Chapter 1:

Gambling and Gambling Research in History

1.1 The Origins of Gambling

According to Greek legend, the origins of gambling emanated from the shady groves of Olympus. Tyche, the goddess of fortune, was wandering through these groves when, by chance, she encountered an opportunistic Zeus. This union resulted in the birth of an eccentric daughter whose only pleasures lay in inventing games of chance, gloating over the quarrels they caused and encouraging depressed losers to suicide. Tyche also endowed her daughter with houses that had everlasting lamps at their doors to attract passers-by (Jones, 1973).

Despite the best efforts of the ancient Greeks, modern historians generally acknowledge that it is impossible to state with any certainty when gambling first began (Jones, 1973; Wykes, 1964). Gambling is a mental phenomenon involving risk-taking and decision-making; qualities that do not lend themselves to accurate dating methods. The concept of chance is likely to have been a part of Stone Age hunting techniques and, through the ages, the stakes gambled have included food, liberty, body parts, execution dates, wives and children (Jones, 1973; Wykes, 1964). The 20th century understanding of gambling is more refined and typically limits it to
the act of "...staking money on uncertain events driven by chance" (Productivity Commission, 1999, p. 10).

Evidence of games and gambling exists in the earliest records of all six racial groups of humankind (Wykes, 1964). Most of the major developments in gambling appeared thousands of years before the birth of Christ. From Egyptian records there is evidence that gambling dates well before 3000 BC. Astragals (four sided knucklebones), from which dice are derived, were popular in Egypt, Greece and India. Board games that use a form of die have been around for at least 5000 years and six-sided dice were used by the Etruscans and introduced to the Romans before the birth of Christ (Arnold, 1978).

Greek and Roman soldiers also wagered on the turn of numbered chariot wheels in a game similar to stick spinning of the North American Indians and Eskimos. These games, believed to be the precursors of roulette, were later refined by Blaise Pascal, a mathematician, and subsequently introduced to England in 1739, America in the early 19th century and more recently to Australia in 1973 with the opening of the first casino in Tasmania (Blaszczynski, 1988; Dickerson, 1984).

The oldest known Eastern games of chance, China's Wei-ch'i and Japan's Go, emerged around 2300 BC. These high-skill strategy games were often used to make social decisions or policies (Blaszczynski, 1988). Gambling for money or property was usually associated with simpler and quicker games such as drawing lots. There is some evidence that playing cards originated from the East, with suggestions varying between Korea, China and India. Card games reached Europe
around 1377, where the standard pack, familiar today, originated. Card playing was popular in England during the 15th and 16th century reaching such notoriety that Henry VIII declared their play illegal. Columbus introduced cards to America in 1492 which later became the home of legendary 19th century poker and faro players, Wild Bill Hickok and Doc Holliday (Arnold, 1977; Blaszczynski, 1988; Wykes, 1964).

The drawing of lots is of ancient origins (Arnold, 1977; Jones, 1973; Wykes, 1964). Lotteries, as they are termed today, were known to exist in early Roman times. Soldiers cast lots for Christ’s clothing at his crucifixion and lots were used in judicial processes to determine innocence or guilt, division of property and selection for political office. Australian aborigines used a similar process in spinning the ‘bone’ to identify guilty parties. Lotteries also became a popular means of raising government and church revenue. Queen Elizabeth I introduced lotteries to England in 1569 to finance colonisation, coastal fortification and other public projects (Dickerson, 1984). Likewise, Belgium, France and Italy quickly adopted this practice. Lotteries were used to raise funds to support the American war of Independence with George Washington reputedly purchasing the first ticket. In Australia, George Adams ran The Tattersalls Club’s first public sweepstakes on the Sydney Cup in 1881 and 14 years later disposed of a Tasmanian bank’s assets through public lottery (O’Hara, 1988).

The historical records of horse racing are fragmentary but its origins are believed to be “a couple of thousand years older than Christianity”, with Homer, Herodatus, Xenaphones and Ovid counted amongst the earliest of “turf writers”
(Day, 1950, p. 55, cited in Blaszczyński, 1988, p. 3). Chariot races of the style depicted in the film ‘Ben Hur’ were a popular sport. Although organised horse racing occurred in 12th century London, the oldest flat course race was first run in 1512 (Dickerson, 1984). The sport of thoroughbred racing evolved from the breeding interests of Henry VIII in the 15th century but it was under the patronage of James I, during the 17th century, that the sport gained status as a national pastime. James I encouraged public spectators and in the following century the Newmarket Jockey club was formed which led to the formal regulation of horse racing in England.

Horse racing in America appears to have been well established before the Declaration of Independence in 1776 (Day, 1950, cited in Blaszczyński, 1988) and the Kentucky Derby was first run in 1875, followed not long after by the establishment of the American Jockey Club in 1894. Horse racing was common in Australia from 1810 with meetings held at Sydney and Parramatta. The Sydney Turf Club, formed in 1825, and the first running of the Melbourne Cup, in 1861, consolidated the sport as a nationally prominent form of gambling (O’Hara, 1988).

Poker machines, referred to by the British and Americans as fruit machines and slot machines respectively, appeared in America during the late stages of the 19th century (Blaszczyński, 1988; O’Hara, 1988). The success of these machines is attributed to the American inventor Charles Fey, a German immigrant, and the very popular machines he produced around the turn of the century. Nickel-in-the-slot machines were in existence before Fey’s involvement but his mechanical background elevated the structural design of these games and ultimately their popularity (Fey, 1983). Fey’s machines were capable of cash pay-outs, accepted nickels and tokens,
and introduced the successive stopping of the three reels. This delay in the reels provided the element of suspense to the game and, along with the near-miss characteristic and complex symbol combinations, were the precursor of modern game design.

The machine that is most often associated with Charles Fey and modern slots is the ‘Liberty Bell’, created in 1899 (Fey, 1983). This machine was essentially a clone of two earlier machines created by Fey (‘Card Bell’ and ‘Horseshoes’) with the exception of some cosmetic improvements. The 1899 Liberty Bell became the forerunner of more than one million ‘bell’ slot machines, which were manufactured over the next 50 years. The popularity of three-reel bell slot machines spread around the world, most notably in Nevada, United States of America (USA) and New South Wales (NSW), Australia (Connor, 1996a).

The historical development of gambling in Australia since colonisation is comprehensively reviewed by Charlton (1987) and O’Hara (1988). The penchant for gambling was transported to Australia from gambling-obsessed Georgian England. Gambling was present on the voyage of the First Fleet and soldiers as well as convicts gambled prodigiously for entertainment and relief from the hardships imposed by isolated life. A significant feature of gambling in the earliest years of NSW was its survival during economically deprived times. It took some years before there were adequate finances for organised gambling to take place. Today, Australians are considered the most prolific gamblers in the world (Charlton, 1987; Dickerson, 1984; O’Hara, 1988).
The growth of gambling activities is related to its economic impact. Cross-cultural studies have shown that gambling plays an integral role, not only in economically developed societies but also in the cultures where traditions predominate (Jones, 1973, Blaszczynski, 1988). Lesieur (1985) noted that the frequency of gambling in a society paralleled economic advancement, social inequities and industrialisation.

In Australia, Tuckwell (1984) and Haig (1985) suggested that economic variables, such as real wages and unemployment, significantly influence gambling expenditure. Today, the forms of gambling available in developed countries are more expansive than those games listed above and include lotto/pools, lotteries, all sports betting, social and political events. Public access to gambling has also increased and most developed countries have attempted to regulate gambling activities (Dickerson, 1984).

Legislation of gambling activities is a contentious issue with governments enticed by the financial gain in taxes yet are increasingly made aware of the possible social costs. The recent introduction of internet gambling further complicates this issue, along with a growing body of research investigating the prevalence and aetiology of negative effects associated with gambling behaviour.

1.2 Explanations of Gambling Behaviour

The pervasiveness of gambling in modern society has legitimised it as an area of study in its own right. Increased individual involvement and substantial
government revenue raised through the gambling industry are two factors that demonstrate its pervasiveness and validate it as an important social issue. For example, in Australia it has been estimated that 82% of the population gambled at least once in the past year, that the average yearly expenditure on gambling, per capita, was $819 and that the various state governments received a combined sum of $3.8 billion in revenue from gambling taxes (Productivity Commission, 1999).

Clearly, gambling is a behaviour of important social consequence and, in the last 25 years, the number of gambling related studies has increased exponentially. This is evident by the establishment of a refereed journal dedicated to gambling issues (Journal of Gambling Studies, established 1985), Institutes for gambling research (e.g., The Australian Institute for Gambling Research, established 1992) and conferences specifically dealing with gambling related matters (e.g., those organised by The National Association of Gambling Studies, Australia, established 1985). A more recent indication of the growing stature of gambling research is the PhD in Gambling Studies offered by the University of Western Sydney, Macarthur, Australia.

As stated in Chapter 1.1, most of the major developments in gambling activities occurred well before the birth of Christ (Arnold, 1977; Wykes, 1964). However, most of the major developments in the understanding of gambling behaviour have occurred this century (Dickerson, 1984). Explanations for gambling behaviour are as old as the act itself, but were typically framed by the church and other groups in positions of power as criticisms of excessive gambling. There was early recognition of the adverse social, economic and political effects of gambling
and countless attempts to control and limit expenditure. Gamblers were considered to have weak moral characters and an insatiable greed for wealth (Arnold, 1977), but insights into gambling behaviour rarely went beyond these types of moral judgements.

Scientific explanations for gambling behaviour began to emerge at the beginning of the 20th century (Dickerson, 1984). Different theoretical approaches have been proffered and intertwined, including economic, sociological, psychoanalytic, psychiatric and psychological themes. The current diversity in theoretical explanations for gambling is evident in the numerous terms applied to excessive gambling. Pathological, habitual, compulsive, addictive, impaired control and problem gambling are terms that dominate the research literature and reflect the various philosophies. Confounding the conceptualisation of the behaviour is the understanding that gambling is not a homogenous activity across the various forms (Dickerson, 1993). Nonetheless, several general theories of gambling behaviour have been proposed and these represent initial attempts to explain participation.

Most general theories of gambling assume some form of human dissatisfaction or deprivation. Thomas (1901, cited in Dickerson, 1984) argued that the appeal of gambling was due to the presence of certainty in organised society, particularly at work, resulting in an instinctive drive that is satisfied through gambling. Callois (1962) proposed that games of chance provided an outlet when hard work and personal skills were powerless to achieve success. These explanations were based on broad sociological and economic principles that were later refined by others to incorporate individual differences and gambling’s unique character.
Devereux (1968, cited in Dickerson, 1984) proposed two themes of motivation to gamble, one arising from dissatisfaction with economic status and the other associated with the satisfying experience of the gambling activity itself. Similarly, Goffman (1969) focussed on the excitement and activity of gaming houses and emphasised the manner in which the activity of gambling satisfied subjective emotional needs.

Although retaining the role of dissatisfaction, Cornish (1978) also emphasised the practical considerations associated with the decision to select one particular form of gambling over another. He assumed that an initial sense of dissatisfaction (reduced or enhanced by individual differences) generated a readiness to seek out and experience compensatory activities, one of which might be gambling. He noted that individuals differed in their preferred form of gambling and that the initial selection of a particular form of gambling would depend upon the information and facilities available and its associated social class factors. Cornish (1978) proposed that, once participating in a particular form of gambling, the very process of gambling transformed the initial general dissatisfaction into particular motives, whether excitement, skill or entertainment, and then satisfied them.

Other general theories have focused upon the individual and have attempted to explain gambling behaviour through the perceptions and behaviours of gamblers. Edwards (1955) proposed a decision theory and postulated that the selection of bets would be, in part, a function of the person's subjective probability and value estimates. The gambler's fallacy (Cohen, 1972) was based on choice behaviour studies and described the inconsistency between gamblers' expectations of
independent bets and simple probability theory. Langer (1975) introduced the illusion of control concept and predicted that a person would stake higher and persist longer if he or she perceived gambling as skill-determined, if it was a form of gambling well known to them, and if they felt a sense of involvement or competition in the activity. Cummings and Corney (1986) put forward a model based on Fishbein's theory of reasoned action and argued that gambling behaviour was rational and based on the individual's analysis of available information and the accuracy of this information.

Personality and individual difference studies, that have attempted to explain general participation in gambling, retain the basic assumption that gamblers have particular needs which may be fulfilled by gambling (Walker, 1992b). Risk-taking characteristics (Dickerson, Hinchy, & Fabre., 1987; Ladouceur, Mayrand, & Tourigny, 1987), sensation-seeking (Coventry & Brown, 1993; Coventry & Norman, 1997; Zuckerman, 1979), physiological arousal (Anderson & Brown, 1984; Berlyne, 1967), need for achievement (Devinney, 1979), extroversion (Graham & Lowenfeld, 1986) and locus of control (Glass, 1982; Hong & Chiu, 1988; Rotter, 1975) have all been examined in gambling research over the years.

Personality and individual difference studies have not only examined gamblers versus non-gamblers, but also gamblers versus problem gamblers. Studies of problem gambling are more prevalent in the literature and lie in the domain of psychology and psychiatry. One early paper was Von Hattingber's (1914, cited in Dickerson, 1984) proposal that the fear and tension inherent in gambling were sexual in nature, reflecting masochistic tendencies arising from childhood guilt in anal
gratification. Most psychoanalytic explanations centred upon childhood
development, parental conflict, unconscious motivation and the pleasure/pain
principle (Ashton, 1979; Halliday & Fuller, 1974). For example, the infamous
gambling binges of Dostoevsky were explained in terms of a compulsive neurotic
state with origins in the childhood compulsion to masturbate.

The work of Bolen and Boyd (1968) was instrumental in drawing the
attention of psychiatrists, particularly in the USA, to the problems of regular
gamblers who sought help. Apart from endorsing psychoanalytic theorising, they
concluded that it was more appropriate to view pathological gambling as a complex
symptom to be found in a wide variety of psychiatric disorders, rather than to
diagnose it as a specific disorder in its own right. This position is now reversed, with
pathological gambling defined as a separate impulse disorder. Rather than attempt to
explain pathological gambling as psychoanalysis did, psychiatry has been more
concerned with defining pathological gambling by identifying types of pathological
gambling, differences between pathological and ‘regular’ gamblers and the
similarities between pathological gamblers and substance addicts (Custer, 1982;
Dickerson, 1984).

The dominant psychological explanations for pathological gambling have
centred upon behavioural and cognitive principles, individual personality, and
emotional differences. The work of Skinner (1953) is often associated with
behavioural explanations and, in particular, the persistence in response rates
generated by intermittent schedules of reinforcement and other structural
characteristics of the game (Cornish, 1978; Delfabbro & Winefield, 1999; Dickerson.

The application of cognitive theory to gambling behaviour has typically focussed on the beliefs gamblers have about strategies for play, luck, controlling outcomes, and their level of skill and knowledge (Dickerson & Adcock, 1987; Gaboury & Ladouceur, 1989; Ladouceur, Gaboury, Bujold, Lachance, & Tremblay, 1991; Ladouceur, Gaboury, Dumont, & Rochette, 1988; Griffiths, 1990a; Griffiths, 1994; Walker, 1992a). Cognitive theorists have suggested the reasoning of gamblers involve invalid or erroneous beliefs and that the results of their own gambles are used to support the validity of these beliefs.

Numerous studies have looked at the role of personality variables in compulsive gambling, such as impulsivity (Blaszczynski, 1988; Blaszczynski, Steele, & McConaghy, 1997; Steele & Blaszczynski, 1997), sensation-seeking (Blaszczynski, Wilson, & McConaghy, 1986; Kuley & Jacobs, 1988) and extroversion (Blaszczynski et al., 1986; McConaghy, Armstrong, Blaszczynski, & Allcock, 1983).

Furthermore, negative mood states, such as anxiety, stress, and depression have been examined in studies of problem gambling (Graham & Lowenfeld, 1986; Griffiths, 1995; McCormick, Russo, Ramirez, & Taber, 1984). More recently, a model of subjective expected emotion, based on a normative theory of risky choice has been developed by Mellers, Schwartz, and Ritov (1998).
Despite the apparent abundance of publications on gambling behaviour, and
in particular problem gambling, the explanatory power of the net result is weak.
Numerous theories have been proposed with dubious conceptual bases and without
rigorous empirical support. From the gambling literature almost any argument can be
drawn with various levels of empirical support and counter-argued with equally
convincing evidence. Few lawful relations have been established and, rather than a
progressive depth of knowledge being established, the literature is marked by an
ever-increasing breadth of research and a failure to integrate. A recent paper by
Dickerson and Baron (2000) conveyed a similar appraisal of the state of the art in
gambling research.

Dickerson and Baron (2000) were critical of the low proportion of research
carrying out the basic task of scientific investigation into psychological constructs
and gambling behaviour. This was explained by the dominance of the pathology
conceptualisation in psychological explanations for gambling, and it was noted that
research methods associated with the mental disorder concept are limited, typically
dependent upon retrospective reports and obscure operational definitions of the
variables under study. Dickerson and Baron (2000) proposed a rejection of the
pathology theme, and instead advocated an integration with known psychological
principles;

"For over a quarter of a century in every other domain of psychological
research mental disorder concepts have generally been rejected in favour of
psychologically relevant and theoretically appropriate constructs. In Cattell’s (1965)
terms psychological research into gambling seems determined to remain an isolated
'shanty town' destructively failing to integrate with the main body of the discipline
(Dickerson & Baron, 2000, p. 7).

Dickerson and Baron (2000) outlined a model of gambling processes that
drew upon the addiction literature and established findings in gambling research. The
focus of their non-recursive model was the construct of self-control/choice and its
interdependence with gambling involvement. Their causal model acknowledged the
additive relationship between key psychological variables and the distinction
between heavy gambling and problem gambling. Furthermore, Dickerson and Baron
(2000) proposed a methodology that aspires to a quantitative rigour absent in the
literature by considering design issues, often raised by gambling researchers but also
often ignored. In an earlier paper, Dickerson (1993) stated that;

"The paucity of substantive research findings can be linked with three
common and erroneous assumptions: 1) that the universe of gamblers is comprised
of two distinct groups, the pathological and the infrequent or social gambler 2) that
the findings of laboratory games can be generalised to real-life gambling and 3) that
gambling is a homogeneous class of behaviours" (p. 231).

To fully understand Dickerson's (1993) comments, the inadequate doctrinaire
approach adopted by most scholarly investigators needs to be contrasted with
initiatives undertaken by the gambling industry. Although research publications from
the gambling industry are rare, the creation of research apparatus by the industry
suggests a focus on practicalities and methodologies commensurate with Dickerson's
(1993) comments. For example, gaming machines are designed with the ability to
record aggregated playing information and computer tracking devices provide details about individual player’s gaming patterns. This information compliments other research undertaken, such as surveys and focus groups (Taylor-Parets & Bos, 1996). Thus, by integrating information obtained from real settings, from all types of players of one particular form, the gaming machine industry has adopted a research strategy that satisfies Dickerson’s (1993) criteria.

Furthermore, there exists some conflict between the actions of the gaming machine industry and the findings of published literature. This has implications for non-industry research. For example, continuity of play (time elapsed between bet placement and outcome) is considered a key component of gaming machine play (Cornish, 1978; Dickerson, 1993; Walker, 1992b) yet despite the ability to increase the continuity of play (reduce the time elapsed) via electronic machines and button presses, the industry has maintained a reel speed similar to that of 20-30 years ago (Bos, 1997). From this evidence, it would appear that scholarly investigators need to pay particular attention to the methodological issues of gambling research to adequately test theoretical principles of gambling behaviour.

