are familiar with, including simulated flight/s?

Yes ( ) No ( )

If ‘Yes’, please explain the case(s) or example(s) you recalled and their similarities.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

5.2 If you answered ‘Yes’ to the previous question. Please indicate below the level of influence that you perceived these case(s) or example(s) had on your decision-making during the flight?

( ) No influence at all.
( ) Very little influence.
( ) Some influence.
( ) Moderate influence.
( ) Major influence.

6. Did the presence of the researcher influence your decision? Yes ( ) No ( )

If YES, how?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

7. If you had the opportunity to ‘turn back time’ and re-fly the flight, is there anything that you would do differently?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

________________________________________________________________________
8. Would you like to comment on any aspects of the experimental process good or bad? (e.g., how the experiment was conducted, time it took, use of flight simulator, researcher etc).

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________

9. My actions throughout the flight did not jeopardise in anyway the safety of the aircraft.

   Strongly disagree | Disagree | Undecided | Agree | Strongly agree

10. My actions throughout the flight did not violate aviation regulations pertaining to low-flying.

   Strongly disagree | Disagree | Undecided | Agree | Strongly agree
11. Which of the following is most like the strategy that you employed to determine the minimum altitude to which you would descend. (Place one tick only in the box adjacent to the most appropriate statement).

I recall previous examples of situations in which I have made similar decisions, and I try and adapt these experiences. ☐

I tend to consider the pros and cons of each alternative and choose the strategy that is likely to lead to the most favourable outcome. ☐

I tend to use a specific rule which specifies when I make a decision and how I make it. ☐

I recall previous examples of situations that I have read/heard about, and I use this information as the basis for making a decision. ☐

I have a model of the way in which decisions should be made, and I use this as the basis for making my own decisions. ☐

I know immediately whether it is Ok or not. ☐

Thank you for your time ☺
SPSS Template for Converting Data from X-Plane Output File to SPSS Version 11 and 11.5.

See Appendix A
Table 15
Summary table of a one-way analysis of variance for training group (pilot or co-pilot during training) as the independent variable and mean absolute roll of the aircraft between 1 and 5 nautical miles as the dependent variable (Experiment 2).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>1</td>
<td>23.11</td>
<td>23.11</td>
<td>4.02</td>
</tr>
<tr>
<td>Error</td>
<td>38</td>
<td>218.19</td>
<td>5.74</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01
Table 16
Summary table for the 2 x 2 x 2 (pilot-in-command x feedback x similarity) between groups factorial analysis of variance for the minimum altitude to which the pilots descended during the test flight (Experiment 2).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLYACC</td>
<td>1</td>
<td>411.94</td>
<td>411.94</td>
<td>8.15**</td>
</tr>
<tr>
<td>CONDITIO</td>
<td>1</td>
<td>10.30</td>
<td>10.30</td>
<td>0.20</td>
</tr>
<tr>
<td>SIMILARI</td>
<td>1</td>
<td>0.475</td>
<td>0.47</td>
<td>0.01</td>
</tr>
<tr>
<td>Interaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FLYACC * CONDITIO</td>
<td>1</td>
<td>28.08</td>
<td>28.08</td>
<td>0.56</td>
</tr>
<tr>
<td>FLYACC * SIMILARI</td>
<td>1</td>
<td>8.58</td>
<td>8.58</td>
<td>0.17</td>
</tr>
<tr>
<td>CONDITIO * SIMILARI</td>
<td>1</td>
<td>271.73</td>
<td>271.73</td>
<td>5.38*</td>
</tr>
<tr>
<td>FLYACC * CONDITIO * SIMILARI</td>
<td>1</td>
<td>137.50</td>
<td>137.50</td>
<td>2.72</td>
</tr>
<tr>
<td>Error</td>
<td>32</td>
<td>1617.70</td>
<td>50.55</td>
<td></td>
</tr>
</tbody>
</table>

*indicates $p < .05$, ** indicates $p < .01$
Table 17
Summary table of a univariate analysis of variance with feedback (positive or negative) as the independent variable and the mean minimum altitude descended during the test flight as the dependent variable (Experiment 2).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>1</td>
<td>269.072</td>
<td>269.072</td>
<td>5.40</td>
</tr>
<tr>
<td>Error</td>
<td>18</td>
<td>895.927</td>
<td>49.774</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01
The following three chi-square analyses examine pilots’ performance in relation to their flight path (individual number of circuits) overhead, north, and south of the oil tanker. A subsequent chi-square analysis failed to identify a significant relationship between descent beneath 500 feet and the number of circuits performed overhead the oil tanker $\chi^2(6, N = 40) = 2.83, p > .05$; Fisher’s exact test, $p = 3.19^{18}$, descent beneath 500 feet and the number of circuits north of the oil tanker $\chi^2(5, N = 40) = 8.27, p > .05$; Fisher’s exact test, $p = 7.69^{19}$, and descent beneath 500 feet and the number of circuits south of the oil tanker $\chi^2(2, N = 40) = 1.03, p > .05$; Fisher’s exact test, $p = 1.12^{20}$. These results suggest that the flight path of the aircraft was relatively consistent between those pilots who descended beneath 500 feet and the pilots who remained above this altitude during the test flight. As no statistically significant difference was observed between the two groups in relation to the descent beneath 500 feet and circuits overhead, north or south of the oil tanker, it might be concluded that all pilots exercised a similar level of risk management behaviour in terms of their choice of flight path during the test flight (see Table 18).

---

18 The $p$ value using Fisher’s exact test was calculated instead of the chi-square value because 12 cells have an expected count less than 5. The minimum expected count is 0.95 (Heiman, 1996; Siegel, 1956).
19 The $p$ value using Fisher’s exact test was calculated instead of the chi-square value because 11 cells have an expected count less than 5. The minimum expected count is 1.43 (Heiman, 1996; Siegel, 1956).
20 The $p$ value using Fisher’s exact test was calculated instead of the chi-square value because 2 cells have an expected count less than 5. The minimum expected count is 1.43 (Heiman, 1996; Siegel, 1956).
Table 18

*Circuit direction and number, distributed across whether participants descended beneath 500 while reading the number on the oil tanker (Experiment 2).*

<table>
<thead>
<tr>
<th>Circuit Direction</th>
<th>Descent below 500 feet</th>
<th>Number of circuits over oil tanker</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>Overhead</td>
<td>Yes</td>
<td>2 3 3 7 2 3 1</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>3 2 5 4 3 1 1</td>
<td>19</td>
</tr>
<tr>
<td>North</td>
<td>Yes</td>
<td>3 2 6 7 0 3 -</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>5 4 4 2 3 1 -</td>
<td>19</td>
</tr>
<tr>
<td>South</td>
<td>Yes</td>
<td>- 13 7 1 - - - -</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>- 9 8 2 - - - -</td>
<td>19</td>
</tr>
</tbody>
</table>
Summary of Experiment

The Role of Experience and Prior Exposure in Learning: An Analysis of Private Pilots

Dear

I would like to take this opportunity to thank you for participating in the research project entitled ‘The Role of Experience and Prior Exposure in Learning: An Analysis of Private Pilots’ conducted by Brett Molesworth and under the supervision of Dr Mark Wiggins.