1.3 Methodological Issues in Gambling Research

The scientific enterprise is based on the rationale that there are consistencies in events that can be revealed through rigorous research methodologies (Salkind, 2000; Weiten, 1995). There exist numerous empirical designs utilised to reveal these laws but there is also an understanding that these laws are sensitive to the context in which the event is studied (e.g., Einstein demonstrated that Newton’s law of gravity
failed to apply in certain circumstances). It therefore becomes difficult to make applicable statements about either causality or prediction in the absence of identifying contextual structures and relevant factors associated with the experience.

One of the major findings of gambling research has been the understanding that gambling behaviour is contextually sensitive and related to the ecological validity of the research design (Anderson & Brown, 1984). This concept of ecological validity not only refers to the context of the gambling behaviour but also to the characteristics of the participants (e.g., level of gambling involvement). Gambling occurs in gambling environments such as casinos, betting shops, clubs and hotels. It always takes place for real sums of money, both as staked and as won, and a full understanding of gambling will only come from the study of the whole range of gamblers, and not simply the novices or the pathological (Dickerson, 1993; Leary & Dickerson, 1985). Thus, serious validity doubts must be cast over studies conducted with students in simulated gambling environments for bogus money, small prizes, or course credit and those involving retrospective accounts of problem gamblers seeking treatment. These studies add little of relevance to the understanding of real gambling behaviours of genuine gamblers in their usual environments.

Anderson and Brown (1984), Dickerson (1993), and Leary and Dickerson (1985) noted that few studies using simulated gambling environments have attempted to verify that the pleasure, excitement and expectations felt in the genuine gambling environment are replicated in the simulation. This is in spite of early theorising suggesting the importance of excitement and arousal in the motivation to gamble (Custer, 1982; Goffman, 1969). Laboratory studies of the arousal of students
‘gambling’ with provided tokens have found insignificant changes in physiological indices, such as heart rate, during play (Rule, Nutter, & Fischer, 1971).

The more recent field study by Anderson and Brown (1984) highlighted the tenuous nature of generalising across samples and situations. Using a laboratory casino, they found that students and regular gamblers playing blackjack for prizes showed the previously established insignificant heart rate changes of approximately 4-7 beats per minutes. However, these same regular gamblers, when observed playing in their own club, gave a mean heart rate increase of 23.1 bpm, with some individuals ranging to an increase of 58 bpm. Furthermore, predicted relationships between stake size and scores on a sensation-seeking scale were not supported for either group in the laboratory but were strongly confirmed for the regular gamblers in the field setting ($r = .57$). Finally, it was also found that playing strategies were context sensitive. In the laboratory, the majority of players (61%) increased their stake size when behind, whereas in the casino, the majority of players (75%) increased their stake size when winning. These results are commensurate with the interpretation that genuine gambling environments are significantly different to simulated environments used in laboratory experiments.

Further evidence for the importance of ecologically valid designs was found in the study of the illusion of control concept (Langer, 1975). This concept is defined as a belief in one’s ability to control chance outcomes and may well be one of the most important cognitive components of gambling. Langer’s (1975) sequence of studies demonstrating the different aspects of the phenomena were all conducted in the field, however, Langer (1975) noted that in preliminary, laboratory, and less
realistic studies, the illusion had been difficult to substantiate. Relevant factors present in the field were not present in the simulated gambling environment.

Anderson and Brown (1984) suggested a number of relevant factors in laboratory simulated gambling which might differ from gambling in its usual environment. First, the aspirations of gamblers in their usual environment may be quite different. For example, holidays, new cars or large money prizes are offered in some competitions, whereas the students’ aspirations may be a percentage point credit towards their course grade, or perhaps $10 or $20 if they win the game. Secondly, real gambling implies the risk of personal monetary loss whereas laboratory gambling usually does not. Finally, laboratory studies usually ignore personality differences, group behaviours, and the way in which these interact with the actual gambling behaviour.

Retrospective accounts from problem gamblers also hold the potential for questionable results. Dickerson (1993) noted that much of the research on the fundamental question of why problem gamblers risk such great losses is conducted retrospectively with people receiving therapy for their problem. Many studies are based on questionnaires completed by members of Gamblers Anonymous. Others use gamblers in treatment to analyse the differences between social and problems gamblers. The use of gamblers in treatment or gamblers who may not have gambled for many years in studies of causation, prediction or even description of the phenomenon of heavy gambling, brings with it the risk of errors of memory and errors of interpretation. For example, Langer’s (1975) research suggested that
gamblers' cognitions are sensitive to the context of testing and it is cognitions, rather than observable behaviours, that are being measured in self-report designs.

Dickerson (1993) commented further upon methodological issues in gambling research, stating that:

"Implicit in much of the work on excessive or pathological gambling has been the assumption that impaired control arises in a similar fashion, whether the person plays poker machines, bets, plays roulette or engages in another preferred form of gambling. Given the very different stimulus and temporal characteristics of the different forms, such an assumption has poor face validity. It is further undermined by the fact that some gamblers use one form exclusively, showing impaired control of that form and that form alone" (p. 226).

Dickerson (1993) advocated the use of discriminating between continuous and discontinuous forms of gambling. The latter is typified by lotto or lotteries where there is a considerable period of time between the staking of a bet and the determination of the result, whereas the former is associated with the opportunity to have a session comprising many sequences of stake, play and outcome (e.g., off-course betting, poker machines, blackjack, roulette, etc.). By acknowledging that various forms of gambling may represent a heterogeneous set of behaviours, Dickerson (1993) argued that relationships between stimulus conditions and gambler responses could be identified. The net result of this is a better understanding of the maintenance of gambling behaviour.
Dickerson (1993) also identified the dimension of skill within the various forms of gambling as a relevant factor in gambling behaviour. On a continuum from ‘no skill’ to ‘all skill’, games like slot machines, lotto and lotteries are clearly at the end of the former, whereas betting on horse racing and card games involves both skill and chance determinants of outcomes. The importance of this dimension is that beliefs about individual skill and attribution of outcomes may not only affect cognition, but also have a significant impact on gambling behaviour. Furthermore, situational factors such as variability in the gambling sequence involving timing, stake size, and the presence of gambling stimuli (e.g., other players winning), all contribute to very different learning situations. Similarly, the subjective experience of the gambler may well vary from one form to another. The relationship of the gambler with the machine, the croupier, or an opponent as in poker, may be relevant factors in the understanding of gambling behaviour.

Two conclusions may be drawn from Dickerson’s (1993) comments. First, given the complexities of generalising gambling research results to other situations, it appears judicious to give more credit to field studies of genuine gamblers than to laboratory studies of students and non-gamblers or retrospective studies of gamblers in treatment. Second, Dickerson’s (1993) criteria may be used as a framework for conducting and appraising gambling studies. He recommended the use of participants who already gamble as part of their leisure activity, the study of participants when gambling with their own money, and the study of participants when gambling using their preferred form. This was to ensure that all the relevant components of the gambling environment are realistic (e.g., the sums of money that may be won or lost, the equipment used, the temporal sequence of stake, play and outcome).
The criteria for ecologically valid research, set out by Dickerson (1993), may appear extreme with its emphasis on external validity that could impede research progress. However, it must be remembered that gambling is a social phenomenon and application of results to the real world is a necessity, not just a possibility. The study of gambling requires a concern for actionable factors, a search for robust results, and recognition that multiple methodologies may need to be undertaken. One of the challenges in carrying out investigations in the real world is in seeking to conclude something sensible about a complex, relatively poorly controlled and generally 'messy' situation (Robson, 1993). Typically, an inverse relationship exists between the external and internal validity of research. By maximising the external validity of results, it could be argued that their internal validity is seriously jeopardised. However, computer software and statistical techniques now allow for greater control of variables, the testing of non-recursive relationships, and the ability to account for hierarchically structured data. These overcome much of the criticism of the ecologically valid approach, such as the issue of low internal validity.

As mentioned above, Dickerson and Baron (2000) have already outlined a rigorous procedure from their work on poker machine players (e.g., Dickerson et al., 1991; Dickerson et al., 1992a; Dickerson et al., 1992b). The predictive powers of the hypothesised model are not yet known, nor whether it is transferable across the various gambling forms. Nevertheless, Dickerson and Baron's (2000) choice of poker machine players for initial testing indicates the potential of the gaming machine environment to lend itself to real world research. Their choice of gaming machines also reflects the importance that this form of gambling has achieved in gambling research. Of all the forms of gambling, gaming machines have had the
most significant impact on gambling in the 20th century. The popularity and
profitability of these devices has played a major role in the growth of gambling
worldwide. Scarne (1975) commented that gaming machines are "... without doubt
gambling's most consistent money maker. There has never been any other gambling
device which has produced such enormous profits with so little effort on the part of
the operator" (p. 430).

This is no more evident than in Australia. Australia is a country with less than
0.5% of the world's population, yet operates 21% of the world's slot machines
(Productivity Commission, 1999). Growth in the popularity of this form of gambling
has seen expenditure on gaming machines reach 52% of net gambling expenditure
(excluding gaming machines in casinos). In per capita terms, each Australian over
the age of 18 spends more than $420 per year on gaming machines (in venues other
than casinos). This compares with $160 on casino products, $120 on racing products
and less than $100 per year on lottery and other gambling products. It has also been
estimated that 2.82% of those who gambled in the past year are problem gamblers,
but this figure doubles to 5.15% when considering those who played gaming
machines (Productivity Commission, 1999). Clearly, poker machines are an
important component of the gambling culture in Australia.
Chapter 2:

Poker Machines and Poker Machine Players

2.1 Poker Machines in the Australian Context

Effective gambling research not only requires an understanding of the methodological issues pertinent to gambling, but also a thorough understanding of the form of gambling being researched. The design theory and technology of gaming machines have behavioural implications for the players and may contribute to explanations of research results. Typically, those conducting gaming machine research have been content with providing a cursory description of the product, rarely going beyond statements likening it to a simple operant chamber.

This view permeates through the psychological literature despite the fact that gaming machines have undergone significant structural changes since their creation. These changes represent new and complex stimuli and, consequently, new and complex responses. Furthermore, the context in which gaming machine playing behaviour occurs, the gaming venue, has rarely been considered as a variable in studies of gaming behaviour.

Gaming machines are mechanical, electrical or electronic devices into which coins or tokens are placed and from which prizes are won (Kelly, 1996a). This broad
definition encompasses a variety of machines including slots, video draw poker, pachinko, pachislo, blackjack and more recently traditional casino games such as roulette, pai-gow, and sic-bo. The terms video gaming machines (VGM), electronic gaming machines (EGM) and approved amusement devices (AAD) are also used in different jurisdictions to describe certain subgroups of gaming machines. Despite the apparent variations in gaming machines, the dominant type of machines in Australia are a group of EGMs commonly referred to as slots (Connor, 1996a).

Slots are gaming machines characterised by three or more spinning reels, each containing symbols of various worth that provide prizes (usually cash) at random. They have low running costs compared to other forms of gambling and contribute greatest to gaming venue profits. Slot machines have gained such importance in the gaming industry that casino revenue from slots are typically 50-80% of total revenue (Connor, 1996a). Their speed of play and spend rate is higher than other types of gaming machines, and this distinction has led them to be referred to as ‘high intensity’ games by the Australian Productivity Commission (Productivity Commission, 1999).

The first slot machines were placed in bars and taverns in San Francisco, USA, in the early 1890s. The first popular slot innovation was the three-reel mechanism with automatic pay-out created by Charles Fey in 1895 (Connor, 1996b; Fey, 1983). Although the same fundamental characteristics of the early slots are still found today, there are numerous structural and cosmetic variations across jurisdictions.
Slots originated in the USA, but today exist in many countries along with other similar machines known as amusement with prizes (AWP), which are non-cash pay-out machines (Kelly, 1996b). Gaming machines in the United Kingdom, Germany, Spain, and Japan are considered as AWP machines whereas South Africa, New Zealand, France, Canada, Australia and the USA are home to the majority of slots (Productivity Commission, 1999). In Australia, slot machines are referred to as poker machines after the dominant symbols displayed on the reels, playing cards. These machines differ from the USA-styled machines by possessing five reels, instead of three and, in general, are more sophisticated offering a greater number of playing options (Sorrell, 1999; Sutherland, 1997).

There are also differences across jurisdictions in the venues where slot machines are played (Kelly, 1996b). In the USA, slots are largely in casinos; in European countries, AWPs exist in amusement arcades, restaurants, corner stores, bars, and cafés, and in Australia, poker machines are primarily found in registered clubs and hotels. Even within each country, there are differences in the structure of the gaming machine dependent upon state jurisdictional requirements. For example, in Australia, poker machines are available in seven of the eight states and territories but differ in accordance with state laws. Note acceptors (or bill acceptors) are common on machines in NSW but are not permitted on machines in South Australia. The maximum stake size on machines in Queensland is restricted to $5 but can be as high as $10 in NSW.

Of the eight Australian states and territories, the NSW government has been the most liberal with structural changes to poker machine design (Sutherland, 1997).
The NSW gaming machine market is the most mature and there are more poker machines in that state than in all others combined. Of the 184,526 poker machines operating in Australia almost 100,000 are in NSW gaming venues (Productivity Commission, 1999). This figure represents about 10% of all slot machines in the world and is the third largest slot machine jurisdiction after the states of Nevada and Colorado, USA.

Almost 40% of adult residents in NSW play the poker machines at least once per year and their expenditure ($635.98 per capita) accounts for 66% of the total gambling per capita expenditure in that state. In 1997/1998, the NSW government received $689.77 million in taxed revenue from poker machine play with the majority of this generated by the registered clubs of NSW. These organisations possess 61% of that state’s poker machines and represent the major venues for poker machine play (Productivity Commission, 1999).

The NSW registered clubs are non-profit organisations providing various services to the community. In 1997, 1500 registered clubs generated $2 billion dollars in poker machine profits and these profits were used to subsidise food and beverages within the clubs, pay for refurbishment of club premises and sponsor community groups. One third of NSW adult residents are members of a registered club with the largest club holding a membership base of around 75,000. These clubs are located in city suburbs, rural and coastal towns and typically operate 7 days per week, with some of the larger clubs licensed to operate 24 hours per day.
Machines in NSW clubs average around $34,000 per year each in profit with the top 200 clubs in NSW generating an average profit per machine of $44,000 each year (Kelly, 1998). At a cost ranging between $10,000 and $15,000 per machine and with minimal operating expenses, the seemingly short ‘life expectancy’ of 2 years per machine still provides generous profits (Kelly, 1998). The largest club in NSW currently operates over 1000 gaming machines, with the majority from four major manufacturers. The NSW clubs, in conjunction with these manufacturers, have played a major role in the development of the poker machine and in the shaping of poker machine playing behaviour.

2.2 The Development of Poker Machines in New South Wales

The NSW government enacted legislation on July 31, 1956 that authorised the use of poker machines in registered clubs. Prior to this, the poker machine endured a chequered passage through NSW clubs and hotels.

The development of poker machines in NSW is comprehensively reviewed by Charlton (1987), O’Hara (1988) and Vibert (1986). Poker machines began appearing in NSW clubs and hotels during the early 1920s but were declared illegal by the Supreme Court. The ruling centred upon the illegality of individuals profiteering from gaming devices, which affected hoteliers directly but provided a loophole for registered clubs. No individual benefited from club profits and the clubs were able to increase the number of machines up until 1932. In that year, the results of a Royal Commission inquiry into gaming recommended the total ban of poker machines in NSW. Seven years later, machines returned to clubs under the earlier
Supreme Court ruling and gradually grew in popularity, providing enormous profits for these organisations.

Recognising the potential of poker machines as a source of revenue, the NSW government officially legalised poker machines in 1956. This decision attracted some criticism from religious organisations but the revenue advantages were difficult to ignore for the beneficiaries such as hospitals, the ambulance service, and the Returned Servicemen’s League. Indeed, in the following 40 years, several billions of dollars were generated by poker machine profits in clubs. For example, in 1957, 952 NSW clubs operated 5596 poker machines and generated $1.5 million in revenue for the state. In 1997, 1453 clubs operated 74,000 machines and contributed $400 million toward state revenue (Department of Gaming and Racing, 1998).

Changes in the accessibility and number of machines have no doubt played a major role in the frequency of gambling behaviour and the success of the poker machine. However, technological advances have altered the structural characteristics of the poker machine further contributing to their continued popularity. As mentioned in Chapter 1.1, Charles Fey’s highly successful Liberty Bell machine was a cosmetically enhanced clone of an earlier, less successful, machine.

Poker machines of the late 1950s were available in 5-cent, 10-cent and 20-cent denominations and operated by pulling a side lever to start the three reels spinning. On most machines, each reel contained 20 stops or symbols providing 8000 combinations. Once the reels ceased spinning, the combination of centre line symbols, from left to right, determined whether a win had occurred. However, unlike
the heavily regulated gaming machine industry today, there were no government controls on the pay-back ratio of the machines or the prizes offered (Vibert, 1986).

It was also around this time that findings from experimental psychology were first applied to poker machine play. The dominant paradigm within psychology was behaviourism and Skinner (1953) likened the poker machine to his operant chamber or ‘Skinner box’. Based on the results of animal studies, Skinner (1953) reasoned that persistent poker machine play was a function of the intermittent schedules of reinforcement inherent in all machines. Later empirical studies by Lewis and Duncan (1958) considered the role of intermittent schedules of reinforcement in persistent poker machine play and concluded that the lower the ratio of reinforcement and the larger the reward, the more persistent the behaviour. However, the poker machine and experimental design used in these studies were far removed from the gambling experience in gaming venues at the time, and even further from the gaming machine experience of today.

Today’s poker machines are all microprocessor-controlled with video graphics simulating the mechanical operation of earlier machines. They are available in eight denominations (1-cent, 2-cent, 5-cent, 10-cent, 20-cent, 50-cent, $1 and $2) although the majority of machines in NSW clubs are of the 1-cent, 2-cent, 5-cent, 10-cent and $1 variety (Department of Gaming and Racing, 1998). All denominations are tokenised and an increasing number have bill acceptors. That is, the player must either place $1 coins in the machine and receive credits (e.g., on a 2-cent machine each dollar inserted equals 50 machine credits) or if the machine has a bill acceptor the player may insert a polymer note of any value (from $5 to $100) and receive
credits. No machine requires lever pulling and most machines contain a video simulation of five spinning reels set inside a variety of cabinet designs. Reel speed can be adjusted but is typically set to 3 seconds from game start to game end. A small percentage of machines also have multiple games available within the one cabinet.

Winning combinations are no longer restricted to the centre line, but up to 25 combinations of pay-lines across the five reels may be bought by the player. Each pay-line costs the player 1 machine credit. Players can also multiply the amount staked per line up to 100 times, depending upon the machine which must be designed to have a maximum stake no greater than $10. This combination of pay-lines by bet multiplication is often referred to as a machine’s credit variation or multiplier potential. A machine with a maximum of 9 pay-lines and a maximum bet multiplication of 10 is referred to as being of a 90-credit variation. Thus, today’s player may insert a $20 note into a 2-cent machine (for 1000 credits), select 9 pay-lines (9 credits or 18 cents) and multiply this by 5, thereby staking 45 credits or 90 cents per button press. Some machines offer a variation to the button press by allowing for a touch screen placement of bets.

Modern machines have fewer symbols per reel than the earlier types, but the increase in the number of reels has led to an increase in the number of symbol combinations. A five-reel machine with only 10 symbols per reel has 100,000 combinations compared to the 8000 of the earlier three-reel example with 20 symbols per reel. If a prize is won, the modern machine will play a digitised ‘winning’ tune and the player has the option to gamble this amount. The gamble
feature may best be described as a ‘double-or-nothing’ option, although some machines offer the opportunity to gamble half of the winning amount or more recently the opportunity to ‘quadruple-or-nothing’ the win. By law, ‘gambling’ may only continue a maximum of 5 times per initial win.

A large number of machines have bonus features, which provide the player with free spins/free games or a second-screen game. A certain winning reel combination will initiate the bonus feature and allow the player to increase the amount won. There is a great deal of variety in the type of bonus feature available on poker machines. However, these may be classified into three groups.

The ‘no-response’ bonus feature automatically initiates and ceases the bonus feature without any response required from the player. This type of bonus feature is usually in the form of free games/free spins or an animated substitute across all displaying symbols. With this bonus feature, the player is not required to make a response for the completion of the feature.

The ‘second-screen’ feature is also known as a game-within-a-game feature. Machines with this feature require a response from the player, which may be described as ‘pick-a-box’, although the box is usually represented by some symbol related to the theme of the machine. The player is presented with several ‘boxes’, on the video screen, that contain hidden prizes of various values. The size of the prize is dependent upon the selection made and the player must select a box before returning to the regular game.
The third group comprises those machines with no bonus feature at all. They may contain special symbols that act as substitutes for other symbols or paying scatter symbols, but these do not interfere with the normal playing of the game. Essentially, this group represents those machines with an absence of the no-response and second-screen bonus feature.

The frequency in which the bonus feature occurs varies dramatically from machine to machine and is sensitive to the number of pay-lines played within each machine. For example, the feature frequency of a machine currently available is 1/104 if 5 lines are played and 1/58 if 9 lines played (i.e., the bonus feature appears on average after every 58\textsuperscript{th} button press). Manufacturers typically report a machine’s feature frequency if played using the maximum number of lines available and, from the specifications of 46 different games, this figure ranged from 1/35 to 1/243.

The ‘hit rate’ or occurrence of winning symbols during regular play is subject to the same conditions as feature frequency and is also sensitive to the return rate of the machine. In NSW, machines are carded (return rate) to return at least 85\% of the turnover in winnings. The return rate of an individual machine is therefore largely determined by the gaming venue upon purchase. Some machines are available in up to six different return rate settings, yet the hit rate does not vary greatly, if at all, across these settings and may be dependent upon the pay-out structure. For example, a current popular machine if carded at 85.01\% will have a hit rate of 1/11.8 but when carded at 95.02\%, the hit rate increases slightly to 1/11.2. That is, a paying combination of symbols (a hit) will occur, on average, every 0.6 games more frequently when playing the maximum number of lines on the machine if carded at
95.02%. This is because the method for increasing the return rate of a machine
usually involves replacing a symbol of a lower value with that of a higher value. The
small change in hit rate is a function of the position of the reel where the symbol
change has occurred.

However, changes in hit rates are far more dramatic when the number of lines
played is altered. For example, the same machine when carded at 95.02% will have a
hit rate of 1/11.2 when playing 9 lines, but this decreases to 1/20.2 when playing 5
lines and 1/100.8 when only playing 1 line. The difference in hit rates between
machines is also quite large. Analysis of 46 machines from three major
manufacturers revealed that hit rates across machines (when playing the maximum
number of lines) varies between 1/4 and 1/13 with a mean of 1/8.5. However, it is
important to note that poker machines are extremely volatile and these specifications
are averages based on 1,000,000 plays. Even after 1,000,000 plays, the return rate
may vary by as much as plus or minus 3.5% from the carded percentage of the
machine. During the first 50,000 plays it may be as large as plus or minus 17% of the
carded percentage.

The maximum prize available on a stand-alone poker machine in NSW is
$10,000, although if the machine is linked to other machines, this may be as high as
$100,000. The size of the prize offered by machines linked to a cashcade jackpot is
determined by the gaming venue, as is the collect limit setting. This refers to the
minimum dollar amount in the machine that requires manual pay-out, and does not
allow the player to automatically receive the winnings from the machine’s coin
dispenser.
The increase in stimuli on poker machines has led to behavioural changes for the poker machine player. The complexity of the modern game presents a range of responses that were previously unavailable. This may be illustrated via a comparison of betting options between machines from different eras. Tables 2.1 and 2.2 display matrices of responses related to the multiplier potential of machines. The percentage figures in Table 2.2 are from a 5-cent machine with a 90-credit variation operating in a club in 1994.

Table 2.1

<table>
<thead>
<tr>
<th></th>
<th>1 Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bet 1</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 2.2

<table>
<thead>
<tr>
<th></th>
<th>1 Line</th>
<th>3 Lines</th>
<th>5 Lines</th>
<th>7 Lines</th>
<th>9 Lines</th>
<th>Bet Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bet 1</td>
<td>4.70%</td>
<td>1.52%</td>
<td>9.31%</td>
<td>2.95%</td>
<td>41.23%</td>
<td>59.71%</td>
</tr>
<tr>
<td>Bet 2</td>
<td>0.50%</td>
<td>0.28%</td>
<td>2.94%</td>
<td>0.52%</td>
<td>15.39%</td>
<td>19.63%</td>
</tr>
<tr>
<td>Bet 3</td>
<td>0.07%</td>
<td>0.09%</td>
<td>0.98%</td>
<td>0.41%</td>
<td>8.56%</td>
<td>10.11%</td>
</tr>
<tr>
<td>Bet 5</td>
<td>0.11%</td>
<td>0.06%</td>
<td>0.43%</td>
<td>0.12%</td>
<td>5.83%</td>
<td>6.55%</td>
</tr>
<tr>
<td>Bet 10</td>
<td>0.13%</td>
<td>0.10%</td>
<td>0.11%</td>
<td>0.04%</td>
<td>3.61%</td>
<td>3.96%</td>
</tr>
<tr>
<td>Line Total</td>
<td>5.52%</td>
<td>2.06%</td>
<td>13.78%</td>
<td>4.03%</td>
<td>74.62%</td>
<td></td>
</tr>
</tbody>
</table>

As shown in Table 2.1, the staking pattern of players was fixed in early machines. There was no response variation available with all players staking identical amounts. However, the 5 x 5 matrix for modern machines shows that the modern poker machine player has a range of stake sizes available, and can comprise
several combinations of the bet multiplication and pay-line features. The frequency of response figures displayed in this matrix not only highlight the variance in responses made on modern machines, but also raise questions about choice and decision making in player staking behaviour.

To further illustrate the complexity of modern poker machine play, Figures 2.1 and 2.2 display possible response chains for machines from different eras.
Figure 2.1. Alternating sequence of stimuli and responses available in poker machine play (until circa 1970).

Figure 2.2. Alternating sequence of stimuli and responses available in current poker machine play.
The sequences of behaviour depicted in the above figures reflect the increased level of involvement in the game for the modern player. Although the discriminative and reinforcing properties of each stimulus have not been proven, the structural changes (Figure 2.2) present a series of stimuli that require a variety of responses from the player. These changes have altered the playing experience, yet there is little available research examining their effect on playing behaviour, such as expenditure patterns.

It could be argued that the industry's motive for such structural changes was to increase the profitability of the machine. This would suggest that machine changes have had some effect on player expenditure, either via increases in the size of bets or increases in the time spent playing. Over the past 40 years, both the competition for the gambling dollar and state taxes have increased dramatically, yet the poker machine, and the clubs that rely upon them, have continued to thrive. This raises further questions about the relationship between structural changes and machine performance.

2.3 Structural Changes and Machine Performance

The association between the registered clubs and the gaming machine manufacturers in NSW has been fundamental to the evolution of the modern poker machine (Sutherland, 1997). Competition for the gambling dollar has increased dramatically over the past 40 years with the introduction of other forms of gambling such as soccer pools, lotto, instant lotteries, keno and the recent establishment of a casino in Sydney. The structural changes to the machines, discussed above, represent
attempts by the gaming machine industry to increase the appeal of the poker machine and the revenue gained.

Poker machine turnover in NSW clubs has increased 182% between 1973 and 1994 (after removing the effects of inflation). There is no doubt that a large proportion of this is due to the 72% increase in the number of poker machines in NSW (Tasmanian Gaming Commission, 1995). However, estimates of the future gaming machine market in Australia and New Zealand suggest that this market will reach saturation point in the year 2000 (Sutherland, 1997). Given that most market gains are going to be made in the states outside of NSW that have recently introduced poker machines, merely increasing the number of poker machines available is unlikely to promote growth for the NSW gaming industry.

It is of interest that during the same period (1973-1994), turnover per poker machine also increased (43%), with the majority of this increase occurring in the few years after 1990 (Department of Gaming and Racing, 1995). Unlike increases in total turnover, it cannot be argued that an increase in turnover per machine is attributable to an increase in the number of machines available. If anything, an opposite effect would be a more reasonable hypothesis (i.e., poker machine growth less than population growth).

Similarly, during the period 1990-1994 the player:machine ratio decreased slightly from 79 players for every 1 machine in 1991 to a figure of 76:1 in 1994. Thus, it cannot be argued that the increase in turnover per machine for this period was the result of the availability of more players per machine. The number of
registered clubs also decreased slightly (3.3%) and, although this is due in part to the amalgamation of clubs, it is difficult to find support for the argument that the increase in poker machine performance was due to the presence of more gaming venues. The possibility that increases in income provided a larger proportion of household income being spent of gambling is also not supported by the very low 0.01% increase in expenditure on all other forms of gambling (i.e., not poker machines) for the same period (Department of Gaming and Racing, 1995; Tasmanian Gaming Commission, 1995).

There is the possibility that the clubs engaged in advertising and other marketing strategies to promote play during this period and they may have also extended their operating hours. However, when examining possible explanations for an increase in turnover per poker machine, the structural changes to poker machine design must also be considered. These features may increase the appeal of poker machine play, thereby attracting more players, and may also promote expenditure of individual players. It would, thus, be expected that the introduction of major structural changes to game design would precede growth in turnover per machine figures.

Utilising figures from the NSW Department of Gaming and Racing (1995) and the Tasmanian Gaming Commission (1995), a chronology of machine changes since 1972 and turnover per machine figures (inflation removed) was compiled (Table 2.3). The introduction of competing forms of gambling is also included to assist explanation.
<table>
<thead>
<tr>
<th>Year</th>
<th>Changes</th>
<th>Dollar Turnover per Machine</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>Tax exemption limit increased to $30,000</td>
<td>228476.65</td>
<td></td>
</tr>
<tr>
<td>1974</td>
<td></td>
<td>219926.60</td>
<td>-3.74</td>
</tr>
<tr>
<td>1975</td>
<td>Soccer Pools Introduced</td>
<td>251156.19</td>
<td>14.20</td>
</tr>
<tr>
<td>1976</td>
<td></td>
<td>241478.20</td>
<td>-3.85</td>
</tr>
<tr>
<td>1977</td>
<td>Machine available in the ACT</td>
<td>227178.54</td>
<td>-5.92</td>
</tr>
<tr>
<td>1978</td>
<td></td>
<td>215888.79</td>
<td>-4.97</td>
</tr>
<tr>
<td>1979</td>
<td>Five-reel Machines</td>
<td>211945.53</td>
<td>-1.83</td>
</tr>
<tr>
<td>1980</td>
<td>Lotto introduced</td>
<td>209222.34</td>
<td>-1.28</td>
</tr>
<tr>
<td>1981</td>
<td></td>
<td>216937.98</td>
<td>3.69</td>
</tr>
<tr>
<td>1982</td>
<td>Instant Lottery introduced</td>
<td>208899.35</td>
<td>-3.71</td>
</tr>
<tr>
<td>1983</td>
<td></td>
<td>191128.76</td>
<td>-8.51</td>
</tr>
<tr>
<td>1984</td>
<td>Card Machines in NSW Hotels</td>
<td>190895.54</td>
<td>-0.12</td>
</tr>
<tr>
<td>1985</td>
<td></td>
<td>195698.08</td>
<td>2.52</td>
</tr>
<tr>
<td>1986</td>
<td>Jackpot increase to $10,000 Casino Qld</td>
<td>193037.50</td>
<td>-1.36</td>
</tr>
<tr>
<td>1987</td>
<td></td>
<td>193925.07</td>
<td>0.46</td>
</tr>
<tr>
<td>1988</td>
<td>$1 and $2 Poker machines</td>
<td>198903.02</td>
<td>2.57</td>
</tr>
<tr>
<td></td>
<td>Poker machine Max stake = $10 Cashcade jackpots introduced</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>Machines available in Victoria</td>
<td>227736.02</td>
<td>14.50</td>
</tr>
<tr>
<td>1990</td>
<td></td>
<td>223709.15</td>
<td>-1.77</td>
</tr>
<tr>
<td>1991</td>
<td>Tokenisation introduced</td>
<td>235218.49</td>
<td>5.14</td>
</tr>
<tr>
<td>1992</td>
<td>Cabinet change (casino style) Machines Qld clubs Keno NSW</td>
<td>238575.98</td>
<td>1.43</td>
</tr>
<tr>
<td>1993</td>
<td></td>
<td>252741.09</td>
<td>5.94</td>
</tr>
<tr>
<td>1994</td>
<td></td>
<td>326653.29</td>
<td>29.24</td>
</tr>
</tbody>
</table>

Table 2.3 does not include all design changes. It was difficult to establish the year of introduction for some machine features (e.g., the various types of feature games) and to also determine when some features became prevalent. Interpretation of the results in Table 2.3 cannot lead to any valid conclusions as it merely attempts to identify a temporal relationship between structural changes and turnover per machine.
Nonetheless, Table 2.3 does show that the growth in performance per machine was frequently negative up until 1989 when a 14.50% increase was recorded. The preceding year (1988) saw the introduction of three major changes to the structural characteristics of poker machines; higher denomination machines were introduced ($1 and $2), maximum stake size was increased to $10 and cashcade jackpots via linked machine offering prizes up to $100,000 were authorised by the NSW government.

It is also apparent that changes to the structure of NSW poker machines usually occurred when increases in competition from other forms of gambling and other jurisdictions were introduced. For example, the jackpot for stand-alone machines increased to $10,000 in NSW (1986) the same year that poker machines appeared in the neighbouring Queensland casino. The year that poker machines were legalised in Queensland clubs and keno introduced to NSW clubs (1992) also saw the introduction of tokenisation on NSW machines. The following year, machine turnover recorded an increase of 5.94% but in 1994 the turnover increased by 29.24%. It is likely that the conversion of machines to tokenisation was a long process and that tokenisation did play a role in this increase.

The exact effect on player behaviour that these machine characteristics have is unknown. Increases in turnover figures per machine could be attributed to a number of factors listed above. However, the design of poker machines continues to evolve and the complexity of playing behaviour continues to increase. In addition, there does appear to be some conceptual similarities between many of the new machine characteristics and possible future design changes.
Future game design changes appear to be mirroring the same approach of the past 25 years. In the absence of substantial growth in the number of poker machines available, increasing the profitability of machines by attracting more players appears to be one approach. For example, in the face of competition from other forms of gambling (e.g., lotto, instant lotteries, keno) the amount won on jackpots has increased to $100,000 on linked machines. This trend is apparent in the immediate future with the recent approval of a mega-link between NSW clubs offering a jackpot prize of up to $1 million. Playing poker machines will then provide the player the opportunity to win amounts normally reserved for state lotto and lotteries.

It is also possible that machine changes in the past such as tokenisation and the note acceptors promote continuous play by eliminating one reason for the player to leave the machine and the gaming area. Similar changes in the future such as cashless gambling are yet to be legalised by the NSW government, but the technology currently exists. In addition, machines with built in televisions and the opportunity to place bets on other events (e.g., horse racing) whilst playing the machine have been developed (Friedman, 1997; Weinert, 1997).

Most current developments in poker machine design are aimed at an emerging market (Connor, 1995, 1996b). This market is believed to consist of computer literate arcade game players who are expected to graduate to gaming machines. It is expected that this generation will desire greater levels of involvement and interaction with the machine than currently exist in poker machine play. Second-screen features are already present on some machines offering a game within a game and a new level of involvement over traditional machines. Virtual reality and
increased quality in sound and graphics are designed to expand the sensory experience demanded by the new Nintendo generation of poker machine players.

Although it has been estimated that the NSW poker machine market will reach saturation point by the year 2000, increased accessibility to gaming machines is likely to occur through on-line services (Friedman, 1997). However, traditional gaming venues and manufacturers are unlikely to benefit from this and the trend of structural changes is likely to continue.

The point must be made that the basic structure of the game has not changed since Fey’s, 1899, Liberty Bell creation. Spinning reels and variable ratios of reinforcement are still present. However, changes have occurred to the accessibility of gaming and the structure of the machine in terms of accessory devices and available options. How these changes have influenced the Australian player, though, has remained an area of investigation largely ignored.

2.4 Poker Machine Players in the Australian Context

Gambling has become an integral part of the Australian community. Such are the achievements of Australian gamblers that they have funded churches and schools with bingo, hospitals with lotteries and the Sydney Opera House with raffles (Macken, 1982). The legalisation of poker machines in NSW further generated public money and has had a significant impact on criminal networks and the recreational activities of the residents of NSW and the border towns. The major impact has been in country and outer metropolitan areas where the local club is
sometimes the only entertainment centre in the area. In 1997, the distribution of clubs was approximately 64% in country NSW with the remainder in Sydney (Meaney, 1997). In that same year, there were approximately 2.5 million club members in NSW.

Macken (1982) stated in the Melbourne Age newspaper that “...the poker machine has done more for NSW’s social life than anything else over the past 26 years” (p. 5). Machines have subsidised state sport, ethnic groups, workers and professional clubs and common interest groups such as religious organisations, musicians and car fanatics. They have enabled clubs to offer entertainment and facilities rarely found in hotels, clubs or entertainment houses in states where they are illegal. Research by gaming operators has found that dining-out is the main additional activity linked to gaming (Barrymore, 1997), and with discounted meals, alcohol and live entertainment, the NSW clubs represent ‘one-stop’ entertainment centres.

However, the growth of the gaming machine funded club industry has not been without its critics (Vibert, 1986). The 1956 authorisation of poker machines in NSW clubs raised expressions of concern from some welfare and business groups. Not surprisingly, the Australian Hotels Association (as it is known today) and the Retail Traders Association took issue with the increased financial power of the registered clubs. The Australian Council of Churches issued a statement before the introduction of the legislation denouncing gambling and, in particular, poker machines. When the legislation was approved and introduced, the Council of Churches issued a resolution stating that the NSW government was prostituting and
perverting the true spirit of adventure in Australian life by appealing to selfish greed and supposedly easy and immediate gain.

Despite the Council of Churches' criticisms of the government and generalisations about the character of the Australian gambler, the community viewed the legislation as reasonable and realistic, as reflected in an article appearing in the Sydney Morning Herald (1956, cited in Vibert, 1986). The article cited advantages of legalised gaming such as increased competition between hotels and clubs and a final resolution to regulatory problems that plagued gaming venues over the past 30 years. In particular, the decision to forbid individual ownership of machines and restrict them to non-profit clubs was recognised as a public benefit. For the players, the notion of lost bets funding community projects was more acceptable than the notion of individuals, such as hoteliers, profiteering from their losses. This same argument was raised again recently by the Registered Clubs Association in protest over the 1997 legalisation of poker machines in NSW hotels (Barrymore, 1997).