In total, there were 40 participants who volunteered their time to assist with the research. The study was the second experiment in a series designed to examine and test potential training methods to improve the risk management behaviour of pilots. Specifically, this study examined the potential benefits of personalising the risk during training and the effects of feedback on pilot performance. Participants were placed in one of four different training groups, which differed on the basis of feedback versus no feedback, and single versus multi-crew training (training condition). During the second week, the pilots all flew the same flight scenario and performance was measured.

The objective in measuring pilot’s performance was not to ascertain those pilots who would be considered superior, but to examine the impact of the training condition during the first week. During the data analyses, the experience of pilots was considered in relation to the total number of hours flown, and factored into their performance on the simulated flight in the second week.

The results reflected favourably on the training method that involved those participants who actually flew the aircraft (pilot-in-command) during the training in comparison to those participants who were simply co-pilots. Furthermore, the results indicated that feedback has potential benefits in situations where pilots are able to recall similar experience/s. Therefore, it appears that improvements in pilots’ risk management techniques may be positively influenced by actively involving pilots in the training, in addition to providing them with feedback, providing that they are able to recall similar experience/s. Such results are pleasing, but more research is needed to examine the potential benefits in other situations other than low-flying.

I would like to, once again, thank you for your time and stress how important your contributions are to improving the level of safety within the general aviation industry.

Regards,

Brett Molesworth
Appendix D: Experiment 3

This appendix contains the material and the stimuli that were developed in order to permit the conduct of Experiment 3. In addition, a sample of the data obtained from this experiment is provided.
Personal Computer Aviation Training Device (PCATD)
MARCS Human Factors and Performance Lab
Information Sheet

Aviation Human Factors

This study is being conducted as part of a PhD degree undertaken by Brett Molesworth at the School of Psychology, University of Western Sydney under the supervision of Dr Mark Wiggins. The aim of the study is to examine the influence of previous experience on various types of aeronautical decision-making.

This study comprises two parts, involving two sessions one week apart. In both sessions, you will be asked to fly a simulated flight on a flight simulator. You will be provided with instructions prior to each exercise that will outline the objectives and you will also be provided with an aeronautical chart and related weather to assist with the planning of the flights. The first session will take no longer than 60 minutes and the second session will take no longer than 75 minutes. You will be also reimbursed a total of $30 for related travel expenses at the conclusion of the study in the second week.

Please note that you are under no obligation to complete this study and that you may withdraw at any time. Your participation in this study will have no bearing on your studies, either at the University of Western Sydney or elsewhere. In addition, any identifying features of your responses will be removed and individual results will be considered confidential.

In some cases, the exposure to aviation-based situations can evoke an undesired emotional response amongst participants. If you experience adverse emotional reactions at any time throughout this study, please advise the researcher, and the study will be concluded immediately.

We appreciate your participation in this study and if you have any questions, please do not hesitate to contact Brett Molesworth (University of Western Sydney) on:
NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (tel: 02 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
MARCS Human Factors and Performance Lab
Consent Form

Aviation Human Factors

I have been asked to participate in the research “The Role of Experience and Prior Exposure in Learning: An Analysis of General Aviation Pilots” conducted by Brett Molesworth and Dr Mark Wiggins, and give my free consent by signing this form. I understand that:

The research project will be carried out as described in the information sheet, a copy of which I have retained. I have read and understood the Information Sheet and have had the opportunity to have all my questions answered to my satisfaction.

My consent to participate is voluntary and I may withdraw from the study at any time. I do not have to give a reason for the withdrawal of my consent.

Signature ...................................................   Date      /      / 2004

NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (tel: 02 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
If you wish to receive a summary of the overall results of this research, please supply your name and address below. A summary will be sent to you at this address on completion of the study.

Name: ___________________________________

Address: ___________________________________

________________________________________
Demographic Information

Age: _____  Gender: Male: □  Female: □

Please indicate which of the following licences that you hold:

GFPT □
Private □
Commercial □
ATPL □

Please indicate which of the following ratings that you hold:

Instructor □
Instrument □

Have you ever conducted any low-level flight training?

Yes: □
No: □

Each of the following questions is related to your flying experience. Please estimate these figures as accurately as possible.

Number of hours (total) experience: ____________

Number of hours (total) as pilot in command: ____________

Number of hours (total) actual IFR experience: ____________

Number of cross-country hours experience (excluding training): ____________

Number of hours (total) during the previous 90 days: ____________

Number of cross-country hours during the previous 90 days: ____________

Number of times you have been forced to fly below 500ft AGL: ____________

Number of hours (total) low-level flying: ____________

Have you ever been involved in an aircraft accident or incident involving low-level flying?

Yes: □
No: □
Do you know of anyone who has been involved in an accident or incident involving low-level flying?

Yes: ☐
No: ☐

Over the previous six months, how often have you used GPS as a primary source of navigation?

Never ☐ Rarely ☐ Sometimes ☐ Frequently ☐ Always ☐

Have you previously participated in research at this university?

Yes: ☐
No: ☐

If ‘Yes’, please briefly describe experiment

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Aviation Research
(Week 1)

Background: You have recently applied for a position at a small aviation company that specialises in servicing the needs of small business clients. This company also has a reputation as one of the few aviation transportation companies that always get the job done.

Task: Prior to offering you a position at the company, you have been asked to fly two left hand circuits departing on runway 04 at Mudgee aerodrome. This should take no longer than 20 minutes and will give your potential employer the opportunity to assess your flying skills. The total fuel on board will permit 20 minutes of flight time plus the mandatory 45 minutes of reserves. Mudgee aerodrome is approximately 1500 feet above sea level and is surrounded by hills.

Please note that there are no restricted areas active for the duration of the flight and ensure that you make use of the materials provided (VNC-3 (Newcastle), a ruler, and an area forecast for the flight).
Traffic Report  
(Week 1)  

Background: You are an employee of a small aviation company that specialises in servicing the needs of small business clients. Your company has a reputation as one of the few aviation transportation companies that always get the job done.

Task: Your employer has asked you monitor the traffic flow of cars that passes a farm house on a busy road north of Mudgee. Due to fuel constraints, the duration of the flight will be approximately 20 minutes. It will take approximately 5 minutes to fly from Mudgee to the farm house, leaving a maximum of 10 minutes to monitor the number of motor vehicles passing the farm house, allowing for another 5 minutes to return to Mudgee. Please note that the duration of time you are permitted identifying the volume of traffic is 10 minutes. As soon as you feel you have completed your task, or if you feel you are unable to complete the task, please return back to Mudgee. The track from Mudgee to the house is 040 degrees and approximately 4 nautical miles. Mudgee aerodrome is approximately 1500 feet above sea level and is surrounded by hills. The area where the farm house is located is approximately 2000 feet above sea level.