In 1958, Australians were recognised as the world's most prolific gamblers and it was during this period that the expansion of registered clubs was at its peak (Vibert, 1986). Membership to clubs was available to all adults, unlike exclusive clubs of the past. The atmosphere and style of the clubs, their size, decor, drinking and gambling were rejected by the middle and upper classes but appealed to the basic working class gambling attitudes. Playing the poker machines was a purely mechanical task and the lawyer, doctor or company manager had absolutely no advantage over the labourer or housewife in this form of gambling (Caldwell, 1986).
The simplicity of poker machine play has also been responsible for many negative descriptions of the activity. For example, the historian Dr Alfred McCoy, was quoted by Macken (1982) as describing poker machine play as a "...pernicious and vicious form of gambling that appeals to those of lower intelligence who can least afford to lose money" (p. 6). Similar ill-informed and negative descriptions of poker machine players are found in other media sources both past and present. In spite of the concerns and criticisms, predictions that poker machines would turn players into moronic gamblers capable of losing a pay packet in a matter of hours have been largely unfounded. Instead, controlled gambling is the norm and poker machine play in NSW clubs has continued to rise in popularity.

The popularity of clubs with poker machines was especially noticeable in towns located near the borders of NSW and the states of Victoria and Queensland (Murphy, 1995). Interstate travellers organised gambling trips to these venues creating significant revenue for the NSW government at the expense of the home states. Despite the obvious success of poker machines in NSW clubs, it was over 20 years before another jurisdiction within Australia allowed poker machines in registered clubs (Australian Capital Territory, 1977). Poker machines began appearing in the Northern Territory and Victorian clubs and hotels in 1991, Queensland in 1992, South Australia in 1994 and Tasmania in 1995. At present, poker machines do not exist in Western Australia. They had appeared in Australian casinos as early as 1973 (Tasmania's Wrest Point casino), but the pervasiveness of poker machines in other states has yet to reach the proportion of that in NSW.
The NSW poker machine market represents the most dominant and mature market in Australia. The unique conditions fostering the development of the gaming machine industry in this state have affected playing behaviour in a way not found in other domestic or international jurisdictions. For example, compared to overseas markets such as the casino dominant United States, NSW poker machine players are considered loyal due to their frequency of play and the integration of gaming activities into regular leisure time experiences. One reason for the pattern of play is the location of gaming venues, typically found in home towns or suburbs, rather than in holiday destinations such as Las Vegas and Atlantic City.

A study of Sydney poker machine players by Breen, Hing, and Weeks (1997) utilised the loyalty characteristic of playing pattern in its design. In an attempt to identify the socio-demographic characteristics of areas supporting poker machine players, the Breen et al. (1997) research categorised clubs according to their statistical location group (SLG). Expenditure per capita figures were then derived for each SLG based on the pooled profit figures of each club in each area. The premise driving this research was that the majority of players played locally rather than crossing over the zoned areas. The results revealed that significant positive relationships existed with per capita expenditure and those areas with greater unemployed, uneducated and unskilled residents, with higher incidences of low income ($12,000-$25,000) and with a greater Lebanese, Greek, Vietnamese, Filipino and Yugoslav population. In contrast, negative relationships existed with those areas with greater numbers of residents with tertiary education qualifications, professionally employed, with household incomes greater than $100,000 and from
Anglo-Saxon dominant countries such as the USA, UK, South Africa, Canada, New Zealand and Australia.

There were several methodological and statistical problems with this research, such as the lack of independence between variables, but the study did reveal the broad distribution of poker machine players in Sydney. In particular, the contribution of certain ethnic groups to poker machine expenditure does challenge the traditional view of the Australian gambling culture. However, the secondary data utilised could not adequately provide a detailed description of the characteristics of poker machine players in New South Wales.

2.5 Characteristics of Poker Machine Players in New South Wales

An understanding of poker machine players in NSW is as important to gaming research as the understanding of poker machine design, outlined in Chapter 2.2. The general sociological statements about poker machine play, discussed in Chapter 2.4, tend to be based on personal opinion or analysis of general population data. These lack precise measurement of variables and fail to provide adequate insight into even the most basic of player characteristics.

There exists a series of studies of NSW poker machine players that provide detailed information about their characteristics. These describe the evolution of players and their behaviour in terms of motivation for play, expenditure patterns, frequency of play, demographic details, psychological characteristics, participation in other forms of gambling, and appealing features of poker machine design.
Based on observational analyses, Barrow (1969) suggested that the majority of NSW club members might be classified as social or recreational gamblers. These individuals attend the club once or twice per week and gamble with friends, spending inconsequential amounts on poker machines. According to Barrow (1969), the prime motivation to play appeared to be amusement and social interaction. Stronger empirical support for Barrow’s (1969) suggestions was found in the studies of Caldwell (1974) and Dickerson, Fabre, and Bayliss (1986).

Caldwell (1974) surveyed 300 club members asking, among others, questions regarding the motivation to play poker machines. Respondents were allowed to cite more than one of the options provided and to generate their own response. Sixty percent responded that they played for amusement, 35% were motivated by the opportunity to win money and 15% played to win the major jackpot.

The Dickerson et al. (1986) survey of 200 club members followed a similar procedure, although the range of available responses was much broader. From this study 14 years later, 48% stated that they played for entertainment, 40% played to win money, 18% played for the jackpot and 16% played for social reasons. Furthermore, 10% played the poker machines for something to do, 6% to forget troubles and 2% for excitement.

A more recent study investigating motivation to play by Dickerson, Blaszczyński, Boreham, Haw, and Walsh, (unpublished) focussed on a particular group of poker machine players. The 95 participants chosen were regular poker machine players (at least once per week) recruited from several Sydney clubs in
1997. The available responses differed again, but from the sample, 57% cited winning, 41% excitement and 45% social reasons for playing poker machines.

Although there were design variations between all of these studies, the understanding of player motivation does appear to be transient over time. For example, over the 27 years the studies were conducted, the importance of winning money has increased from 35% (1974) to 40% (1986) to 57% (1997). However, the use of similar, though not identical terms such as winning money and winning the jackpot and, amusement, entertainment and excitement, prevents any convincing comparison on this dimension and highlights the problem of interpretation with the survey method.

A broader source of information about NSW poker machine players is the ‘Study 2’ report from the Australian Institute for Gambling Research (1996). This study employed a door-knock survey design of NSW residents, which provided a description of gambling patterns and demographic profiles of players based on frequency of play.

One of the key findings from the 1996 Study 2 database was that 83% of poker machine expenditure is accounted for by regular (at least once weekly) players. From the 1390 NSW residents surveyed in 1996, only 6% reported playing the poker machines regularly, but clearly this is a group who contribute greatest to the overall poker machine expenditure. Of the other participants in the survey, 32% reported having played the poker machines less frequently than once per week in the past 12
months. This left 62% who reported never playing poker machines in the past 12 months.

Utilising the database from the 1996 Study 2, the demographic variables measured were analysed for the three groups of participants (regular players, infrequent players and non-players). These findings are presented in Table 2.4.

Table 2.4
Demographic Characteristics (percent) of Regular, Infrequent and Non-poker machine players in NSW (1995)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regular Players</th>
<th>Infrequent Players</th>
<th>Non-Players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>53.7</td>
<td>51.9</td>
<td>47.6</td>
</tr>
<tr>
<td>Female</td>
<td>46.3</td>
<td>48.1</td>
<td>52.4</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>22.0</td>
<td>25.3</td>
<td>20.7</td>
</tr>
<tr>
<td>30-44</td>
<td>26.8</td>
<td>36.1</td>
<td>34.0</td>
</tr>
<tr>
<td>45-59</td>
<td>20.7</td>
<td>20.5</td>
<td>21.6</td>
</tr>
<tr>
<td>60-70+ years</td>
<td>30.4</td>
<td>18.1</td>
<td>23.7</td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>51.2</td>
<td>59.6</td>
<td>65.2</td>
</tr>
<tr>
<td>Country</td>
<td>48.8</td>
<td>40.4</td>
<td>34.8</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>40.2</td>
<td>34.6</td>
<td>38.3</td>
</tr>
<tr>
<td>Partnered</td>
<td>59.8</td>
<td>63.4</td>
<td>61.7</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than $30,000</td>
<td>63.2</td>
<td>56.0</td>
<td>42.3</td>
</tr>
<tr>
<td>$30,000-$50,000</td>
<td>29.0</td>
<td>29.2</td>
<td>32.6</td>
</tr>
<tr>
<td>$50,000 +</td>
<td>7.90</td>
<td>14.7</td>
<td>17.0</td>
</tr>
<tr>
<td>NESB</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>19.5</td>
<td>16.5</td>
<td>19.8</td>
</tr>
<tr>
<td>No</td>
<td>80.5</td>
<td>83.5</td>
<td>81.2</td>
</tr>
</tbody>
</table>

The results from Table 2.4 confirm that poker machine play appeals to a broad cross-section of the NSW population. There is little that is outstanding about the characteristics of poker machine players, both regular and infrequent, when
compared to non-players. However, regular players were represented slightly higher than the other two groups in the age group above 60 years, the country areas and the lowest income bracket. This result is likely to be due to related variables. It may be that regular poker machine play is undertaken by older retired persons who, generally, have greater time for recreation, lower incomes, and live in country areas that have fewer alternative forms of entertainment. However, overall, those who play poker machines regularly or infrequently and those who do not are demographically similar. It cannot be concluded that poker machines appeal to certain types of NSW residents based on the 1996 participation rates and the variables in Table 2.4.

The 1996 Study 2 survey also measured participation in other forms of gambling for the previous 12 months. This is of some interest given the increased competition for the gambling dollar that NSW poker machines face. Of those who engaged in poker machine play, only 0.2% did not participate in any other form of gambling. A partial list of the participation rates for other forms is presented in Table 2.5.

<table>
<thead>
<tr>
<th>Form</th>
<th>Regular Players</th>
<th>Infrequent Players</th>
<th>Non-Players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lotto</td>
<td>78.0</td>
<td>68.8</td>
<td>48.8</td>
</tr>
<tr>
<td>Instant Lottery</td>
<td>65.9</td>
<td>68.4</td>
<td>37.2</td>
</tr>
<tr>
<td>Keno</td>
<td>57.3</td>
<td>34.1</td>
<td>8.1</td>
</tr>
<tr>
<td>TAB</td>
<td>40.2</td>
<td>29.6</td>
<td>12.5</td>
</tr>
<tr>
<td>Card Machines</td>
<td>30.5</td>
<td>29.3</td>
<td>7.8</td>
</tr>
<tr>
<td>Bingo</td>
<td>26.8</td>
<td>13.1</td>
<td>3.6</td>
</tr>
</tbody>
</table>
Not all other forms of gambling measured in the 1996 study are presented in Table 2.5. The two most popular were lotto and instant lotteries with most other forms failing to record figures over 50%. This is of some interest with regard to the groups that did engage in poker machine play, as they are both forms that are not available in NSW clubs. Despite the efforts of the clubs to provide one-stop entertainment venues, a large proportion of poker machine players are also gambling in non-club facilities. Of the other forms of gambling available in clubs, keno for the regular group was the only one to achieve a participation rate greater than 50%. Keno is only available in registered clubs and this figure indicates that the majority of regular poker machine players will also participate in keno at some time in a 12 month period.

However, other gambling forms, available in clubs, such as bingo and the TAB (betting shop) are not as popular with regular or infrequent poker machine players (both are also available in other venues). The low percentage of regular and infrequent poker machine players engaging in card machine play may be a result of the different venues. During the period of the survey, card machines were only available in NSW Hotels, which attract a different clientele to the clubs (typically young and male). The frequency of participation in poker machine play mirrors the proportion of participation in other forms of gambling. That is, the regular players of poker machines were also found to participate more frequently in other forms of gambling, followed by infrequent players and non-players.

The Study 2 survey was designed to examine the socio-economic effects of gambling on individuals, families and the community. Hence, psychological
variables relating to mood and personality were not included. These variables are useful in the description of poker machine players as they have the ability to provide deeper insight into the characteristics of poker machine players.

Dickerson et al. (unpublished), in their study of 95 regular players from several Sydney clubs, included a range of psychological questionnaires measuring personality, mood, alcohol consumption, along with questions regarding playing patterns and demographic information. Although the sample was not randomly determined and a subset of poker machine players was targeted, the survey was conducted in the ecologically valid setting of Sydney clubs. The participants recruited were highly involved in poker machine play and reported an average spend of $43.25 per playing session and an average of 3.21 playing sessions per week. This equates to over $7,200 per year which is more than 10 times the per capita figure for NSW. Despite this obvious deviance from the norm, other results were consistent for regular players on those variables in Table 2.4 (demographic) and Table 2.5 (participation in other forms).

Analysis of the psychological variables for these players failed to reveal any key differences when compared to population norms. The majority (68%) were classified under the Alcohol Use Disorders Identification Test as being in the lowest risk category of experiencing problems due to hazardous alcohol consumption. Most had also experienced normal levels of depression (64%), anxiety (61%) and stress (64%) in the past week according to the Depression, Anxiety and Stress Scale (Lovibond & Lovibond, 1995). The NEO Five Factor Personality Inventory (Costa & McRae, 1992) measuring neuroticism, extroversion, openness, agreeableness, and
conscientiousness was also implemented. For three of these personality dimensions (neuroticism, extroversion and conscientiousness), the distribution of the sample of regular gamblers again resembled that of adult population norms.

However, for the agreeableness dimension, 63% of the sample scored in the low and very low category (expected frequency = 31%), which suggests that a greater number tended to be hard-headed, sceptical, proud and competitive than would be found in the general adult population. Also, for the openness dimension, 40% of respondents scored in the low and very low category (expected frequency = 31%). This dimension measures openness to new experiences and low scoring participants tend to be practical, down-to-earth, traditional and set in their ways.

Dickerson et al. (unpublished) also surveyed aspects of playing patterns including appealing characteristics of favourite poker machines. The majority of players (71%) indicated that they had a favourite machine and, from a list provided, were asked to indicate the appealing features of this machine. The results are presented in Table 2.6.

Table 2.6
Appealing Characteristics of Favourite Poker Machine for Regular Players

<table>
<thead>
<tr>
<th>Appeal of Favourite Machine</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easier to Understand</td>
<td>57.6</td>
</tr>
<tr>
<td>More Frequent Pay-outs</td>
<td>51.5</td>
</tr>
<tr>
<td>Won Large Amount On</td>
<td>42.4</td>
</tr>
<tr>
<td>Larger Pay-outs</td>
<td>34.8</td>
</tr>
<tr>
<td>Colour and Design</td>
<td>34.8</td>
</tr>
<tr>
<td>The Symbols Used</td>
<td>31.6</td>
</tr>
<tr>
<td>Greater Options</td>
<td>26.3</td>
</tr>
<tr>
<td>Position in Club</td>
<td>18.9</td>
</tr>
<tr>
<td>The Sounds</td>
<td>11.6</td>
</tr>
</tbody>
</table>
Given that the 40% of the group rated in the lower categories of the ‘openness to new experiences’ personality trait, it is perhaps fitting that the majority of this group rated ease of understanding as their favourite feature. As a group ‘set in their ways’, it is likely that they would resist adapting to some of the newer, sophisticated machines with a greater number of options such as special bonus features (which appealed to only 26.3%).

The gaming industry acknowledges that although the new technology and increased sophistication of poker machines are fundamental to future design and markets, the simpler more traditional machines still generate the largest turnovers (Friedman, 1997; Weinert, 1997). This appears to conflict with the explanation in Chapter 2.3 that structural changes have occurred due to player demand.

In summary, the findings of research examining the characteristics of NSW poker machine players highlight some important variables for poker machine research. A range of motivations for play exist, but the importance of money has increased in the past 30 years. Regular players contribute the largest proportion of playing expenditure, but as a group do not differ greatly from infrequent and non-players on most demographic variables. They do, however, appear to be older, to reside in country areas and to have lower incomes. Regular players also engage more frequently in other forms of gambling, particularly lotto and lotteries, than infrequent and non-players.

The mood of regular players mirrors that of population norms, however, two personality characteristics have been identified to deviate from the norm. Regular
players may be considered as less agreeable and less open to new experiences than that of population norms.

The majority of regular players have a favourite machine, and these players report that the ease of understanding is the most appealing characteristic of their favourite machine. This finding is somewhat paradoxical given the explanation that structural changes in poker machine design have occurred due to loyal players demanding greater variety in their games. Furthermore, it raises some questions about the nature of the relationship between structural changes and player expenditure.

2.6 Structural Changes and Player Expenditure

One of the most common measures of player expenditure is dollars per capita. This refers to the average yearly spend by the adult population on poker machines and is a useful figure when comparing yearly changes, states and countries.

However, per capita figures are diluted due to the inclusion of the total population, of which not all play poker machines. As mentioned in Chapter 2.5, over 60% of the NSW adult population reported no participation in poker machine play (Productivity Commission, 1999). A further indicator of the inadequacy of per capita expenditure figures, is the disparity between the per capita estimate for NSW ($635.98) and the estimate from Dickerson et al. (1997) study of regular players (over $7,200).
When considering the relationship between structural changes and per capita expenditure, the same possible explanations apply as they did for structural changes and machine performance. However, there exists some evidence of a relationship between player expenditure and machine characteristics.

The Productivity Commission (1999) outlined a formula for the expected (or average) dollar value of losses from playing 1 hour continuously that considers the multiplier potential of the machine.

\[
\text{Expected Loss} = \frac{\text{D} \times \text{C} \times \text{L} \times (1 - r) \times 3600}{\text{BPT}}
\]

*Equation 2.1. Expected dollar value of losses for playing 1 hour continuously.*

In this equation, the multiplier potential of poker machines is implicated as directly affecting rates of loss. However, the reality is that the multiplier potential can only directly influence stake size (the size of each bet placed per reel spin). In Equation 2.1, the assumption of 1 hour continuous play must first be met for the multiplier potential to have any relationship with total dollar loss.

The multiplier potential comprises three machine characteristics, denomination, bet multiplication and pay-lines. In Equation 2.1, D refers to the denomination of the machine, C the number of credits staked per line (termed bet multiplication in Table 2.2), L is the number of lines played per button press, r is the return rate of the machine and BPT is the elapsed time per button push.
By fixing the denomination to 5 cents, the return rate to 85%, and the BPT to 5 seconds, the effect of the multiplier potential on stake size and rate of loss can be ascertained. In 1956, there was no multiplier potential on any machine, hence, the player could only play 1 line by 1 credit per line. The expected loss per hour for this machine is

\[ \$5.40 = 5 \times 1 \times 1 \times (1 - 0.85) \times 3600/5 \]

Today, however, on a machine with identical characteristics, but also with a maximum of 9 lines and a maximum bet multiplication of 10 (i.e., maximum stake size = $4.50), the expected hourly loss is

\[ \$486.00 = 5 \times 9 \times 10 \times (1 - 0.85) \times 3600/5 \]

It may be argued that these characteristics not only present the modern player with responses that increase stake size, but also present the player with responses that can decrease stake size. Today’s machines are available in lower denominations (e.g., 1-cent, 2-cent) and this leads to a reduced the cost of play. If the player chooses to play the minimum number of lines and the minimum bet multiplication (as on the 1956 machine), the expected hourly loss on a modern 1-cent machine would only be $1.08. This supports the notion that the modern poker machine represents better value for money.

However, if the multiplier potential of the machine was used in a manner similar to the response patterns of Table 2.2 (i.e., 41.23% of games played with the
maximum number of pay-lines and the minimum bet multiplication) the expected hourly loss on a 1-cent machine would be $9.72. This is almost double that of the 1956 5-cent machine. This clearly shows the importance of the multiplier potential, the related importance of stake size and the possible effect on a player’s overall loss. However, explanations of why players choose to play in this way are absent.