You will be provided with a VNC-3 (Newcastle), a ruler, flight protractor (airtour), pencil and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
Reflection Questions  
(Week 1)

Please state the number of cars you counted. ___________

Briefly reflect on the flight that you have just flown, and write down any key points or lessons learnt.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

In your own words, please summarise on one main point or rule that you could conclude or derive from your flight.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Thank you for completing the questionnaire 😊
Traffic Report
(Week 2)

Background: You are an employee of a small aviation company that specialises in servicing the needs of small business clients. Your company has a reputation as one of the few aviation transportation companies that always get the job done.

Task: Your employer has asked you monitor the traffic flow of cars that passes a farm house on a busy road north of Mudgee. Due to fuel constraints, the duration of the flight will be approximately 20 minutes. It will take approximately 5 minutes to fly from Mudgee to the farm house, leaving a maximum of 10 minutes to monitor the number of motor vehicles passing the farm house, allowing for another 5 minutes to return to Mudgee. Please note that the duration of time you are permitted identifying the volume of traffic is 10 minutes. As soon as you feel you have completed your task, or if you feel you are unable to complete the task, please return back to Mudgee. The track from Mudgee to the house is 040 degrees and approximately 4 nautical miles. Mudgee aerodrome is approximately 1500 feet above sea level and is surrounded by hills. The area where the farm house is located is approximately 2000 feet above sea level.

You will be provided with a VNC-3 (Newcastle), a ruler, flight protractor (airtour), pencil and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
Traffic Report
(Week 2)

1. Please state the number of cars you counted ________.

2. Throughout the flight, what was the lowest altitude to which descended?
   _____ ft-AGL.

   2.2 If you think that you descended below 500ft, can you explain why this was the case?

   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________

3. At any point throughout the exercise, were you able to recall any similarities between the flight undertaken and any other experience/s that you are familiar with, including previous simulation?

   Yes ( )   No ( )

   If ‘Yes’, please explain the case(s) or example(s) you recalled and their similarities.

   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
Freight Train
(Week 2)

**Background:** You are an employee of a small aviation company that specialises in servicing the needs of small business clients. Your company has a reputation as one of the few aviation transportation companies that always get the job done.

**Task:** Your employer has been asked to investigate some unusual business that has been occurring relating to goods transported on freight trains. Your task is to locate and report to your employer the number of the freight train under investigation. The freight train is approximately 23 carriages in length. It can be identified by a three digit call sign on either side of the leading four carriages, located directly behind the locomotive. Due to fuel constraints, the duration of the flight will be approximately 20 minutes. It will take approximately 5 minutes to fly from Mudgee aerodrome to the last known location of the freight train, leaving a maximum of 10 minutes to complete the task and 5 minutes to track back and land at Mudgee. Please note that there is no minimum requirement for the task. As soon as you feel you have completed your task, or if you feel you are unable to complete the task, please return back to Mudgee. The track from Mudgee to the last known area of the freight train is 345 degrees and approximately 6.5 nautical miles. Mudgee aerodrome is approximately 1500 feet above sea level and is surrounded by hills. The area where the freight train is suspected is approximately 2000 feet above sea level.

You will be provided with a VNC-3 (Newcastle), a ruler, flight protractor (airtour), pencil and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
Freight Train  
(Week 2)

1. Please state the number on the side of the carriage you were asked to read __________.

2. Throughout the flight, what was the lowest altitude to which descended? ____ ft-AGL.

   2.2 If you think that you descended below 500ft, can you explain why this was the case?

   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

3. At any point throughout the exercise, were you able to recall any similarities between the flight undertaken and any other experience/s that you are familiar with, including previous simulation?

   Yes ( )   No ( )

   If ‘Yes’, please explain the case(s) or example(s) you recalled and their similarities.

   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
Stranded Climber  
(Week 2)

Background: You are an employee of a small aviation company that specialises in servicing the needs of small business clients. Your company has a reputation as one of the few aviation transportation companies that always get the job done.

Task: Your employer has been informed from one of your small business clients that one of their employees went bush walking over the weekend and has not been seen since. There is an unconfirmed report that an individual is stranded at an altitude of approximately 1000 feet AGL on a cliff face somewhere in the vicinity of where the company’s employee went bush walking. Your task is to fly to the cliff face and investigate this unconfirmed report. The cliff face is located approximately 6.5 nautical miles north of Mudgee aerodrome. It will take approximately 5 minutes to fly from Mudgee to the last known location of the bush walker, leaving a maximum of 10 minutes to search the cliff face and 5 minutes to track back and land at Mudgee. Please note that there is no minimum requirement for the task. As soon as you feel you have completed your task, or if you feel you are unable to complete the task, please return back to Mudgee. The track from Mudgee to the cliff face is 345 degrees and approximately 6.5 nautical miles. Mudgee aerodrome is approximately 1500 feet above sea level and is surrounded by hills. The ground surrounding the cliff is approximately 2000 feet above sea level.

You will be provided with a VNC-3 (Newcastle), a ruler, flight protractor (airtour), pencil and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
Stranded Climber
(Week 2)

1. Were you able to positively identify the stranded climber?

   Yes: □
   No: □

2. Please estimate the horizontal distance between your aircraft and the cliff face at the closest point throughout the flight.
   _______ meters.

3. Please explain why you chose to fly at the above-mentioned distance from the cliff face.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

4. At any point throughout the exercise, were you able to recall any similarities between the flight undertaken and any other experience/s that you are familiar with, including previous simulation?

   Yes ( )  No ( )

   If ‘Yes’, please explain the case(s) or example(s) you recalled and their similarities.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
Cooling Tower
(Week 2)

Background: You are an employee of a small aviation company that specialises in servicing the needs of small business clients. Your company has a reputation as one of the few aviation transportation companies that always get the job done.

Task: There have been unconfirmed reports of a protestor abseiling down the side of a cooling tower at a newly opened power plant. The cooling tower is approximately 700 feet above the ground and the exact location of the protestor is not known. Your employer has been asked to confirm if these reports are correct. The cooling tower is located approximately 6.5 nautical miles north of Mudgee aerodrome. It will take approximately 5 minutes to fly from Mudgee to the cooling tower, leaving a maximum of 10 minutes to investigate the reports and 5 minutes to track back and land at Mudgee. Please note that there is no minimum requirement for the task. As soon as you feel you have completed your task, or if you feel you are unable to complete the task, please return back to Mudgee. The track from Mudgee to the cooling tower is 345 degrees and approximately 6.5 nautical miles. Mudgee aerodrome is approximately 1500 feet above sea level and is surrounded by hills. The area where the cooling tower is located is approximately 2000 feet above sea level.

You will be provided with a VNC-3 (Newcastle), a ruler, flight protractor (airtour), pencil and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
1. Were you able to positively identify a protestor on the cooling tower?

   Yes: □
   No: □

2. Please estimate the horizontal distance between your aircraft and the cooling tower at the closest point throughout the flight.
   _______ meters.