In Table 2.3, changes in turnover per machine figures were compared with changes in the structural design of poker machines. It was suggested that increases in machine turnover figures might be related to the structural characteristics of the machines. It is possible that a similar pattern may exist between per capita expenditure and machine characteristics. These figures may be highly correlated, given that both are calculated from expenditure figures, but information for only those who do play the poker machines has not been consistently documented.

Nonetheless, the interest is not in the relationship between the size of the population and the number of machines available, but in the size of the yearly change in these figures within the context of structural changes to machines. It was reported that between 1973 and 1994, the turnover per machine figure had increased 182%. For this same period, per capita expenditure on poker machines (adjusted for inflation) had also increased by the relatively smaller 53.8%. However, as in the turnover per machine figures, the bulk of this increase has occurred relatively recently. Between 1988 and 1994, a 59.3% increase in per capita expenditure was recorded. As argued previously, there are numerous possible explanations for the increase in expenditure on poker machines, such as increases in the number of machines, club marketing strategies, and extended operating hours.
Table 2.7 replicates Table 2.3, but utilises changes in expenditure per capita.

If a machine feature, such as the multiplier potential, has an effect on player expenditure, in real loss terms, it would be expected that per capita expenditure would increase in those years following the introduction of machine features related to the multiplier potential; that is, denomination, pay-lines, and bet multiplication.

Table 2.7
Structural Changes, Per capita Expenditure (inflation removed), and Yearly Percent Change

<table>
<thead>
<tr>
<th>Year</th>
<th>Changes</th>
<th>Dollars per Capita</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>Tax exemption limit increased to $30000</td>
<td>314.69</td>
<td></td>
</tr>
<tr>
<td>1974</td>
<td></td>
<td>326.36</td>
<td>3.58</td>
</tr>
<tr>
<td>1975</td>
<td>Soccer Pools Introduced</td>
<td>390.68</td>
<td>19.71</td>
</tr>
<tr>
<td>1976</td>
<td></td>
<td>397.83</td>
<td>1.83</td>
</tr>
<tr>
<td>1977</td>
<td>Machine available in the ACT</td>
<td>379.86</td>
<td>-4.52</td>
</tr>
<tr>
<td>1978</td>
<td></td>
<td>364.07</td>
<td>-4.16</td>
</tr>
<tr>
<td>1979</td>
<td>Five-reel Machines</td>
<td>363.74</td>
<td>-0.09</td>
</tr>
<tr>
<td>1980</td>
<td>Lotto introduced</td>
<td>361.85</td>
<td>-0.52</td>
</tr>
<tr>
<td>1981</td>
<td></td>
<td>374.46</td>
<td>3.48</td>
</tr>
<tr>
<td>1982</td>
<td>Instant Lottery introduced</td>
<td>355.53</td>
<td>-5.06</td>
</tr>
<tr>
<td>1983</td>
<td></td>
<td>313.49</td>
<td>-11.82</td>
</tr>
<tr>
<td>1984</td>
<td>Card Machines in NSW Hotels</td>
<td>303.07</td>
<td>-3.32</td>
</tr>
<tr>
<td>1985</td>
<td></td>
<td>304.97</td>
<td>0.63</td>
</tr>
<tr>
<td>1986</td>
<td>Jackpot increase to $10,000 Casino Qld</td>
<td>292.18</td>
<td>-4.19</td>
</tr>
<tr>
<td>1987</td>
<td></td>
<td>297.02</td>
<td>1.66</td>
</tr>
<tr>
<td>1988</td>
<td>$1 and $2 Poker machines</td>
<td>303.79</td>
<td>2.28</td>
</tr>
<tr>
<td></td>
<td>Poker machine Max stake = $10 Cashcade jackpots introduced</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td></td>
<td>354.55</td>
<td>16.71</td>
</tr>
<tr>
<td>1990</td>
<td>Machines available in Victoria</td>
<td>354.16</td>
<td>-0.11</td>
</tr>
<tr>
<td>1991</td>
<td></td>
<td>385.24</td>
<td>8.77</td>
</tr>
<tr>
<td>1992</td>
<td>Tokenisation introduced</td>
<td>395.36</td>
<td>2.63</td>
</tr>
<tr>
<td></td>
<td>Cabinet change (casino style)</td>
<td></td>
<td></td>
</tr>
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Unlike results for turnover per machine, the majority of yearly changes for expenditure per capita have been growths. The greatest reduction in per capita expenditure on poker machines, 11.82%, occurred in 1983, the year after instant lottery was introduced. This result appears to support the results in Table 2.5 that regular poker machines players preferred 'other' form of gambling was instant lotteries. The other negative growth figures were all minor with the major period for this pattern appearing after legislation of machines in the ACT (1977-1978), the introduction of lotto (1980) and the advent of card machines (1984).

The largest growth of 19.71% was recorded between 1974 and 1975. No structural changes to machine design were noted in the previous years, however, the next largest increase, 16.71%, occurred in 1989 following the introduction of three structural changes. Two of these characteristics are directly related to the multiplier potential of the machine. In 1988, higher denomination ($1 and $2) machines were introduced. Also, in the same year, the maximum stake permissible on machines was increased to $10, paving the way for increases in the number of pay-lines and bet multiplication available on machines.

The suggestion that changes to the multiplier potential have influenced player expenditure patterns highlights the importance of the response chain Figures 2.1 and 2.2. The multiplier potential was merely one machine characteristic introduced in the past 40 years, and the effect of this feature, along with the other features displayed, needs to be examined empirically. It was also stated that the design of the poker machine would continue to change in the future, introducing a range of new features and a range of new responses for the poker machine player. Theoretical explanations
for machine effects can therefore assist in the prediction of responses as well as contributing to efficacy of poker machine research.
Chapter 3:

Issues in Poker Machine Research

3.1 Methodological Considerations

It was previously argued that one of the most significant findings of gambling research was that of methodological considerations. In particular, it has been emphasised that caution should be exercised when generalising results across different forms and when interpreting the results from ecologically invalid studies.

Driving these methodological considerations is the understanding that lawful relations are sensitive to context (Weiten, 1995). One of the basic tenets of research is that the closer the conditions are to the environment that the behaviour normally occurs in, the greater the external validity of the findings (i.e., the application and generalisation to the population). In gambling studies, this has been demonstrated with regard to arousal levels in blackjack players and the illusion of control concept in lottery games (Anderson & Browne, 1984; Langer, 1975). Therefore, studies that utilise simulated gaming devices, undergraduate students, bogus money and, in general, those that create an artificial environment, fail to meet the research principles established for reliable and valid gambling research. Laboratory research may help identify the components of complex behaviours and assist with the model building process, but until the results are replicated under ecologically valid
conditions, there remains the risk of generalising beyond the evidence (Robson, 1993; Sarantakos, 1998).

It is often argued that laboratory experiments provide greater internal validity by allowing for greater control of extraneous variables and can better establish cause and effect relationships (Robson, 1993; Sarantakos, 1998). However, extraneous variables are present in the real world and measuring and understanding the interrelationship between relevant variables will provide a better understanding of complex behaviours. Just as two parts hydrogen mixed with one part oxygen will produce either water, ice or steam depending on the context in which the event occurs, it has been demonstrated that the relationship between gambling behaviour variables is also dependent upon the context in which they occur. The problem for many researchers is that real world studies are generally more difficult, require greater planning, time, statistical knowledge and a conceptual understanding of the behaviour.

It therefore follows that many experimental studies of poker machine play are difficult to generalise to real gaming in Australian clubs. For example, Lewis and Duncan (1958) examined the relationship between schedules of reinforcement and persistence-when-losing, using a poker machine in a laboratory setting. Participants experienced a simple two-stage paradigm of playing and winning on a percentage of pulls (the training period) and then continuing play without winning at all until they decided to stop (the extinction period). Participants persisted longer during extinction when they had won less frequently during training. Persistence also increased when larger amounts were won.
These studies, in spite of the use of a poker machine, were quite unrealistic. Participants were given unlimited supplies of tokens to play the machine and the ratios of winning (1/3, 1/1.5, and 1/1) were much higher than what would be experienced in real gaming. As mentioned in Chapter 2.2, the average hit rate of modern machines was estimated at 1/8.5 and at the time of the study was much lower (Scarne, 1975, suggested that it was about 1/13). Given that the aim of the Lewis and Duncan (1958) study was to examine the relationship between gaming behaviour and variable ratios of reinforcement, it is difficult to generalise these findings when a fundamental factor, the VR schedule, was different.

In another experimental study of poker machine playing behaviour, Strickland and Grote (1967) investigated the effect that near-misses have on playing duration. This phenomenon remains one of the basic characteristics of poker machine play. Strickland and Grote (1967) arranged a simplified form of machine to display only red bars or green bars, with 70% red on the first wheel, 50% on the second, and 30% on the third. By prescribing three reds or three greens as the winning combination, they could present players with a relatively high-frequency of winning symbols, either early in the outcome sequence or late, whilst keeping the probability of a win constant at $p = .105$ (one win every 10.5 handle-pulls for each group). To control for any effect that might be due to colour alone, the first and third wheels were interchanged for half of the participants. Thus, there were four groups, with two exposed to a high proportion of winning symbols on the first reel (but in a different colour sequence) and two groups exposed to a high proportion of winning symbols on the third reel.
Each of the 44 male high school students (median age 15.9 years) who took part were given 100 nickels ($10) with which to play, and received 40 cents for each winning combination, (thereby over-riding the machine’s pay structure). Participants were also required to read aloud the sequence of symbols to ensure they were paying attention to the reels. The results revealed that significantly more players from the groups presented with a greater proportion of outcomes representing a near-miss (70% of symbols on the first reel were winning symbols), chose to continue play with their winnings compared to the other groups (13 compared to 5). With the frequency of wins (1/10.5), the size of wins (40 cents) and the total number of games played (100) controlled, it was suggested that the result supported the notion that near-misses play a role in the continuation of play. That is “…it seems that early, frequent, and extended anticipation of a win promotes continued playing” (Strickland & Grote, 1967, p. 12).

Several problems exist with the design of this study in relation to its ecological validity. Strickland and Grote (1967) acknowledged that the participants were naive slot machine players whose playing behaviour is likely to have differed from regular players. However, they failed to recognise that the machine utilised was also dissimilar to that in real gaming venues. The win rate of 1/10.5 trials was consistent with other machines at the time, but the pay-back rate was unrealistic. A 40 cent win occurring, on average, every 10.5 trials (or every $1.05 gambled) provided a return rate of 38%, which is much lower than machines in gaming venues at present.
More importantly, Strickland and Grote (1967) only supplied group means on win rates and distribution of wins, yet performed a non-parametric statistical procedure based on frequency of wins in the final analysis. Given that there were 11 participants in each group playing 100 trials each, the mean after 1100 plays is not a very informative parameter when the final analysis is based upon frequency.

Strickland and Grote (1967) used the mean to demonstrate control, but a more useful approach would have been a measure of the win rate and distribution of wins for those who elected to continue (the 13 from the first 2 groups and the 5 from the last 2 groups). It may have been that these participants had a more frequent hit rate, their wins were recorded closer to the final (100th) trial and that these characteristics, and not the near-miss effect, promoted continuous play. That is, the final analysis indicates that there was a difference in the patterns of play, in terms of the number who continued from each group, but it is not known whether the pattern of hit rates were different, as the mean disguises this. A poker machine set to an average of 87% return rate with an average hit rate of 1/10 does not guarantee that each playing session is similar and the game’s volatility needs to be factored in, or at least reported.

Further problems with the Strickland and Grote (1967) experiment are evident in their final analysis. The dependent variable, continued play, was measured by the number of players from each group who continued, instead of the duration of play or number of trials during the continuation period. Strickland and Grote (1967) provided this information and reported similarities for both groups (16.1 and 16.8). In fact, the group with the machine set to provide a greater number of near-misses
played 0.7 fewer trials in their continuation than the other group. In what reads as a piece of post hoc damage control, Strickland and Grote (1967) explained (in their results section) that this finding was "...anticipated, since at the point where the decision was made to continue, a variety of cognitive rules could be (and in fact were) formed consistent with the decision" (p. 12) despite no reference to this process being made in the introduction of their report. Given the argument that the near-miss phenomenon promotes continuous play, the number of trials in the continuation period would seem to be an equally important measure of the phenomenon.

Other problems with this study lie in its relevance to the nature of gaming machine play today. In Australia, the majority of machines have five reels, multiple pay-lines and contain numerous symbols of various worth rather than one winning combination. Determination of a near-miss is much harder than the red/green symbols and playing is not a clear win or lose proposition, as in the Strickland and Grote (1967) experiment. On modern poker machines, some combinations are rewarded, but at less than the amount staked (it is still unclear whether an actual loss in the presence of a win should be considered a reward or a punisher; Walker, 1992b).

Despite the problems with this experiment, the results are reported by other researchers as evidence of the near-miss effect. Some (e.g., Griffiths, 1993a; Reid, 1986) have misinterpreted the findings as support for the argument that the near-miss effect promotes longer play, not more players continuing play (perhaps due to the choice of dependent variable in the original study).
Reid (1986) reviewed the Strickland and Grote (1967) experiment and cited another study which was a partial replication but allowed for a degree of player control in an attempt to explore the illusion of control concept. Reid (1986) explained that the results of this experiment found no evidence that the illusion of control promoted continuous play and that no significant differences were recorded between near-miss groups. Although Reid (1986) does not provide a reference for this study, he used this conflict between results to raise valid questions about the methodology of the Strickland and Grote (1967) experiment. Reid (1986) argued that reading aloud the symbols is not a characteristic of normal slot machine play and may have increased the aversiveness of early losing by forcing the participants to attend to success symbols on later reels after seeing that they had failed on the first reel. It is possible that this negative effect, rather than any positive effect of near-misses, may have produced the observed difference between the two groups.

Together with the examination of the Lewis and Duncan (1958) and the Strickland and Grote (1967) studies, Reid’s (1986) comments further exemplify the effect of laboratory designs on research outcomes. Although using a genuine gaming machine, these studies highlight the importance of maintaining the original structural characteristics of the gaming machine, such as symbol presentation and the schedule of reinforcement.

3.2 Schedules of Reinforcement

Hurlbut, Knapp, and Knowles (1980) noted that the variable ratio schedule of reinforcement is considered to lie at the heart of all poker machines. Since
Skinner's (1953) statement, secondary accounts of behaviour analysis universally offer the slot machine as a proto-typical example of a VR schedule of reinforcement. Similarly, students in introductory psychology courses are usually offered the slot machine exemplar as a way of understanding and remembering how a VR schedule is defined and what effects on behaviour it produces (e.g., Weiten, 1995). However, Hurlburt et al. (1980) demonstrated that these types of gaming machines do not operate with a variable ratio of reinforcement, but with a random ratio of reinforcement. They provided a simple example of each that exposes the difference.

A variable ratio 3.5 indicates that, on average, every 3.5 responses will be reinforced. When this type of VR schedule is designed, it is done with a determined number of reinforced responses, for example, 1, 2, 3, 4, 5 and 6, arranged in a variable order to form the VR sequence. In other words, the maximum number of responses before reinforcement will be 6, the minimum 1. If done repeatedly and randomly, this will result in an indefinitely long sequence of digits (not digits of an indefinite size) which may serve as the run lengths on a VR schedule whose mean run length is 3.5. One-sixth of all runs will be of length one, one-sixth of length 2, one-sixth of length 3, et cetera.

In a random ratio 3.5, the sequence will contain elements with a mean of 3.5, but the elements themselves can range from 1 to an indefinitely large number. Thus, whereas both types can be specified by an average sequence of run lengths, the distribution of these two will be greatly different (similar to the criticisms of Strickland and Grote (1967) that the mean hides the distributional properties). In poker machine play, this has potentially significant behavioural ramifications.
Under the VR schedule outlined above, the probability of a reinforcer on the next response increases with every non-rewarded response. That is, the first response has a 1/6 (16.6%) chance of being rewarded, and if no reward is provided, then the next response has a 1/5 (20%) chance of being rewarded, the next has a 1/4 chance (25%), the next 1/3 (33%), the next 1/2 (50%) and finally a 1/1 (100%) chance. Thus, the maximum number of non-reinforced responses is 5 and if this sequence occurs, then there is a 100% probability that the next response will be rewarded. Under these conditions, the player could rationally expect a win after a loss and develop a strategy of increasing the stake size to increase the impending reward. The development of this type of strategy is considered the basis for the principle of gambler's fallacy (Cohen, 1972), but the probabilities indicate that there is no fallacy under a VR schedule.

Furthermore, after a response has been rewarded, the probability of the next response (recommencement of play) being rewarded is 1/6. Therefore, the probability of it not being rewarded is 5/6. Thus, although the reinforcement rate is not fixed (a win could occur on the next response), the probability of a win is fixed and therefore, after a win, the gambler may not respond immediately because previous experience has shown that another immediate win only occurs 16.7% of the time, but unrewarded responses after a win have occurred 83.3% of the time.

Under a random ratio schedule, each response-outcome is independent of the previous as there is a constant probability of pay-off for each trial. The size of this probability is determined by the number of winning symbol combinations divided by the total number of combinations. In the Strickland and Grote (1967) experiment, the
machine had three reels with 20 symbols on each, providing 8000 different combinations. There was only one winning combination (e.g., three red symbols on the same line) but the distribution of winning symbols was 14 on reel 1, 10 on reel 2 and 6 on reel 3, providing 840 possible winning combinations (14 x 10 x 6). This figure (840) divided by the total combination figure (8000) provides a constant probability figure of .105. That is, each trial has a 10.5% chance of being rewarded or, on average, a win should occur every 10.5 responses, but the number of non-reinforced trials is theoretically infinite. Under these conditions, the gambler’s fallacy is true because the distribution of wins for a RR schedule differs to that of a VR schedule.

The implications of this for gaming machine research is that experimental studies utilising simulated gambling devices need to specify the type of schedule used. Designing simulated games with a VR schedule alters a fundamental component of poker machine play that could alter playing behaviour (with regard to gambler’s fallacy and strategic play). This weakens the results of studies that have utilised VR schedules (e.g., Levitz, 1971) and casts doubts over other research which do not specify the schedule used in the simulated gaming device (e.g., Kyngdon & Dickerson, 1999).

Hurlburt et al. (1980) compared playing behaviour under the two types of schedules. Their dependent variables were schedule preference and strategy employment. Their aim was to determine if participants preferred a VR schedule to a RR schedule and whether participants employed a strategy on a VR schedule but not a RR schedule.
Four conditions were created containing games with a VR 6, VR 20, RR 6 and RR 20 schedule and participants were exposed to each and allowed to alternate depending upon personal preference. The results indicated that significantly more participants played more trials on the game that provided a greater frequency of reward during the training stage. There was, however, no significant preference for a game based on its schedule type. The results also identified that 28 of the 80 sessions conducted by the participants (20 participants X 4 conditions) employed some consistent strategy. Of these 28, 22 were identified as the type to maximise pay-off if done whilst playing a VR schedule (i.e., stake more after loss). However, this type of strategy was evenly divided between the VR and RR schedule games, indicating a lack of discrimination between the two schedules.

Although these results suggest no behavioural differences between the schedules, the support for the null hypothesis may be explained by the conditions of the experiment. This study involved 20 undergraduate psychology students playing computer-simulated games in a laboratory setting, utilising bogus money. Not only were the conditions ecologically invalid, but the power of the statistical test chosen (chi-square analysis) was adequate to detect very large effect sizes only, which may explain the retention of the null hypothesis in the preference analysis. Furthermore, the identification of strategy was based on 80 chi-square analyses of distributions which, with $\alpha = .05$, suggests that at least four significant distributions are likely to have been the result of a Type I error. Therefore, the actual distribution of ‘consistent strategy’ across the two schedule types is unknown.
Hurlburt et al. (1980) noted other explanations for their results. They suggested that the manner in which the participants were introduced to the schedules might be critical as "Shaping is apparently more likely than verbal instructions to lead to differential responding" (p. 638). Thus, the behavioural significance of the theoretical difference between VR and RR may become more apparent over a greater number of trials, as learning of the distributional properties of the VR schedule may take some time.