   2.1 Please explain why you chose to fly at the above-mentioned distance from the cooling tower.

   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________

3. Throughout the flight, what was the lowest altitude you descended?
   _____ ft-AGL.

   3.1 If you think that you descended below 500ft, can you explain why this was the case?

   ____________________________________________
   ____________________________________________
   ____________________________________________
   ____________________________________________
4. At any point throughout the exercise, were you able to recall any similarities between the flight undertaken and any other experience/s that you are familiar with, including previous simulation?

Yes ( )    No ( )

If ‘Yes’, please explain the case(s) or example(s) you recalled and their similarities.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Traffic Report
(Week 2-Hint)

Background: You are an employee of a small aviation company that specialises in servicing the needs of small business clients. Your company has a reputation as one of the few aviation transportation companies that always get the job done.

Task: Your employer has asked you monitor the traffic flow of cars that passes a farm house on a busy road north of Mudgee. Due to fuel constraints, the duration of the flight will be approximately 20 minutes. It will take approximately 5 minutes to fly from Mudgee to the farm house, leaving a maximum of 10 minutes to monitor the number of motor vehicles passing the farm house, allowing for another 5 minutes to return to Mudgee. Please note that the duration of time you are permitted identifying the volume of traffic is 10 minutes. As soon as you feel you have completed your task, or if you feel you are unable to complete the task, please return back to Mudgee. The track from Mudgee to the house is 040 degrees and approximately 4 nautical miles. Mudgee aerodrome is approximately 1500 feet above sea level and is surrounded by hills. The area where the farm house is located is approximately 2000 feet above sea level.

Please note that the training flight undertaken in the first week is relevant to this flight and should be used to assist with the current task.

You will be provided with a VNC-3 (Newcastle), a ruler, flight protractor (airtour), pencil and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
Freight Train  
(Week 2-Hint)

Background: You are an employee of a small aviation company that specialises in servicing the needs of small business clients. Your company has a reputation as one of the few aviation transportation companies that always get the job done.

Task: Your employer has been asked to investigate some unusual business that has been occurring relating to goods transported on freight trains. Your task is to locate and report to your employer the number of the freight train under investigation. The freight train is approximately 23 carriages in length. It can be identified by a three digit call sign on either side of the leading four carriages, located directly behind the locomotive. Due to fuel constraints, the duration of the flight will be approximately 20 minutes. It will take approximately 5 minutes to fly from Mudgee aerodrome to the last known location of the freight train, leaving a maximum of 10 minutes to complete the task and 5 minutes to track back and land at Mudgee. Please note that there is no minimum requirement for the task. As soon as you feel you have completed your task, or if you feel you are unable to complete the task, please return back to Mudgee. The track from Mudgee to the last known area of the freight train is 345 degrees and approximately 6.5 nautical miles. Mudgee aerodrome is approximately 1500 feet above sea level and is surrounded by hills. The area where the freight train is suspected is approximately 2000 feet above sea level.

Please note that the training flight undertaken in the first week is relevant to this flight and should be used to assist with the current task.

You will be provided with a VNC-3 (Newcastle), a ruler, flight protractor (airtour), pencil and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
**Stranded Climber**

*(Week 2-Hint)*

**Background:** You are an employee of a small aviation company that specialises in servicing the needs of small business clients. Your company has a reputation as one of the few aviation transportation companies that always get the job done.

**Task:** Your employer has been informed from one of your small business clients that one of their employees went bush walking over the weekend and has not been seen since. There is an unconfirmed report that an individual is stranded at an altitude of approximately 1000 feet AGL on a cliff face somewhere in the vicinity of where the company’s employee went bush walking. Your task is to fly to the cliff face and investigate this unconfirmed report. The cliff face is located approximately 6.5 nautical miles north of Mudgee aerodrome. It will take approximately 5 minutes to fly from Mudgee to the last known location of the bush walker, leaving a maximum of 10 minutes to search the cliff face and 5 minutes to track back and land at Mudgee. Please note that there is no minimum requirement for the task. As soon as you feel you have completed your task, or if you feel you are unable to complete the task, please return back to Mudgee. The track from Mudgee to the cliff face is 345 degrees and approximately 6.5 nautical miles. Mudgee aerodrome is approximately 1500 feet above sea level and is surrounded by hills. The ground surrounding the cliff is approximately 2000 feet above sea level.

Please note that the training flight undertaken in the first week is relevant to this flight and should be used to assist with the current task.

You will be provided with a VNC-3 (Newcastle), a ruler, flight protractor (airtour), pencil and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
Cooling Tower
(Week 2-Hint)

Background: You are an employee of a small aviation company that specialises in servicing the needs of small business clients. Your company has a reputation as one of the few aviation transportation companies that always get the job done.

Task: There have been unconfirmed reports of a protestor abseiling down the side of a cooling tower at a newly opened power plant. The cooling tower is approximately 700 feet above the ground and the exact location of the protestor is not known. Your employer has been asked to confirm if these reports are correct. The cooling tower is located approximately 6.5 nautical miles north of Mudgee aerodrome. It will take approximately 5 minutes to fly from Mudgee to the cooling tower, leaving a maximum of 10 minutes to investigate the reports and 5 minutes to track back and land at Mudgee. Please note that there is no minimum requirement for the task. As soon as you feel you have completed your task, or if you feel you are unable to complete the task, please return back to Mudgee. The track from Mudgee to the cooling tower is 345 degrees and approximately 6.5 nautical miles. Mudgee aerodrome is approximately 1500 feet above sea level and is surrounded by hills. The area where the cooling tower is located is approximately 2000 feet above sea level.

Please note that the training flight undertaken in the first week is relevant to this flight and should be used to assist with the current task.

You will be provided with a VNC-3 (Newcastle), a ruler, flight protractor (airtour), pencil and an area forecast for the flight. Please make use of the material provided to plan your flight. Please note that the total contents of fuel will permit 20 minutes of flight plus the mandatory 45 minutes for reserves. No restricted areas will be active for the duration of the flight.
Meteorology for all Flights

Area 20

AREA FORECAST Current

OVERVIEW:
ISOLATED SHOWERS SEA/COAST/E RANGES N OF ABOUT WILLIAMTOWN.
ISOLATED THUNDERSTORMS NORTHEAST OF
KEMPSEY/INVERELL/GOONDIWINDI

WIND:

<table>
<thead>
<tr>
<th>Height (ft)</th>
<th>Wind (kt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>040/05</td>
</tr>
<tr>
<td>5000</td>
<td>110/10</td>
</tr>
<tr>
<td>7000</td>
<td>210/15</td>
</tr>
<tr>
<td>10000</td>
<td>220/20</td>
</tr>
<tr>
<td>14000</td>
<td>PS05</td>
</tr>
<tr>
<td>18500</td>
<td>230/25</td>
</tr>
<tr>
<td>20000</td>
<td>ZERO</td>
</tr>
<tr>
<td>24000</td>
<td>MS09</td>
</tr>
</tbody>
</table>

REMARK [1]: WIND BELOW AT 5000 AND BELOW TENDING GRADUALLY SE.
[2]  WIND IS STRONGER BY 10/15 KNOTS IN SOUTH.

CLOUD:
ISOL CB 4500/30000 AS IN OVERVIEW.
LOC BKN ST 3000/5000 E RANGES AFTER 10Z.
LOC BKN ST 0600/3000 SEA/COAST, 3000/5000 RANGES WITH PRECIPITATION.

SCT CU/SC 2500/11000 SEA/COAST, 4500/13000 RANGES, LOC BKN.

WEATHER:
TS/SH.

VISIBILITY:
3000M TS, 6000M SH.

FREEZING LEVEL:
14500 FAR S / 15500 FAR NE.

ICING:
MOD IN CLOUD ABOVE FZL.

TURBULENCE:
MOD IN CU.

CRITICAL LOCATIONS: [CLOUD HEIGHTS ABOVE MEAN SEA LEVEL]
MT VICTORIA: 9999 FEW CU/SC 4500
   FM11 BKN ST 3700 [CLOUD ON GROUND].
MURRURUNDI: 9999 SCT CU/SC 4500.
   FM11 BKN ST 3000.
Mudgee TAF
YMDG Current
TAF YMDG CURRENT 04007KT CAVOK
T 26 26 26 21 Q 1019 1019 1020 1021
Post-Mission Questionnaire

1. On reflection of the flights today, are you able to recall any similarities between the four examples?

   Yes ( ) No ( )

   If ‘Yes’, please explain the similarities that you noticed.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

2. On reflection of the flights today, please state a general rule that could be applied to all four flights?

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

3. At any point throughout the exercise, were you able to recall any similarities between the exercises undertaken today and any other experience/s that you are familiar with, including previous simulation?

   Yes ( ) No ( )

   If ‘Yes’, please explain the case(s) or example(s) you recalled and their similarities.

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
3.2 If you answered ‘Yes’ to the previous question. Please indicate below the level of influence that you perceived these case(s) or example(s) had on your decision-making during the flight?

( ) No influence at all.
( ) Very little influence.
( ) Some influence.
( ) Moderate influence.
( ) Major influence.

4. As you were flying during any of the four flights, were you able to recall any of the Low-flying rules?

Yes ( ) No ( )

4.1 If Yes, what rules could you recall?

__________________________________________
__________________________________________
__________________________________________
__________________________________________

5. My actions throughout any of the flights did not jeopardise in anyway the safety of the aircraft.

| Strongly disagree | Disagree | Undecided | Agree | Strongly agree |

6. Did the presence of the researcher affect your work? Yes ( ) No ( )

If YES, how?

__________________________________________
__________________________________________
__________________________________________
__________________________________________
__________________________________________
__________________________________________
7. Would you like to comment on any aspects of the experimental process good or bad? (e.g., how the experiment was conducted, time it took, use of flight simulator, researcher etc).

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

8. Which of the following is most like the strategy that you employed to determine the track in which you decided to plan. (Place one tick only in the box adjacent to the most appropriate statement).

I recall previous examples of situations in which I have made similar decisions, and I try and adapt these experiences. [ ]

I tend to consider the pros and cons of each alternative and choose the strategy that is likely to lead to the most favourable outcome [ ]

I tend to use a specific rule which specifies when I make a decision and how I make it. [ ]

I recall previous examples of situations that I have read / heard about, and I use this information as the basis for making a decision. [ ]

I have a model of the way in which decisions should be made, and I use this as the basis for making my own decisions. [ ]

I know immediately whether it is Ok or not. [ ]

Thank you for your time 😊
Aviation Research

Age in years: ______

Gender: ☐ Male ☐ Female

Please state your occupation. __________________

Please state the highest level of formal schooling you have completed. _____________

Each of the items below contains two choices A and B. Please indicate which of the choices most describe your likes or the way you feel. In some cases you may find items in which both choices describe your likes or feelings. Please choose the one which better describes your likes or feelings. In some cases you may find items in which you do not like either choice. In these cases mark the choice you dislike least. Do not leave any items blank. It is important you respond to all items with only one choice, A or B. We are interested only in your likes or feelings, not in how others feel about these things or how one is supposed to feel. There are no right or wrong answers as in other kinds of tests. Be frank and give your honest appraisal of yourself.
1. A. I like “wild” uninhibited parties
   B. I prefer quiet parties with good conversation

2. A. There are some movies I enjoy seeing a second or even third time
   B. I can’t stand watching a movie that I’ve seen before

3. A. I often wish I could be a mountain climber
   B. I can’t understand people who risk their necks climbing mountains

4. A. I dislike all body odours
   B. I like some of the earthy body smells

5. A. I get bored seeing the same old faces
   B. I like the comfortable familiarity of everyday friends

6. A. I like to explore a strange city or section of town by myself, even if it means getting lost
   B. I prefer a guide when I am in a place I don’t know well

7. A. I dislike people who do or say things just to shock or upset others
   B. When you can predict almost everything a person will do and say he or she must be a bore

8. A. I usually don’t enjoy a movie or play where I can predict what will happen in advance
   B. I don’t mind watching a movie or play where I can predict what will happen in advance

9. A. I have tried cannabis or would like to
   B. I would never smoke cannabis

10. A. I would not like to try any drug which might produce strange and dangerous effects on me
    B. I would like to try some of the drugs that produce hallucinations

11. A. A sensible person avoids activities that are dangerous
    B. I sometimes like to do things that are a little frightening

12. A. I dislike “swingers” (people who are uninhibited and free about sex)
    B. I enjoy the company of real "swingers"

13. A. I find that stimulants make me uncomfortable
    B. I often like to get high (drinking alcohol or smoking marijuana)
14. A. I like to try new foods that I have never tasted before
B. I order the dishes with which I am familiar so as to avoid disappointment and unpleasantness

15. A. I enjoy looking at home movies, videos or travel slides
B. Looking at someone’s home movies, videos, or travel slides bores me tremendously

16. A. I would like to take up the sport of water skiing
B. I would not like to take up water skiing

17. A. I would like to try surfboard riding
B. I would not like to try surfboard riding

18. A. I would like to take off on a trip with no preplanned or definite routes or timetable
B. When I go on a trip I like to plan my route and timetable fairly carefully

19. A. I prefer the “down to earth” kinds of people as friends
B. I would like to make friends in some of the “far-out” groups like artists or anarchists

20. A. I would not like to learn to fly an airplane
B. I would like to learn to fly an airplane

21. A. I prefer the surface of the water to the depths
B. I would like to go scuba diving

22. A. I would like to meet some people who are homosexual (men or women)
B. I stay away from anyone I suspect of being gay or lesbian

23. A. I would like to try parachute jumping
B. I would never want to try jumping out of a plane, with or without a parachute

24. A. I prefer friends who are excitingly unpredictable
B. I prefer friends who are reliable and predictable

25. A. I am not interested in experience for its own sake
B. I like to have new and exciting experiences and sensations even if they are a little frightening, unconventional, or illegal
26. A. The essence of good art is in its clarity, symmetry of form, and harmony of colours  
B. I often find the beauty in the clashing colours and irregular forms of modern paintings

27. A. I enjoy spending time in the familiar surroundings of home  
B. I get very restless if I have to stay around home for any length of time