Alternatively, if it is true that there are no behavioural differences between the two types of schedules, what are the implications for poker machine play? It may be argued that players cannot distinguish between a VR and RR schedule and develop a strategy of play on RR schedules that appear rational on VR schedules. Poker machines simulate a VR schedule and therefore, as argued above, gambler's fallacy is a somewhat logical behaviour. This is especially pertinent when taken out of the theoretical context of infinite non-reinforced responses which distinguish the two schedules. According to the gambler's fallacy principle, it is only illogical to expect a win approaching rather than to expect that an infinite number of responses will go unrewarded (Cohen, 1972). Gambler's fallacy appears to be based on the theoretical possibility of outcomes without the consideration of prior experience on the player (i.e., a win does eventually follow a response rather than infinite non-wins).

Under a VR schedule, the distribution of reinforcement is rectangular. This reflects a property of the VR schedule, namely that the frequency of wins occurring after 1 response is the same as the frequency of wins occurring after 2, 3, 4, 5 or 6
responses (i.e., there is no mode of response-reinforcer ratios). However, under a RR schedule, the distribution of reinforcement is not rectangular. With a RR 3.5, a win may occur after 100 responses (which is impossible under a VR 3.5), but this skews the average rate to a higher figure (the effect an outlier has on the mean). Therefore, the majority of reinforcers should occur closer to and below the mean, which compensates for the effect of this outlier and provides the lower mean.

This hypothesis, that the distribution of a RR schedule will have a mode that is lower than the mean, was tested using a modern poker machine operating in a registered club. The machine was of a 1-cent denomination with a maximum number of pay-lines equal to 20. In total, 863 bets (button pushes) were made by the researcher with 406 made playing 20 lines and 457 betting 10 lines (the stake size was not multiplied beyond this). The differences between the four distributions are displayed below. Figure 3.1 shows the expected distribution of wins under a VR 2.5 schedule, Figure 3.2 displays the results from the 863 bets on the 1-cent machine played (reflecting the machine’s RR schedule). Figure 3.3 shows the results when playing 10 lines, and Figure 3.4 displays the distribution of wins when playing 20 lines.
Figure 3.1. Distribution of reinforcers under a VR 2.5 schedule.

Figure 3.2. Distribution of reinforcers (total play) under a RR schedule (RR 2.56).
Figure 3.3. Distribution of reinforcers when playing 10 pay-lines (RR 3.0).

Figure 3.4. Distribution of reinforcers when playing 20 pay-lines (RR 2.2).
Figures 3.3 and 3.4 clearly display the effect that pay-line adjustments have on reinforcement rate. Increasing the number of pay-lines from 10 to 20 increased the mean reinforcement rate from 3 to 2.20. The run of non-reinforced trials was longer when playing 10 lines (maximum = 12) compared to 20 lines (maximum = 7). The mode or most frequently occurring number of reinforced trials was 1 under both conditions, but the percentage of trials rewarded after one response was higher when playing 20 lines (45%) compared to 10 lines (28%).

Figures 3.1 and 3.2 demonstrate the difference in reinforcer rates between a VR schedule and a RR schedule. Both have a similar mean reinforcement ratio but the distribution of reinforcers were considerably different. It is also evident that a RR schedule possesses a mode of reinforcement, which is more frequent than the mean reinforcement rate. Just how this difference is reflected in gambling behaviour is unclear, but it is possible that regular players become sensitive to the mode and operate according to its value (thereby changing the schedule of reinforcement to a fixed ratio). This would appear a more parsimonious explanation as the alternative suggests that players learn the mean reinforcement rate during training conditions. There has been some evidence of substantial post reinforcement pauses in studies examining response rates which suggests play is operating under a FR schedule (Delfabbro & Winefield, 1999; Dickerson et al., 1991; Dickerson et al., 1992a; Dickerson et al., 1992b). However, further studies examining the within sessions characteristics of poker machine play are required.

The current results were based on one machine only and it is not known how similar the reinforcement patterns of other machines may be. There also needs to be
adequate testing of behavioural changes in relation to the mode if this property of the
distribution is relevant to gaming strategies. It must be remembered that the general
literature on VR schedules deals with response rates (with the classic example being
that of disk pecking pigeons) rather than with strategies related to the staking patterns
of the gambler.

Underlying the assumptions of the above analysis is the question concerning
the reinforcer in terms of win size and the role of non-reinforced trials (Walker,
1992b), but the point remains that gaming machine research needs to be aware of the
consideration of RR versus VR schedules, and in particular when conducting studies
utilising simulated gaming devices.

3.3 Ecological Validity of Laboratory Studies

Contrary to the evidence for the ecological validity argument, there is also
support for the ecological validity of laboratory studies. Others have argued that the
merits of real world studies are overstated and that it is dependent upon the variables
under study.

Ladouceur et al. (1991) suggested that there is good ecological validity for
the testing of slot machine gamblers’ erroneous cognitions in the laboratory.
Furthermore, the use of players’ own money can be overcome if the player is allowed
to keep the winnings. The basis for this assertion was a study comparing cognitive,
behavioural and motivational measures of gamblers across settings. Ladouceur et al.
(1991) concluded that, “Results showed that playing videopoker in the laboratory
produces cognitive, behavioural, and motivational phenomena which are equivalent to those observed in a natural setting." (p. 115).

The Ladouceur et al. (1991) interpretation of results has served as justification for other research to violate the conditions of ecological validity, such as allowing players to gamble with other people's money (e.g., Delfabbro & Winefield, 1999; Griffiths, 1994). However, the study conducted by Ladouceur et al. (1991) does not provide convincing evidence for the ecological validity of laboratory studies. In fact, it could be argued that this study provides evidence opposite to the conclusion drawn by Ladouceur et al. (1991).

The major problem with the Ladouceur et al. (1991) study is the lack of information provided. Although it is known that a comparison was made between playing a video poker machine in a laboratory 'casino' and playing the same machine in a grocery store, an adequate description of the grocery store context is missing. It must be remembered that Anderson and Brown (1984) suggested that contextual effects might be due to differences in the prize structure, the number of other players and the number of other machines. This descriptive information is missing and it may have been the case that the grocery store, with regard to gambling atmosphere, possessed characteristics that more closely reflected a laboratory than a casino.

An examination of the individual results reported by Ladouceur et al. (1991) provided evidence contrary to their conclusion. It was reported that there were no significant differences in the number of verbalisations made whilst playing in the laboratory or in the grocery store, \( t(18) = 4.9, p > .05 \). The number of verbalisations
is a cognitive measure associated with the ‘thinking aloud’ technique and is typically used to detect erroneous beliefs. However, the actual $t$-statistic presented (4.9) is significant ($p < .01$). This may simply be a typing error but, in the absence of relevant means to verify this, it may also be a case of misinterpretation of significance. Based on the figures reported, it must be concluded that there was a significant difference between settings in the number of verbalisations (personal communication with Ladouceur, June 2000, revealed that the $t$-statistic published should be .49).

It was also reported that the number of tokens staked per bet on the video poker game was greater under the laboratory condition than under the grocery store condition. The number of tokens staked is a behavioural measure of risk-taking. Given that the laboratory condition involved players betting with ‘others’ money, Ladouceur et al. (1991) suggested “...giving money to the subject may have produced a disinhibiting effect” (p. 115). This statement acknowledges a behavioural difference between the two methodologies and attests to the need for real world research. Video poker players stake higher when betting with money other than their own. This result supports the statements made by Anderson and Brown (1984) and is counter to the overall conclusion drawn by Ladouceur et al. (1991).

The conclusion drawn by Ladouceur et al. (1991) appears to hinge on another behavioural measure of risk-taking, that of doubling-up. This is a feature of gaming machines that allows the player to re-gamble any win obtained during the course of play, usually in a double-or-nothing format. This measure is crucial to the claim that allowing players to keep wins negates any effect that gambling with other money
may have on playing behaviour. It would be expected that gambling with other money would lead to an increase in this form of risk-taking, again due to a disinhibiting effect. To control for any machine effect, Ladouceur et al. (1991) utilised the same machine in both conditions and found no significant differences in the number of double-ups between the two settings. That is, players did not engage in this form of risk-taking any more or less in the grocery store than in the laboratory.

However, due to the absence of descriptive statistics for this measure, other explanations may be drawn. Data from poker machines in Australia (Gibson, 1997) indicate that the double-up feature is not popular and the rate of doubling-up varies greatly across machines and can be as low as 2.17% for some machines. The result in the Ladouceur et al. (1991) study may simply reflect the unpopularity of this feature on the machine utilised, rather than a true measure of risk-taking. That is, the comparison between means for each setting may have been a comparison of figures very close to 0. The participants in this sample were regular players who had experienced the double-up feature before and, as indicated by the result for stake size, will vary their risk-taking behaviour when gambling with 'other' money. However, it is possible that players will not adopt a risk-taking behaviour they do not usually engage in, and this explains the null effect for the double-up measure.

Alternatively, on Australian poker machines, the maximum number of double-ups permissible is five. If this feature is popular with Canadian video poker players, then the ceiling imposed by the game design may not have allowed for increases in this form of risk-taking in the laboratory setting. Again, the absence of descriptive statistics does not allow for a full understanding of the results reported.
Finally, operationally defining risk-taking by the number of double-ups may be inappropriate not only because the feature is unpopular, but because of the probabilities involved. The reality is that 50% of the time the player wins and 50% of the time the player loses. Hence, financially, the result is one of breaking-even over the course of play, whether this is done 5 times or 500 times. To equate risk-taking with breaking-even is dubious. A better measure of risk-taking would be the (monetary) size of the wins doubled. It was reported that the average stake size was larger in the laboratory setting, due to ‘other’ money being used, and perhaps the average size of the win re-gambled was also larger.

There also exists some evidence from other studies that fails to support the conclusion of Ladouceur et al. (1991). Delfabbro and Winefield (1999) utilised the method suggested by Ladouceur et al. (1991) with regard to ‘other’ money and reported that 3 of the 26 poker machine players stated during debriefing that they would have discontinued gambling sooner if they had been playing with their own money.

Similarly, Griffiths (1994) utilised the thinking aloud technique as a measure of cognitive activity. His 2 X 2 analysis of variance (regular/occasional, thinking aloud/non-thinking aloud) found significant differences in playing behaviour between treatment groups. The thinking aloud group played significantly longer in terms of both numbers of plays and time. The results of this study question the thinking aloud method and its disruption of playing behaviour. The disruption to play of deliberate verbalisations in gaming studies has also been mentioned with regard to
the near-miss phenomenon (Strickland & Grote, 1967). It would appear that both verbalisation of thoughts and the use of other money techniques influence the behaviour of the player, at least in terms of session length.

Walker (1992a) also questioned the need for ecologically valid designs and defended analogue studies utilising student players. He suggested that failure to meet the rigorous methodological procedure results not in different effects but in weaker effects, and if these are significant then they are nonetheless present. That is, if a relationship between variables is established in non-players then this relationship is likely to be stronger for regular players.

Walker’s (1992a) argument for the use of students assumes that gambling involvement may be represented on a continuum, which may very well be true, but should not be used to condone sampling bias and the use of non-representative samples. Sears (1986) argued that in social psychology, the sampling bias associated with the use of student participants has led to inaccurate substantive conclusions about human social behaviour. Without evidence to the contrary, this would seem equally applicable to gambling studies. It also must be noted that Anderson and Brown (1984), Ladouceur et al. (1991) and Delfabbro and Winefield (1999) have found that compromising the ecological validity of studies results, not only in changes in effect sizes, but in different effects (e.g., strategies of play, stake size and session length).

The fundamental assertion in the argument for ecologically valid studies is that the relationship between variables may differ depending upon the conditions in
which the variables are observed. This has been demonstrated when comparing artificial and real world environments but it can also be argued that the results from ecologically valid gaming studies may fail to be replicated in other ecologically valid gaming settings. For example, fruit machine gaming in the UK differs from poker machine play in Australia with regard to key variables related to the machine, the player and the playing venue. Fruit machines contain an element of skill. They are located in shopping centre amusement arcades which have no age restrictions, no non-gaming activities such as licensed restaurants and live entertainment, and also contain a greater variety of machines including video games with no monetary gambling. It therefore follows that studies of gaming machine play in the UK often comprise a different sample in terms of age, sex, history of play, playing patterns, who are exposed to different stimuli and conditions than Australian gaming machine players.

For example, from a survey of NSW residents (Chapter 2.5) it was found that there was not an overwhelming sex bias in either regular or infrequent poker machine players. Furthermore, older persons were over-represented in the regular players’ group. However, the majority of gaming machine research conducted in the UK has utilised samples of adolescents (predominantly males) who dominate the amusement arcades (Griffiths, 1991). For example, Fisher (1993) surveyed 460 UK secondary school students (aged 11-26 years); Huxley and Douglas (1992) surveyed 1332 school children (aged 11-25 years); Ide-Smith and Lea (1989) surveyed 30 male and 20 female 13-24 year olds; Griffiths (1990b) interviewed and surveyed 50 adolescent fruit machine players (mean age 16.2 years).
In addition, when differentiating between forms of gambling, it has been suggested to consider the form along the dimensions of skill and continuity (Dickerson, 1993). These dimensions also apply within forms traditionally grouped together. As emphasised by the Productivity Commission (1999), gaming machines are not all alike in these dimensions across the various jurisdictions. Australian card machines, Canadian video lottery terminals and the UK fruit machines are similar to Australian poker machines on the continuity dimension but differ on the skill dimension. Unlike poker machines, an element of skill is introduced into these games and prior experience and knowledge may have an effect on the outcome of each game.

The fundamental difference between card/fruit machines and poker machines is that the former provide a ‘hold’ feature, which influences the probability of generating a winning sequence. For example, when playing a draw poker card machine, the player is required to retain or ‘hold’ certain cards during the game. Fruit machines allow the player to retain certain reels and re-spin others. Some knowledge of the winning combinations of the game therefore can affect the outcome of the game.

Griffiths, (1993b) in his study on UK fruit machines, found that more experienced players were able to play significantly longer than occasional players (controlling for spending money and machine played), in terms of number of plays (playing time was similar between the two groups but the regular player has a significantly faster bet rate and therefore more plays). Australian poker machines offer a similar feature with certain symbols but the ‘hold’ is determined by the
machine not the player and the feature is activated on chance, eliminating any skill component.

It has also been noted previously (Chapter 2.2) that the gaming environment in the USA differs from that of Australia. The majority of slot machines are located in large casinos and attract tourist gamblers rather than the loyal players that frequent the clubs of NSW. The USA style slot machines are similar in terms of skill and continuity but are less sophisticated, containing fewer options which may reflect a less complex playing behaviour. The irregular playing patterns and unfamiliarity with games may also retard the acceptance of new game features.

The implication of these differences in the gaming experience across jurisdictions is that findings from studies examining gambling behaviour conducted with different types of players, with different motives, on different machines in different venues need to be replicated in the Australian context before any generalisations can be accepted. Although the argument for ecologically valid gaming research does limit the application of research results, it also provides a sound framework with which to assess studies of Australian poker machine play.
Chapter 4:

Studies of Australian Poker Machine Play

4.1 Cognitive Explanations

The major studies of Australian poker machine players have focussed on cognitive and behavioural explanations of session characteristics. These studies have varied in design, with some (e.g., Walker, 1992a) adapting traditional experimental methodologies to the gaming room floor. Others (e.g., Delfabbro & Winefield, 1999; Dickerson et al., 1991; Dickerson et al., 1992a; Dickerson et al., 1992b) have conducted structured observational studies of ‘natural’ playing behaviour and, although employing multiple methods, might be considered to more closely reflect a survey approach. In all cases, the research undertaken provide the most accurate and relevant information regarding both general and psychological characteristics of Australian poker machine players.

Walker (1992a) tested certain principles of cognitive theory utilising university student gamblers. According to this theory, regular gamblers have a set of beliefs, related their knowledge of the game, that maintains their gambling despite losses. These beliefs are considered irrational and, from this, Walker (1992a) formulated the hypothesis “...that gamblers whose preferred style of gambling is the
slot machine will exhibit irrational thinking especially when playing slot machines.” (p. 252).

To test this prediction, Walker (1992a) examined levels of irrational thinking between poker machine players, card machine players and amusement game players. Each type of game differed on the skill dimension with poker machines requiring the lowest level of skill, and amusement games the highest. In total there were 26 participants (aged 18-40 years) who played one form of gaming at least twice per week. Walker (1992a) argued that his homogeneous sample of first year psychology students controlled for the confounding variables of age, sex and education that might have been present if the participants were drawn from gaming sites. That is, “...slot machine players may be older, less well-educated, and more often women whereas video amusement players may be younger, better educated and more often men.” (p. 253). However, there exists several problems with Walker’s (1992a) approach and his measurement of player characteristics.

An alternative approach, to the issue of confounding variables, would have been to control these variables in a sample from the gaming sites through sampling, or to factor these variables into the analysis and determine their effect, rather than speculating.

The three groups contained similar distributions of males and females, however, their mean education level and age were not reported. Walker (1992a) also failed to measure the level of exposure to the various gaming forms. The categorisation of players was based on preferred form or current exposure rates and it
is not known whether the poker machine group had a greater history of playing all forms of games than the other two groups. Also, the sample of poker machine players only totalled nine and it is difficult to argue that they were representative of any population.

Walker’s (1992a) experiment was conducted in an ecologically valid setting and with the player's own money, but required each participant to play each type of machine for an instructed 30 minutes. During play, participants engaged in a thinking aloud activity that required the verbalisation of thoughts during play. These were recorded by the experimenter utilising a hand held microphone.

Eight judges interpreted the verbalisations and the inter-judge reliability of this measure was high (84%), but was determined by the consistency of all judges’ evaluations of only one participant’s responses. Again, this method could have been improved with a different sampling technique. A random sample of responses from all participants and use of Cohen’s Kappa as an index of concordance rather than a raw percentage would provide a better estimate of inter-judge reliability (Robson, 1993).

Given the categorisation of irrational thinking and the nature of slot machines, it was not surprising that the proportion of irrational thoughts was highest whilst playing poker machines for all players. A rational statement was defined as “...a statement of strategy which is correct (optimal with respect to winning) in relation to the structure of the game,” (p. 254). It is difficult to conceive any rational strategy statements for poker machine play, other than ‘my win/loss was the result of'
a chance event’. Poker machines are games of pure chance and therefore, by default, there are fewer rational statements that could be made during play when compared to card and amusement machines. Although this result showed some support for the hypothesis, it must be noted that all groups engaged in some irrational thinking across all machine types.

Walker (1992a) also reported that those players who preferred poker machines verbalised a significantly greater proportion of irrational thoughts across all machines than the other two groups. The problem with this result is the utilisation of proportion as a scale. It may be argued that the poker machine players verbalised fewer rational statements, thus increasing their proportion of irrational statements. Walker (1992a) did not compare raw frequencies, presumably because the time spent playing was different for some players (some refused to engage in a game for the instructed 30 minutes). Thus, both the proportion of irrational statements compared to all statements and the proportion of irrational strategic statements compared to rational strategic statements were the dependent variables. Therefore, Walker’s (1992a) conclusion that;

“...the results reported here show that slot machine players, when asked to say aloud their thoughts, emit more irrational statements than do video poker or video amusement machine players independently of the type of game they are playing.”(p. 258),

is a rather selective view of the analysis. It may have simply been the case that slot machine players emitted fewer rational statements and, if this were the case,
then the cognitive link needs to place importance on the value of each rational statement.

Furthermore, the study provided no connection between irrational thinking and maintenance of play, as suggested by cognitive theory. Even if the study employed a different methodology, the measurement of irrational thinking appears extremely subjective and sensitive to over inclusion. For example, Walker (1992a) provided four statements classified as irrational; “C’mon baby!”; “Come to mama!”; “You owe me!” and “You pay me and I’ll pay you” (p. 258).

Exactly how these statements reflect “... a set of beliefs which maintain gambling despite losses” (p. 251) is not given. They do not appear to reflect a special knowledge of machines that would provide a winning edge. Even under Walker’s (1992a) definition of irrational statements as being “…a statement of strategy which is incorrect or an attempt to influence the outcome in a way which is inappropriate.” (p. 255), the above responses do not apply. These statements appear harmless, as part of the fun of gaming or indeed any leisure activity. That is, rather than each thought being related to a strategy which will influence the outcome, each thought may be related to the entertainment of the gambling activity. A gambler cheering on a horse or football team (“C’mon team!”) that has been wagered on would be classified as irrational under the study’s criteria. For this reason, Walker’s (1992a) measurement criteria may have overestimated the number of irrational thoughts for all groups. However, empirical support is needed for the alternative explanations given above.
Furthermore, the fact that some players refused to play certain machines for the recommended 30 minutes is worthy of investigation. This appears to be a strong behavioural measure of participants' belief in the outcome, yet the statement 'I want to stop playing now' would not qualify as either rational or irrational under the study's criteria. Yet, if the player added 'I want to stop playing now, the machine isn't going to pay' then this would be classified as irrational because the player has made a statement of strategy that is incorrect (i.e., special knowledge about the machine's pay ratio).

Hence, the group differences may not represent any real difference in irrational thoughts, but differences in harmless statements that participants use to make the activity more pleasurable. Whether these bear any relationship with continuous play is unknown and they may also be related to level of involvement in gaming activities, which Walker (1992a) failed to accurately measure.

4.2 The Dickerson Studies: Study I

The Dickerson et al. (1991, 1992a, 1992b) studies were a series of ecologically valid studies of Australian poker machine players examining psychological explanations of session characteristics. In these studies, a session is typically regarded as a period of continuous play with allowances for other gambling related activities (e.g., searching for a machine, buying change). The focus of this research was the examination of behavioural principles, and to a lesser extent, cognitive and individual difference measures. Apart from the examination of real
players in real settings, another major strength of this research has been the undertaking of replicated studies.

The original study, Dickerson et al. (1992a), was a pilot study of ten regular poker machine players (five males, five females). Two participants allowed for two playing sessions to be observed, providing data on a total of 12 sessions. These participants played poker machines at least 3 times per week, their mean age was 36.4 years (range 18-61 years) and their mean expenditure per session was $16.25. They had played at their present level of involvement for at least 12 months. The study utilised a direct observation methodology that permitted the simultaneous recording of behavioural, subjective and physiological events into a hand-held microcomputer as they occurred in the participants’ usual gaming environment. The session location, time and length were all determined by the participants.

The procedure of the study allowed for measures of the gaming experience in three temporally distinct sections. Prior to play, participants were interviewed about their typical session characteristics, (location, length, expenditure), how much they perceived to be a big win, their expectations of winning during the session and their present level of excitement. This interview also contained items measuring levels of depression and anxiety. During play, heart rate was monitored electronically, subjective levels of excitement were assessed using visual analogue scales, and the observer recorded number of plays per minute, number of small wins per minute (1-50 credits), and number of big wins per minute (> 50 credits). A post-play interview sought information about financial position at the end of the session and allowed for
debriefing. Analysis of the data was conducted not only within each period, but also examined relationships between periods.

Descriptive playing behaviour information was first reported and provided information not found in self-report studies such as the 'Study 2' report discussed in Chapter 2.5. The mean duration of sessions was 71 minutes (39-122 minutes) which did not include non-playing activities greater than 3 minutes (e.g., talking with friends). Breaks in play for each session averaged 4.3 minutes and the mean play rate was 11.07 games per minute (0-21 plays per minute). That is, on average, each pull of the handle occurred every 5.42 seconds. This speed of play result supports the BPT of 5 seconds factored into Equation 2.1.

The methodology employed and the descriptive information provided, represent the major strengths of this study. However, there were numerous problems with the statistical analyses of playing data.

It was reported that the variables, heart rate, subjective estimates of excitement and likelihood that the machine would pay-out showed no significant changes during the course of play nor between minutes in which no wins, small wins or big wins occurred. Dickerson et al. (1992a) failed to indicate the type of statistical test used for this analysis, but given that a table of means was provided it is assumed that ANOVA was used. With only 12 sessions observed, the use of parametric procedures was misguided as there is little doubt that the effect sizes need to be very large for the test to have adequate power to detect a mean difference at $\alpha = .05$. 

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Dickerson et al. (1992a) created a dependent variable that measured persistence-when-losing. This was operationally defined as the average rate of dollars lost per session, which, it is assumed, was calculated by dividing expenditure by session length. Therefore, a player that loses $20 in 5 minutes is more persistent than a player who loses $20 in 10 minutes. This measure of persistence has not been proven valid and appears to be a measure of bad luck more than anything else.

Furthermore, three of the playing sessions recorded wins and were eliminated because they failed to fit the ‘when losing’ part of the definition and this provided a final sample of nine sessions. The use of regression analysis on these nine sessions was, again, misguided. This statistical modelling procedure is extremely sensitive to violations of assumptions (which were not reported) and is particularly sensitive to the size of the participants:variable ratio (Tabachnick & Fidell, 1996). Utilising the variables depression and anxiety as predictors, Dickerson et al. (1992a) concluded that depression was the only significant predictor and accounted for 36% of the variance in persistence. This figure is meaningless, as it is likely to be an artefact of the insubstantial cases:variables ratio.

Dickerson et al. (1992a) also undertook auto-regression analyses of each session. Utilising play rate as the dependent variable, which was measured every minute (number of handle-pulls per minute), it is assumed that the sample size for this analysis varied between 39 and 122 (the duration of the playing session in minutes) across sessions. Eight independent variables were entered, which, conservatively, would indicate a sample size of at least 110 (to detect medium sized relationship at \( p = .05 \)) given that the assumptions for the procedure were met (e.g.,
normal distribution, insubstantial measurement error). This information was not provided and, furthermore, the procedure relied upon a step down method of analysis, which removed variables with estimates that achieved a $p > .05$.

This is a contentious procedure as it allows the data to drive the study, capitalises on chance differences and often leads to over-fitting of the data. For these reasons, stepwise procedures typically require more cases again and cross validation with a second sample (Rowe, 1998; Tabachnick & Fidell, 1996).

Thus, the problems with the analyses were that the violations of assumptions and small sample sizes may have led to either under or overestimates of regression coefficients and under/over-estimates of model fit or the coefficient of determination. This, in turns, raises doubts about the generalisation of the results to the population.

Nonetheless, the results were interpreted as suggestive that small wins increased play rates and big wins decreased play rates, compared to baseline play rates where no wins were present. This trend occurred for 8 of the 12 sessions, but it is difficult to assess the effect of extraneous variables on these results, as there was no information regarding the characteristics of individual players. Because the analysis is no longer on all players, mean descriptions of the sample are inappropriate. For example, the coefficients obtained may be directly related to the number of trials for each participant (altering the power of each test and the reliability of the coefficient of determination) or some individual characteristic such as age, experience or level of involvement.
With 16 individual analyses of the data thus far, Dickerson et al. (1992a) further compromised the study’s efficacy by proceeding to a Markov analysis of play rate. This involved creating a transition matrix of probabilities of play rate changes (rise, fall, remain the same) in the following minute of play, the second minute of play and the remainder of the session for those minutes where no wins, small wins and big wins were recorded. This created nine matrices, which were each subjected to chi-square analysis.

From the chi-square analyses, it was reported that there was a significant structure in the play rate matrices of the following minute for the baseline (no wins) condition and the small wins conditions. From these matrices it was determined that play rates remained the same in the following minute when no win was recorded, but increased if a small win was recorded in the previous minute. No structure was found in the minute of play following a big win.

The structure of the play rate for the second minute (second order effects) was not reported despite earlier hypotheses. However, stationarity effects (over the remainder of the trials) were reported for the baseline and small wins conditions. Both these chi-square figures were reported as not significant, but closer examination of the figure for the small wins group revealed that it clearly is ($\chi^2 = 1332.47, df = 280, p < .001$). Furthermore, the probability values of the other (significant) chi-square values have been underestimated and this raises questions about the reliability of the reported findings.
Dickerson et al. (1992a) also conducted two t-tests of mean play rates between baseline and small and big win conditions. This takes the number of statistical analyses to well over 20 and one of these significant findings can therefore be expected to have occurred by chance (Type I error).

Based on these results Dickerson et al. (1992a) concluded that,

"The above results provide strong evidence that the gambling of high-frequency poker machine players is a highly disciplined and stereotyped behaviour sensitive to the reinforcement schedule inherent in the machine characteristics and, as far as within session dynamics are concerned, only weakly related to cognitive and arousal processes." (p. 245).

The study does not provide strong evidence for anything except that more research is needed in this area. As a pilot study of ten players, it assists with refining the complex methodological techniques utilised but descriptive, rather than inferential, statistics would have been more appropriate in the published report. To Dickerson et al. (1992a) credit, they are one group of a few gambling researchers who did persist with their inquiry and replicated the study with a larger sample size.

4.3 The Dickerson Studies: Studies II and III

Sixty-four poker machine players, of various levels of involvement, were recruited for the follow-up study. Low-frequency players (males = 9, females = 11) played poker machines less than twice per year. Medium-frequency players (males =
6, females = 16) played poker machines once every 1 to 3 months. High-frequency players (males = 13, females = 9) played poker machines at least once a week. Numerous variables were examined with these groups and the results reported over two papers; Dickerson et al. (1991) and Dickerson et al. (1992b).

Information regarding demographics and involvement in other gambling activities were measured and provided a detailed profile of the participants under study. There was no significant variation between the groups in sex distribution, but significant differences were found for age and marital status. The high-frequency players were older than both the low-frequency and medium-frequency groups, and contained a smaller proportion of single people. Other forms of gambling, such as off-course betting, on course betting, lotteries and bingo, were not undertaken on a weekly basis by any of the low-frequency players. Four of the medium-frequency players used one of these forms weekly, and one medium-frequency player used two ‘other’ gambling forms weekly. Ten of the high-frequency players used another form of gambling weekly, while one further high-frequency player gambled in two ‘other’ ways each week. This information follows a similar pattern to the profile of players provided in Table 2.6.

Dickerson et al. (1991) also reported descriptive statistics of the session characteristics similar to their first study. The mean duration of play for low-frequency participants was 13.05 minutes (5-29 minutes), and for medium-frequency players was 21.75 minutes (6-107 minutes). These values did not differ significantly. The mean duration of play for high-frequency players was 40.10 minutes (8-127), which was significantly longer than for the low-frequency players and approached
significance when compared to the medium-frequency players’ mean ($p = .07$). The high-frequency group also played significantly faster (~ one game per 6 seconds) than the medium and low-frequency players (~ one game per 8 seconds).

The procedure of the study was identical to the pilot in terms of sequence (pre-play, during play, and post-play), but examined a greater number of variables related to individual differences (e.g., personality, mood, arousal), cognition (expectations of outcomes) and behaviours (persistence, rate of play). Thus, the independent variable of treatment group (frequency of play) predominated during the initial stages of analyses.

The results (Dickerson et al., 1991) indicated that there were no significant differences between groups on trait measures of sensation-seeking or the Eysenck personality questionnaire. There was also no significant difference between groups on pre-play state measures utilising the Profile of Mood Scale. No significant differences were reported between groups in responses to pre-play questions about their expectations for the session, which included items regarding the expectations of a big win, finishing financially ahead and getting a ‘good run’. Groups did not differ in the amount of money considered to be a big win and there were no significant differences in baseline heart rate, heart rate during play or heart rate change (baseline to play) between the three groups.

However, the results for subjective measures of excitement indicated that high-frequency players tended to report a greater range of excitement during their sessions than the low-frequency and medium-frequency players. It was also found
that high-frequency players bought significantly more change to start with than the low-frequency and medium-frequency players (no significant difference between these two). Low-frequency players returned for more change significantly less often than the other two groups but the final net balance was not significantly different between groups.

The overall conclusion drawn from these analyses was that low-frequency and medium-frequency players did not significantly vary on key variables and this allowed for the pooling of data from these two groups (Dickerson et al., 1991). However, it would also appear that the high-frequency group only differed on the subjective excitement variable and the argument put forward by Dickerson et al. (1991) that the predictors of persistence might be different between groups is difficult to maintain. Nonetheless, persistence was measured by session duration and numerous regression analyses were conducted for both the high-frequency group and the low/medium-frequency group.

The predictors of persistence were the facets of individual difference variables mentioned above (i.e., demographics, personality, mood, heart rate and subjective excitement, finances, expectations and financial outcome). For the low/medium-frequency group, the only significant predictor was subjective excitement at the end of the game relative to the mean excitement during the game (a newly created independent variable). This provided an explained variance statistic of 31%. For the high-frequency group, significant predictors included age, disinhibition, vigour, elevation in heart rate at the end of the session, size of perceived big win and the number of big wins. These variables were then re-entered into a single equation
and only two remained significant; age and number of big wins, accounting for 71% of the variance.

The dependent variable was then operationally re-defined to measure persistence-when-losing. This variable was a measure of time spent playing whilst in an overall net loss position. For low/medium-frequency groups, it was found to be positively related to confusion and vigour, accounting for 16% of the variance. For the high-frequency group, anger/hostility and the size that a big win means to participants emerged as predictors, accounting for 56% of the variance.

Results of the play rate analysis were presented in a separate paper (Dickerson et al., 1992b). All three groups remained distinct for this analysis; thus, there was no combination of the low-frequency and medium-frequency players. Replicating the pilot study, a Markov analysis of transitions in play rates (i.e., all plays) for each group confirmed the presence of first order effects. That is, play rates in 1 minute were significantly related to play rates in the previous minute. Second order effects (a relationship between present play rate and the play rate of the minute before last) were not evident (nor was such evidence found in any of the following analyses). There was also no evidence that effects were non-stationary, meaning there was no evidence that the pattern of changes in play rate depended on how long a participant had been playing.

Dickerson et al. (1992b) followed the strategy used in the pilot (Dickerson et al., 1992a) and established a no-win baseline for each of the three data sets. These were then used in examining the effects of small wins and big wins. In the baseline
condition, only the high-frequency group showed a structured play rate as evidenced by the significant first order effect. In contrast, it was reported that all three groups showed a significant first order effect for the transition matrices conditional on there being a small win(s) in this minute. For all groups, the mean play rate showed a significant increase from the baseline condition. In addition, the matrix for the high-frequency group showed a significantly different frequency distribution from that found at baseline. This difference indicated a large reduction in the fall from the highest rates of play and an increase in the rise from the lowest rates of play. The analysis of the transition matrices conditional on a small win(s) in the previous minute confirmed that, for the high-frequency group, the speeding up of play rates compared with baseline was weaker but sustained. However, Dickerson et al. (1992b) found that the effect was much weaker in the medium-frequency group, evidenced only by a sustained higher mean play rate but no first order effect, and was absent in the low-frequency group.

The reported effect of a big win(s) (> 50 credits) on play rates was that higher rates of play were virtually eliminated in all groups (Dickerson et al., 1992b). The means of the low-frequency and medium-frequency groups were significantly lower than respective baselines. Only the mean of the high-frequency group remained higher than baseline and also retained structure in the form of the ‘1 minute memory’. In the subsequent minute, however, both this elevated rate and structure disappeared with all groups showing significantly lower than baseline rates of play.

The major problems with this study (Dickerson et al., 1991; Dickerson et al., 1992b) were similar to those of the pilot. There were a very large number of analyses
undertaken, which increases the probability of a significant result occurring due to sampling error. Furthermore, the collapsing of the low-frequency and medium-frequency groups into one group is problematic given the statistical test used. Both the sample size of 22 for the high-frequency group and 42 for the low/medium-frequency group are insufficient for regression analyses. Tabachnick and Fidell (1996) warned that the lower the participants:variables ratio the greater the possibility of model over fit, to the point where a perfect solution can be obtained by reducing this ratio. Therefore, comparisons between the coefficients of determination for each regression analysis, cannot reliably be undertaken, given both the insubstantial and different cases:variables ratio of both groups. Thus, there is little support for Dickerson et al. (1991) interpretation;

"The fact that on both variables high-frequency players were far more predictable than other players supports the general learning theme that as players have more experience or ‘training’ their play becomes more habitual and stereotyped.” (p. 544).

Similarly, the claim that the difference between high and low/medium groups provided good face validity in “...terms of its likely relevance to concepts of excess and pathology” (p. 544) is misguided. The possibility remains, that on both variables, high-frequency players achieved a greater explained variance statistic because the model was over fitting the data due to small sample sizes and the sample size difference between groups.
For the play rate analysis, however, each group contained roughly the same number of participants, but more importantly the analysis was based on rate of play for each playing minute and contained a greater number of cases for each group. Unlike the pilot (Dickerson et al., 1992a), the results were pooled for each group, rather than analysis of individual sessions of play and this overcomes the criticism of undertaking numerous chi-square analyses. All three groups showed a significant first order effect for the transition matrices conditional on there being a small win in the first minute. For all groups, the mean play rate showed a significant increase from the baseline condition.

Comparing the results of the high-frequency group in the follow-up study (Dickerson et al., 1992b) with those of the pilot study (Dickerson et al., 1992a), there was generally good agreement. The play rate structure or 1 minute memory was sustained during periods without wins. Small wins significantly increased play rates and the effect was sustained over the subsequent minute. Big wins produced different results in the immediately following minute, with the participants in the follow-up group showing both a rate higher than baseline and retaining structure whereas the pilot group showed a significantly lower rate and no structure. However, in the subsequent minute, the pilot group remained at a low rate without structure and the follow-up group gave the same pattern of responses.

There are several explanations that may resolve this difference. One possibility is that the second follow-up study is a less typical or reliable finding as it was derived from only 9 observations of big wins compared with 29 observations in the pilot. However, despite the small sample of big wins in the follow-up study, a
first order effect was confirmed and this might well suggest that the results were valid. One problem in attempting to resolve the difference is that the methodology employed located the big win event within a 1 minute time frame and play rates immediately after cannot be discerned (i.e., in any remaining seconds of the 1 minute frame). Despite this difference between the two groups of high-frequency players across studies, the follow-up results provided some support for the conclusion that such players evidence a stereotypic pattern of play that is sensitive to the size of the pay-out of the poker machine. As Dickerson et al. (1992b) noted, “...it can only be concluded that big wins are followed by a collapse of structure and rates but that in high-frequency players this may occur after a brief delay.” (p. 13).