28. A. I like to dive off the high board  
B. I don’t like the feeling I get standing on the high board (or I don’t go near it at all)

29. A. I like to date people who are physically exciting  
B. I like to date people who share my values

30. A. Heavy drinking usually ruins a party because some people get loud and boisterous  
B. Keeping the drinks full is the key to a good party

31. A. The worst social sin is to be rude  
B. The worst social sin is to be a bore

32. A. A person should have considerable sexual experience before marriage  
B. It’s better if two married people begin their sexual experience with each other

33. A. Even if I had the money, I would not care to associate with flighty rich people in the jet set  
B. I could conceive of myself seeking pleasures around the world with the jet set

34. A. I like people who are sharp and witty even if they do sometimes insult others  
B. I dislike people who have their fun at the expense of hurting the feelings of others

35. A. There is altogether too much portrayal of sex in the movies  
B. I enjoy watching many of the sexy scenes in movies

36. A. I feel best after taking a couple of drinks  
B. Something is wrong with people who need alcohol to feel good

37. A. People should dress according to some standard of taste, neatness and style  
B. People should dress in individual ways even if the effects are sometimes strange
38. A. Sailing long distances in small sailing crafts is foolhardy  
   B. I would like to sail a long distance in a small but seaworthy sailing craft  
39. A. I have no patience with dull or boring people  
   B. I find something interesting in almost every person I talk to  
40. A. Skiing down a high mountain slope is a good way to end up on crutches  
   B. I think I would enjoy the sensations of skiing very fast down a high mountain slope
Risk Perception
(Questionnaire 1)

In this exercise, you will see several descriptions of other pilots who are involved in aviation situations. Your task will be to decide how risky each situation is. Unless the description says otherwise, you may assume that the pilot involved in the situation is an average general aviation pilot, with about 300 hours of total experience, who has flown about 30 hours over the last 12 months.

You will rate the risk in each of the situations on a scale of 1 to 100.

The 1 to 100 risk scale is defined as follows:

1 -- Virtually zero risk involved in this situation. It is about as safe as sitting on the couch watching TV.

50 -- The same amount of risk as driving your car on a freeway in moderate traffic and good weather conditions during the day.

100 -- Extremely high risk of a serious, probably fatal accident. The pilot will be very fortunate to escape from this situation alive and with the aircraft undamaged.

<table>
<thead>
<tr>
<th>Item</th>
<th>Rating</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>On short final a pilot drops his microphone on the floor. He looks down while bending over trying to reach it. He inadvertently moves the control yoke and the aircraft banks sharply.</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>The pilot is in a hurry to get going and does not carefully check his seat, seat belt, and shoulder harness. When he rotates, the seat moves backward on its tracks. As it slides backward, the pilot pulls back on the control yoke, sending the nose of the aircraft upward. As the airspeed begins to decay, he strains forward to push the yoke back to a neutral position.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>A line of thunderstorms block the route of flight, but a pilot sees that there is a space of about 10 miles between two of the cells. He can see all the way to clear skies on the other side of the thunderstorm line, and there does not seem to be any precipitation along the route, although it does go under the extended anvil of one of the cells. As he tries to go between the storms, he suddenly encounters severe turbulence and the aircraft begins to be pelted with hail.</td>
</tr>
<tr>
<td>4</td>
<td>Low ceilings obscure the tops of the mountains, but the pilot thinks that he can see through the pass to clear sky on the other side of the mountain ridges. He starts up the wide valley that gradually gets narrower. As he approaches the pass he notices that he occasionally loses sight of the blue sky on the other side. He drops down closer to the road leading through the pass and presses on. As he goes through the pass, the ceiling continues to drop and he finds himself suddenly in the clouds. He holds his heading and altitude and hopes for the best.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Just after takeoff a pilot hears a banging noise on the passenger side of the aircraft. He looks over at the passenger seat and finds that he can't locate one end of the seatbelt. He trims the aircraft for level flight, releases the controls, and tries to open the door to retrieve the seatbelt.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>During the planning for a 2 hour cross-country flight, a pilot makes a mistake in computing the fuel consumption. He believes that he will have over an hour of fuel remaining upon arrival, but he will really only have about 15 minutes of fuel left.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>After working a full day, a businesswoman drives out to the airport for her three hour flight home. She is tired, and the sun is setting, but the weather forecast is for clear sky and good visibility. About an hour after takeoff, she begins to feel very tired and sleepy. She regrets not bringing any coffee along, and opens the cockpit air vent to get some fresh, cool air.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>It is late afternoon and the VFR pilot is flying west into the setting sun. For the last hour, the visibility has been steadily decreasing, however his arrival airport remains VFR, with 4 miles visibility and haze. This is a busy uncontrolled airfield with a single East-West runway. He decides to do a straight-in approach.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>When he took off about an hour earlier, there was a quartering headwind of about 15 knots. He made it into the air, but it was a rocky takeoff, and one he hoped none of the other pilots at the small airport noticed. Now as he entered the downwind leg for landing, he noticed that the windsock was indicating almost a direct crosswind of about the same strength. On final he is holding a large crab to keep from drifting away from the centreline, and as he starts the flare he begins to drift toward the side of the runway.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>While on a local sightseeing flight, the pilot notices that the weather is deteriorating to the west. A line of clouds is moving in his direction, but they are still over 20 miles away. He decides to cut his flight short and turns to return to his home airfield about 25 miles east of his present position.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>The instructor pilot had been suffering from a cold and when he arose in the morning, he took an over-the-counter antihistamine to try and control his runny nose. After a morning of giving instruction in the flight simulator, he had a lesson scheduled after lunch with a pilot working on his commercial licence. He felt a little drowsy, but the weather was good and they were going to be working on short-field landings, so he did not cancel the lesson.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>A pilot is cruising in good weather to a destination airport about an hour away. It is midday, and there are three hours of fuel on board.</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>An experienced pilot with a rated passenger are taxiing out for takeoff. They are at a controlled airfield, on the ground-control radio frequency. They have been cleared to &quot;taxi to and hold short of Runway 31&quot; and are now approaching the hold-short line.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>An instrument-rated pilot on an IFR flight plan has just climbed through a 4000 foot thick layer of clouds. Although icing was not forecast, he notices a trace of ice on the edges of the windscreen. The aircraft is not equipped for flight into known or forecast icing conditions. As he approaches his destination airport, air traffic control issues a clearance that will require him to hold for approximately 15 minutes in the cloud layer.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>For the first part of this late night flight, the low-time VFR pilot has enjoyed a spectacular view of the stars as he cruised at 8,500 feet with over 25 miles visibility. As he nears his destination airport, which sits on the far side of a large lake, he notices that the visibility is decreasing because of haze nearer the surface. As he starts across the lake at about 2,500 feet he loses sight of the lights on the shore, and the dim lights scattered far apart on the ground seem to be indistinguishable from the stars.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>It is time for an oil change and the pilot/owner decides to do it himself. He consults with his local A&amp;P mechanic and then follows his instructions. He does not have the work inspected afterwards and makes the appropriate log book notation himself.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>While cruising at 4,500 feet AGL, the engine on the single-engine aircraft sputters and quits. The pilot checks the fuel settings and tries to restart the engine but is unsuccessful. He sees a level field within gliding distance and turns toward it. He will be landing into the wind.</td>
<td></td>
</tr>
</tbody>
</table>
Risk Perception
(Questionnaire 2)

In this exercise, you will be given descriptions of common aviation and everyday situations. After you have read the description of each situation, you will decide how risky the situation would be if YOU were in that situation tomorrow. Base your rating on your personal training and experiences, and use the 1 to 100 risk rating scale shown below.

The 1 to 100 risk rating scale is defined as follows:

1 -- Virtually zero risk involved in this situation. It is about as safe as sitting on the couch watching TV.

50 -- The same amount of risk as driving your car on a freeway in moderate traffic and good weather conditions during the day.

100 -- Extremely high risk of a serious, probably fatal accident. The pilot will be very fortunate to escape from this situation alive and with the aircraft undamaged.

<table>
<thead>
<tr>
<th>Item</th>
<th>Rating</th>
<th>Scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>During the daytime, fly from your local airport to another airport about 150 miles away, in clear weather, in a well-maintained aircraft.</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Jaywalk (cross in the middle of the block) across a busy downtown street.</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Make a two-hour cross-country flight with friends after checking your weight and balance.</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Fly across a large lake or inlet at 500 feet above ground level.</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>At night, take a cross-country flight in which you land with over an hour of fuel remaining.</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Climb up a 10-foot ladder to replace an outside light bulb.</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Fly in clear air at 6,500 feet between two thunderstorms about 25 miles part.</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Take a two-hour sightseeing flight over an area of wooded valleys and hills, at 3,000 above ground level.</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>During the daytime, take a cross-country flight in which you land with 30 minutes of fuel remaining.</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Make a traffic pattern so that you end up turning for final with about a 45 degree bank.</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Drive your car on a freeway near your home at night, at 110 KPH in moderate traffic.</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Take a two-hour flight in a jet aircraft on a major US air carrier.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>During the daytime, take a cross-country flight in which you land with over an hour of fuel remaining.</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>During the daytime, fly from your local airport to another airport about 150 miles away, in a well-maintained aircraft, when the weather is marginal VFR (3 miles visibility and 2,000 foot overcast).</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Fly across a large lake or inlet at 1,500 feet above ground level.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Make a traffic pattern so that you end up turning for final with about a 30 degree bank.</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Drive your car on a freeway near your home, during the day, at 110 KPH in moderate traffic, during heavy rain.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Start a light aircraft with a dead battery by hand-propping it.</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Make a two-hour cross country flight with friends, without checking your weight and balance.</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Drive your car on a freeway near your home during the day, at 110 KPH in moderate traffic.</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>At night, take a cross-country flight in which you land with 30 minutes of fuel remaining.</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Take a two-hour sightseeing flight over an area of wooded valleys and hills, at 1,000 above ground level.</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>At night, fly from your local airport to another airport about 150 miles away, in clear weather, in a well-maintained aircraft.</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Fly across a large lake or inlet at 3,500 feet above ground level.</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Ride an elevator from the ground floor to the 25th floor of an office building</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>At night, fly from your local airport to another airport about 150 miles away, in a well-maintained aircraft, when the weather is marginal VFR (3 miles visibility and 2,000 foot overcast.</td>
<td></td>
</tr>
</tbody>
</table>
Data Pertaining to Serial Order of Test Flights and Accumulative Cognitive Load.

Table 19
*Summary table relating to a series of univariate analyses of variances with order of test flights as the independent variable and the mean minimum altitude or separation from object as the dependent variable (Experiment 3).*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Variation in Cognitive Load</td>
<td>3</td>
<td>92.36</td>
<td>30.79</td>
<td>0.84</td>
</tr>
<tr>
<td>Minimal Variation in Cognitive Load</td>
<td>3</td>
<td>242661.90</td>
<td>80887.30</td>
<td>2.19</td>
</tr>
<tr>
<td>Moderate Variation in Cognitive Load</td>
<td>3</td>
<td>590.38</td>
<td>196.79</td>
<td>0.67</td>
</tr>
<tr>
<td>Significant No Variation in Cognitive Load</td>
<td>3</td>
<td>1.73</td>
<td>.58</td>
<td>1.01</td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01.
Data Pertaining to Zuckerman’s Sensation Seeking Scale.

Table 20
Summary table of a univariate analysis of variance, with training group as the independent variable and scores on Zuckerman’s Sensation Seeking Scale as the dependent variable (Experiment 3).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GROUP</td>
<td>2</td>
<td>220.044</td>
<td>110.022</td>
<td>3.277*</td>
</tr>
<tr>
<td>Error</td>
<td>42</td>
<td>1410.267</td>
<td>33.578</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01
Data Pertaining to Hunter’s Risk Perception Scales.

Table 21
Summary table relating to a series of univariate analyses of variances with training group as the independent variable and the individual factors on Hunter’s Risk Perception Scales as the dependent variable (Experiment 3).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed Risk</td>
<td>2</td>
<td>45.02</td>
<td>22.51</td>
<td>0.20</td>
</tr>
<tr>
<td>Nominal Risk</td>
<td>2</td>
<td>381.94</td>
<td>190.97</td>
<td>0.81</td>
</tr>
<tr>
<td>Immediate High Risk</td>
<td>2</td>
<td>11.91</td>
<td>5.95</td>
<td>0.11</td>
</tr>
<tr>
<td>General Flight Risk</td>
<td>2</td>
<td>364.69</td>
<td>182.34</td>
<td>0.68</td>
</tr>
<tr>
<td>High Flight Risk</td>
<td>2</td>
<td>203.40</td>
<td>101.70</td>
<td>0.76</td>
</tr>
<tr>
<td>Altitude Risk</td>
<td>2</td>
<td>156.59</td>
<td>78.29</td>
<td>0.45</td>
</tr>
<tr>
<td>Driving Risk</td>
<td>2</td>
<td>224.10</td>
<td>112.05</td>
<td>0.55</td>
</tr>
<tr>
<td>Everyday Risk</td>
<td>2</td>
<td>437.36</td>
<td>218.68</td>
<td>0.99</td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01.
SPSS Template for Converting Data from X-Plane Output File to SPSS Version 11 and 11.5.

See Appendix A
Data Pertaining to Traffic Report Flight

Table 22
Summary table of a univariate analysis of variance with training group as the independent variable and the mean absolute roll of the aircraft between one and two nautical miles during the Traffic Report test flight as the dependent variable (Experiment 3).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>SS</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GROUP</td>
<td>2</td>
<td>2.39</td>
<td>1.19</td>
<td>.21</td>
</tr>
<tr>
<td>Error</td>
<td>42</td>
<td>241.64</td>
<td>5.75</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01

Table 23
Summary table of an analysis of covariance with training group (only those participants who could recall similarities between test fight and other flight/s) as the independent variable, participant’s score on the SSS as the covariate and the square root of the mean minimum altitude descended during the Traffic Report test flight as the dependent variable (Experiment 3).

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS</td>
<td>1</td>
<td>55.42</td>
<td>55.421</td>
<td>2.087</td>
</tr>
<tr>
<td>GROUP</td>
<td>2</td>
<td>244.95</td>
<td>122.48</td>
<td>4.61*</td>
</tr>
<tr>
<td>Error</td>
<td>32</td>
<td>849.767</td>
<td>26.555</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01
Data Pertaining to the Train Spotting Flight

Table 24
Summary table of an analysis of covariance, with training group (only those participants who could recall similarities between test flight and other flight/s) as the independent variable, participant’s score on the SSS as the covariate and the mean minimum altitude descended during the Train Spotting test flight as the dependent variable (Experiment 3).

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>Df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS</td>
<td>1</td>
<td>24399.39</td>
<td>24399.39</td>
<td>.59</td>
</tr>
<tr>
<td>GROUP</td>
<td>2</td>
<td>42752.13</td>
<td>21376.07</td>
<td>.51</td>
</tr>
<tr>
<td>Error</td>
<td>31</td>
<td>1293791.85</td>
<td>41735.22</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01
Data Pertaining to Cliff Flight

Table 25
*Summary table of an analysis of covariance with training group (only those participants who could recall similarities between test fight and other flight/s) as the independent variable, participant’s score on the SSS as the covariate and the square root of the minimum separation from the Cliff Face as the dependent variable (Experiment 3).*

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS</td>
<td>1</td>
<td>649.86</td>
<td>649.86</td>
<td>2.26</td>
</tr>
<tr>
<td>GROUP</td>
<td>2</td>
<td>261.27</td>
<td>130.64</td>
<td>.46</td>
</tr>
<tr>
<td>Error</td>
<td>26</td>
<td>7469.71</td>
<td>287.30</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01

Table 26
*Summary table of an analysis of covariance with training group (‘hint’, ‘no hint’ and control) as the independent variable, participant’s score on the SSS as the covariate and the mean minimum altitude to which the participants descended during the Cliff Face test flight as the dependent variable (Experiment 3).*

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS</td>
<td>1</td>
<td>343283.95</td>
<td>343283.95</td>
<td>1.92</td>
</tr>
<tr>
<td>Group</td>
<td>2</td>
<td>13772.75</td>
<td>6886.38</td>
<td>.04</td>
</tr>
<tr>
<td>Error</td>
<td>26</td>
<td>4637931.57</td>
<td>178381.98</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01
Data Pertaining to the Cooling Tower Flight

Table 27
Summary table of an analysis of covariance with training group (only those participants who could recall similarities between test flight and other flight/s) as the independent variable, participant’s score on the SSS as the covariate and the mean minimum separation (log 10) away from Cooling Tower as the dependent variable (Experiment 3).

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS</td>
<td>1</td>
<td>.64</td>
<td>.64</td>
<td>1.18</td>
</tr>
<tr>
<td>GROUP</td>
<td>2</td>
<td>1.05</td>
<td>.52</td>
<td>.96</td>
</tr>
<tr>
<td>Error</td>
<td>27</td>
<td>14.75</td>
<td>.55</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01

Table 28
Summary table of an analysis of covariance with training group (‘hint’, ‘no hint’ and control) as the independent variable, participant’s score on the SSS as the covariate and the mean minimum altitude to which the participants descended during the Cooling Tower test flight as the dependent variable (Experiment 3).

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSS</td>
<td>1</td>
<td>1804.97</td>
<td>1804.97</td>
<td>.02</td>
</tr>
<tr>
<td>Group</td>
<td>2</td>
<td>81674.04</td>
<td>40823.52</td>
<td>.34</td>
</tr>
<tr>
<td>Error</td>
<td>27</td>
<td>3222051.63</td>
<td>119335.25</td>
<td></td>
</tr>
</tbody>
</table>

* indicates p < .05, ** indicates p < .01
Summary of Experiment

The Role of Experience and Prior Exposure in Learning: An Analysis of Private Pilots

Dear

I would like to take this opportunity to thank you for participating in the research project entitled ‘The Role of Experience and Prior Exposure in Learning: An Analysis of Private Pilots’ conducted by Brett Molesworth under the supervision of Dr Mark Wiggins.

In total, there were 45 participants who volunteered their time to assist with the research. The study was the third experiment in a series designed to examine and test potential training methods to improve the risk management behaviour of pilots. The study in which you participated examined the extent to which information acquired during a training task, would generalise to other situations. In addition, the study examined the perceived benefit of providing a ‘hint’ within the aviation training context. Participants were placed in one of three different training groups. The first two training groups involved pilots who were actively involved in the training task and received feedback concerning their performance. In the second week, the first group received a hint as to the similarities between each of the four test flights and the training flight (‘hint’ group), while the second group did not receive any hint as to the similarities (‘no hint’ group). The third group in the experiment acted as a control group. One of the four flights in the second week was a direct reproduction of the experimental groups’ training flight, while the other three test flights were varied based on vertical limitations, horizontal limitations and a combination of both. The main aim of the study was to examine pilots’ risk management behaviour in relation to the vertical and horizontal limitations.

The objective in measuring pilots’ performance was not to ascertain those pilots who would be considered superior, but to examine the impact of the training condition during the first week. Previous research indicates that pilots’ performance from one task to another is primarily based on their ability to recall similarities between the two tasks. Therefore, data from only those pilots who could recall a similar experience/s to the test flights were analysed.

The results were positive, but only for the test flight that was a direct reproduction of the experimental groups’ training flight. Pilots from the ‘hint’ group during this test flight remained, on average at a higher altitude in comparison to those pilots in the ‘no hint’ group and the control group. In relation to the other three flights, no significant differences in pilot performance were noted. These findings are somewhat surprising since it was expected that the second test flight, where pilots were asked to read the number located on the side of the freight train, would yield positive results. In our previous two studies, a similar training flight was employed, where pilots were asked with counting the number of motor vehicles that passed by a house over a ten minute period, followed by a test flight in the succeeding week. The test flight required participants to read a number located on the deck of an oil tanker and the results revealed
a degree of transfer between the two tasks. In comparing the results from experiments one, two and three, there appears to be some inconsistency in the results. Two possible reasons are cited for these inconsistencies, which require further exploration. Firstly, it is not clear if the location of the number on the freight train affected pilots’ performance. Moreover in the first two experiments, the number was located on the deck of the oil tanker (horizontal), while in the current experiment the number was located on the side of the freight train (vertical). The second reason that might explain the differences in the results relate directly to pilots’ risk management behaviour. It is thought that pilots in the first two experiments may have naturally adopted a more risk averse behaviour, since the task they were required to perform was directly over water. In such situation, pilots must anticipate potential problems, such as an engine failure, and adopting a more risk averse behaviour (remaining at a higher average altitude) increases the options available to facilitate the likelihood of a successful outcome.

I would like to, once again, thank you for your time and stress how important your contributions are to improving the level of safety within the general aviation industry.

Regards,

Brett Molesworth