Although personality, emotional, physiological, learning and cognitive factors were implicated a priori in Dickerson et al. (1991), no substantive grounds were provided for the inclusion of most variables. The study was exploratory, data driven, hypothesis generating and invariably led to theory conflation. Aside from the learning theory explanations and concepts of excess and pathology, Dickerson et al. (1991) interpreted the persistence regression result for high-frequency players as suggestive that;

“...older players, perhaps with fewer time constraints, played longer when they had accumulated winnings or machine credits. Such persistence at a leisure activity could be adaptive rather than indicative of impaired control or excess...”(p. 540).
This is another post hoc interpretation of the data, resulting from the lack of theory driven hypotheses and appropriate measurement techniques. The design of exploratory research is never robust enough to allow for theoretical interpretations of inferential statistics and offering face validity arguments is indicative of this, as is the operational re-definition of the dependent variable and the misuse of statistical modelling techniques. Similarly, the significant variables (anger/hostility) in the persistence-when-losing analysis were linked to “...adaptive or ego-enhancing” (Dickerson et al., 1991, p. 544) explanations with the perception of big wins variable explained by a “...decision model of subjective expected utility.” (Dickerson et al., 1991, p. 544). The results of the play rate analysis in the follow-up study were considered “...in terms of the opponent process theory of acquired motivation.” (Dickerson et al., 1992b, p. 13). There was no unification of explanations and therefore a distinct absence of theoretical value in the study. As mentioned above, Walker (1992b) was able to offer another post hoc interpretation of these results using cognitive principles.

However, the findings of Dickerson et al. (1991, 1992a, 1992b) are of importance for two reason. First, the studies were the first published with data on Australian poker machine players using an ecologically valid method and do provide valuable information regarding session characteristics. Second, the results generated further research and inspired Delfabbro and Winefield (1999) to conduct a replication of the studies. In particular, Delfabbro and Winefield (1999) were interested in the rates of responding results and learning theory interpretations of Dickerson et al. (1992a). The issues raised by Delfabbro and Winefield (1999) were based upon Walker’s (1992b) concerns that Dickerson et al. (1992a) did not
adequately demonstrate the operation of established learning principles, that the observations may be adequately explained using alternative theoretical perspectives and that the behavioural effects observed were spurious, an artefact of the methodology employed.

4.4 Theoretical Implications

The relationship between response rates and magnitude of reinforcement was curvilinear in the Dickerson et al. (1992a) study, but operant conditioning principles predict a positive linear relationship (Walker, 1992b). However, Delfabbro and Winefield (1999) cite several studies in which the reverse is found to be true. In addition, Walker (1992b) contested that in gaming machine play, the outcome is not defined on a reward/non-reward contingency. A non-reward in poker machine play more accurately represents punishment as it is a loss of coins, and under learning theory should lead to a decrease in response strength rather than the continuation of the behaviour.

Furthermore, the design of the poker machine is far more complicated than any device created for laboratory testing of learning theory principles. Even the machines in the Dickerson et al. (1992a) study were much simpler than the machines of today, which contain features that may be related to gambling behaviour. For example, modern machines provide the player with the ability to vary the amount wagered on each response (thereby increasing the potential magnitude of the win or loss), and the possibility of betting on more than 1 pay-line at a time. Thus, unlike play on earlier machines and laboratory gaming devices, today’s poker machine
players are able, by their own actions, to vary the potential magnitude of
reinforcement, the potential amount lost, and also the frequency of reinforcement (as
demonstrated in Figures 3.1-3.4).

As a result of these difficulties, Walker (1992b) exhorted researchers to
consider other theories, such as those based upon cognitive principles. For example,
as Walker (1992b) noted, the tendency of players to decrease response rates
following large wins, and to persist despite losing-streaks could be explained in
terms of gambler's fallacy or representative bias. This bias occurs when players
believe that short-run sequences of events should reflect the characteristics of long-
run sequences. The logic driving this fallacy implies that wins should eventually
follow long losing sequences, and losses follow large wins, so as to maintain the
long-run expected return. Thus, even though outcomes may be completely
independent, players in the Dickerson et al. (1991, 1992a) studies may have only
decreased response rates after large wins because of their erroneous belief in the law
of averages (i.e., that they would have to wait a long time before the next good win).

Conversely, the maintenance of response rates during losing streaks could be
due to players believing that the sequence was eventually going to end. Dickerson et
al. (1992a) did attempt to address this issue with a measure of expectancy, but the
methodology employed did not provide a suitably large number of cases to empower
the regression analysis to detect effect sizes. Also, the expectancy ratings were taken
after a large win and it is possible that this may have been partially responsible for
the observed decreases in response rates.
Delfabbro and Winefield (1999) also questioned the methodology used by Dickerson et al. (1991, 1992a) and its ability to adequately explain results with learning theory. Based on aggregated response rates, the results from Dickerson et al. (1992a) did not allow for examinations of post reinforcement pauses (PRPs) and running rates of play. That is, it is not known whether the recorded changes in play rates, in the Dickerson et al. (1992a) study, were the result of pauses after a win or actual changes to the playing rates after wins, or both.

The Delfabbro and Winefield (1999) study addressed these issues in a re-examination of the Dickerson et al. (1992a) study. It was predicted that response rates were sensitive to the magnitude of the reinforcement and that these were more likely to be the result of PRPs rather than any change in running rates. They also examined the cognitive relationship between expectancy of win and changes in response rates. Delfabbro and Winefield (1999) tested Walker’s (1992b) claim that cognitive principles, in particular gambler’s fallacy, may explain the Dickerson et al. (1992a, 1992b) results. Finally, a measure of stake size was included to determine whether this aspect of expenditure was sensitive to variations in reinforcement. No rationale was given and no hypotheses made with regard to this variable, other than it being of potential relevance.

To test their predictions, 18 regular (at least weekly, 8 men, 10 women) and 21 occasional (less than weekly, 8 men, 13 women) poker machine players were recruited. As found in the Dickerson et al. (1992a) study, the regular gamblers spent significantly more money per session and played for longer during each session. The gaming session took place in an ecologically valid environment and observations of
play was recorded with a small video camera. Players were told that they would receive $20 for participating in the experiment and were given the choice of using this money in the experiment and receiving nothing afterwards or using their own money during the experiment. They were told to play for at least 15 minutes on any machines they prefer. The poker machines in the gaming venue were all of the 5-cent denomination and possessed 9 pay-lines with a maximum bet multiplication of 10.

To test cognitive predictions, a short rating scale (1-10) was placed just above the buttons and asked players to rate how confident they were that the machine would pay-out a good-sized win (> 50 credits) during the next 1-10 trials. Players were asked to speak aloud a number (from the scale) every 30 seconds and were prompted if they forgot (the experimenter was absent from most trials reducing the possibility of observer effects).

The results of the session characteristics found no significant differences between frequent and occasional players in time spent playing, total amounts wagered and won, and rates of responding. Although the study was believed to represent a typical session of play, there were apparent differences between these results and the participants’ self-report, with earlier analyses revealing significant differences between groups in time and money spent in a session of play.

Analyses of response rate variations were two-fold. First, post reinforcement pauses were measured and the results indicated that there was no significant difference in PRPs between groups, no interaction between groups and win level but a significant difference between win levels. Delfabbro and Winefield (1999) altered
the independent variable from their earlier definition and created three levels, 1-25, 26-50, >50 credits. The results suggested that the greater the size of the win, the greater the size of the PRP. Second, the analyses of running rates (average rate of responding without a PRP) did not provide any significant main effects or interactions with the same categorisations.

For the cognitive analysis, the player's expectancy of outcome (using the rating scale) was examined with regard to the presence of wins and losses. If poker machine players consistently employed gambler's fallacy logic, it would be expected that they would increase their expectancy of a win following losing sequences, and decrease expectancy following winning sequences. It was found that only the occasional players were significantly more likely to change expectancies. However, the results indicated that these players tended to increase expectancy of win following a win, and decrease expectancy of a win following a loss. This significant relationship was not reported for regular players.

The results of the stake size analysis revealed that significantly more stake size changes were made by occasional players and that regular players tended to employ more consistent betting strategies. Stake size changes were also analysed in relation to the outcome of the previous game (win or loss), and the results suggested that players tended to increase stake size when winning, and decrease stake size when losing. This relationship was significant for regular players only.

The response rate results were interpreted by Delfabbro and Winefield (1999) as providing some support for learning theory explanations of poker machine playing
behaviour. Post reinforcement pauses were positively related to the magnitude of reinforcement but were not related to running response rates. It was noted that the observation of PRPs in schedule-induced behaviour was typically considered within fixed schedules, however, they have been observed under a VR schedule in other research but typically when the ratio is quite large.

Delfabbro and Winefield’s (1999) interpretation that the VR 3 found in their study qualifies as a large VR is debatable. Also, from the literature, their prediction appears to be without a null hypothesis, as there is a failure to formulate mutually exclusive hypotheses. That is, if no PRPs were found then the result could be attributed to the VR schedule, yet when PRPs were found the result was also attributed to the VR schedule.

The explanation for these results was based on Lowe, Davey, and Harzem (1974, cited in Delfabbro & Winefield, 1999) who theorised that an observed association between PRPs and reinforcement size might be related to discrimination learning. While all reinforcement may have a discriminative quality, larger reinforcements may provide a stronger signal to the respondent that reinforcement will not be available for a certain number of responses. Delfabbro and Winefield (1999) then questioned this interpretation based on the fact that poker machines employ a RR schedule. That is, it would seem odd to attribute discriminative qualities to PRPs given that the next reinforcement could have occurred on the very next response. Thus, the observation that pauses occur raises the possibility that players may not respond to gambling schedules as being entirely random, but more periodic or cyclic as is typically the case on fixed-ratio schedules.
Without an adequate learning explanation, Delfabbro and Winefield (1999) attempted to explain this within a cognitive framework and the concept of gambler’s fallacy. Their results from the expectancy data showed no support for the hypothesised relationship between outcome of play and expectancies (similar finding to Dickerson et al., 1992a). However, Delfabbro and Winefield (1999) suggested that these results may have been a consequence of the measures used and speculated on the role of verbal rules.

Another, more parsimonious, interpretation of the PRPs’ result is that the larger the win the larger the PRP by simple virtue that bigger wins take longer to accumulate on the credit meter. Delfabbro and Winefield (1999) considered this in their design by excluding the time the machine took to pay. However, given that time taken to accumulate on the credit meter would be highly correlated with win size, then it may be that the time taken for large wins disrupts play and this imposed delay is used by the player to engage in other adjunctive behaviours (e.g., having a drink, lighting a cigarette, looking at other games). These behaviours then carry over into what would be defined as playing time. That is, re-commencement of play does not immediately follow win accumulation. Hence, the PRP result may have more to do with the time taken for credits to accumulate than the type of reinforcement schedule utilised in poker machines.

Delfabbro and Winefield’s (1999) application of gambler’s fallacy to explain PRPs is unnecessary and contradicts the results of their own study. Not only was there no support from cognitive measures of this phenomenon, but there was also no behavioural support. The principle of gambler’s fallacy predicts that players expect a
win after a series of losses. If a player does expect a win to follow a loss then this may be measured by the player’s staking patterns. It would be expected that a player would increase their stake size when expecting a win to maximise the size of the return. However, Delfabbro and Winefield’s (1999) study found the opposite. Players tended to increase stake size after a win and decrease stake size after a loss. Therefore, the study found no support for gambler’s fallacy using cognitive measures (as reported) but also no support using behavioural measures. The conclusion drawn from this is that gambler’s fallacy exists using self-reports or the thinking aloud method but does not necessarily convert into behavioural change as measured by staking patterns.

Delfabbro and Winefield (1999) draw some parallels with the Dickerson et al. (1992a) pilot study. Both showed that larger reinforcements appear to disrupt ongoing behaviour and that poker machine gambling shares many of the characteristics of other schedule-induced behaviours. In addition, both studies showed that the behaviour of regular players is more habitual or stereotyped than that of occasional players. Thus, where Dickerson et al. (1991) found that the response rates of regular players were strongly influenced by variations in reinforcement, the present study found that this consistency might also extend to other behaviours. For example, regular players appear to have stronger fixed expectations about the profitability of machines (represented by a reduced likelihood of varying their expectations of winning), and more consistent betting strategies (reflected in a tendency to wager a similar amount all the time) than occasional players. Delfabbro and Winefield (1999) found that regular players would change their bets in
accordance with the nature of the outcomes (i.e., increase stake sizes when winning, decrease when losing), unlike occasional players.

However, there were also numerous fundamental differences between the studies. Delfabbro and Winefield (1999) found no evidence that players' response rates were affected by changes in the variations of reinforcement (i.e., running rates did not significantly vary across win size). This may be due to the different methodologies employed. Dickerson et al. (1992a) analysed the structure of play rates and the relationship between win levels and running response rates compared to an established baseline (no wins condition) between groups. Delfabbro and Winefield (1999) examined changes in PRPs (after reinforcement) and changes in running response rates after reinforcement between groups. Since Dickerson et al. (1992a) failed to consider the relationship between PRPs and size of reinforcement, their results may have been due to this effect. However, this would suggest, under the Dickerson et al. (1992a) methodology, that response rates would still show a similar pattern to that of Delfabbro and Winefield's (1999) PRP finding; that is, a positive relationship between response rates and reinforcer size. This was not the case.

Delfabbro and Winefield (1999) attempted to resolve the differences between their own and Dickerson et al. (1992a) study by noting differences in the structural characteristics of the machines. The machines in the more recent study were of the 5-cent denomination, whereas Dickerson et al. (1992a) used 20-cent machines. This created differences in the size of the credits with 50 credits worth $2.50 in the Delfabbro and Winefield (1999) study and worth $10 in the Dickerson et al. (1992a) study. In addition, the modern machines in the recent study have a different hit rate
or response: reward ratio and provided more frequent and smaller rewards. It is believed that a combination of small and large pay-outs, avoiding intermediate pay-outs, leads to greater persistence (Daley, 1986).

Also, as discussed in Chapter 2.2, other structural characteristics such as number of pay-lines and game start (handle-pull versus button press) have also undergone dramatic changes in recent years. This has implications about the role that external structural characteristics (not related to schedules) may have on poker machine playing behaviour.

4.5 The Role of Structural Characteristics

Slot machines have occupied gaming rooms since the end of the 19th century (Fey, 1983; O’Hara, 1988). Although some changes have occurred with the hit rate and speed of play, they have retained their basic structural component of intermittent reinforcement with high continuity (Fey, 1983). However, recent advances in game design have generated a number of additional, less covert, structural characteristics, particularly on Australian machines (Sutherland, 1997). Delfabbro and Winefield (1999) speculated about the behavioural effects of these more recent machine characteristics to explain differences between research findings conducted over time. Other authors have also speculated about the role of modern machine characteristics.

Cornish (1978), in his description of the structural characteristics of gambling, included not only the schedule of reinforcement and contiguity of events but also noted the multiplier potential of modern forms of gambling. In poker
machine terms, this refers to the range of staking patterns on offer, in accordance with the denomination of the machine, the number of pay-lines and multiplication of bets provided by the machine. Cornish (1978) argued that forms of gambling which offered participants a variety of odds and/or stake levels at which to make bets, and hence choose the rate at which wins or losses multiply, were likely to appeal to a greater variety of people. He also believed that these forms of gambling increased the potential for impaired control over expenditure. The rationale behind this was a combination of the illusion of control effect and operant conditioning principles;

"The opportunity that a wide range of odds or stakes gives people to exercise skilful regulation of their play according to their pattern of previous losses and wins is offset by the dangers this facility may create in some circumstances. When the opportunity to use longer odds bets or higher stakes in order to multiply winnings or recoup losses is combined with a high event frequency and short pay-out interval, participants may be tempted to continue gambling longer than they might otherwise do." (Cornish, 1978, p. 168).

This is of particular relevance to the pay-out ratio or the ratio of potential winnings to the gambler’s stake. Games like poker machines offer the chance to win a large prize for a small outlay whilst incorporating the opportunity to vary stake size with high event frequency and short pay-out interval.

Similar sentiments were expressed by Griffiths (1993a) in his comprehensive review of the structural characteristics of UK fruit machines. The argument put forward by Griffiths (1993a) was that sophisticated gaming machines are designed
with additional structural characteristics, some of which may serve to increase
persistent play via increased participation and a limited exercise of skill. Machine
characteristics such as pay-out interval and event frequency, the psychology of the
near-miss and symbol ratio proportions, win probability, bettor involvement and skill
were examined along with more modern features such as marketing inducements, the
multiplier potential, tokenisation, light and sound effects, and the psychology of
naming.

Griffiths' (1993a) view on the role of the multiplier potential was identical to
that of Cornish's (1978), citing the potential to appeal to a wide range of gamblers.
He also attempted to provide empirical support for the appeal of the multiplier
potential by citing research conducted in the UK that found certain machine
denominations appealed to different players based on age and sex (Griffiths, 1991).

Griffiths (1993a) argued that low coin denominations (1-cent, 2-cent, 5-cent,
10-cent) might be appealing to some gamblers as they indicate there is little money
to lose especially in relation to the large prizes advertised. He also linked
denomination with another modern machine characteristic, tokenisation, and argued
that staking in 'credits' instead of real monetary value may disrupt the gambler's
financial value system. This disruption may lead to increases in expenditure as it
makes account keeping difficult for the gambler.

The situation is similar in Australia and was demonstrated earlier with
Equation 2.1 and the relationship between expected hourly loss and expenditure
rates. Inserting $1 into a tokenised 1-cent machine provides 100 credits which may
appear good value to some, but can be also be lost in one bet depending upon the multiplier potential of the machine.

The other two characteristics outlined by Griffiths (1993a) are somewhat related given their symbolic interpretations. The ‘psychology of naming’ suggests that different machine names produce different impression formations and these are structural characteristics that are potentially gambling inducing. Griffiths (1993a) identified groups of machine names, some which suggested that a player could win money but not lose it, some which suggested that skill was a feature of the game, and some which suggested that the odds of winning were fair in comparison to the house.

The flashing lights and sound effects of fruit machine give a constant impression of fun and activity, as well as the impression that winning is more common than losing. Griffiths (1993a) stated that pathological gamblers were significantly more attracted to the ‘aura’ (lights, music, symbols) of fruit machines than the non-pathological gambler. Also, the sounds of machines creates an illusion that winning is frequent by playing loudly after all wins (regardless of the net position) and also generate excitement. It is suggested that light and colour affect performance and arousal levels and that gaming venues and machine manufacturers prefer colours toward the red end of the colour spectrum because of its arousing properties (Griffiths, 1993a).

Despite the claims by Griffiths (1993a) and Cornish (1978), there exists nothing in the way of valid empirical support for the notion of structural effects. Both papers cited a Royal Commission report (1950) and a paper by Weinstein and
Deistch (1974) indicating that this issue has been speculated upon for some time. A review of the non-academic literature confirm that the role of these characteristics continue to generate attention, but very little in the way of research.

Popkin’s (1994) article in U.S. News and World Report, titled “Tricks of the trade: the many modern ways casinos try to part bettors from their cash.” extended the speculations of Cornish (1978) and Griffiths (1993a) and provided other examples of stimuli that might influence gambling behaviour. Popkin (1994) put forward a case for the effect of lighting and colour and argued that people are drawn to bright red machines, but these colours quickly tire players causing them to seek softer hues. Since casinos want to avoid transitional periods when players leave one machine in search of another, bright coloured machines are positioned at the ends of long rows of slots to maximise this colour’s ability to lure players. But the machines closer to the middle of the row feature softer colours, like blues and greens, which, it is believed, have greater retaining capacity. Another related factor is dim lighting within gaming venues which is an attempt to reduce stress levels which may tire players and cause them to stop playing (Popkin, 1994).

Many of Popkin’s (1994) comments centre upon the notion of maximising the time a player spends at the venue. The rationale is that each form of gambling provides the house with a mathematical edge, and the games and gaming venues are designed to increase the time spent playing. This ultimately increases the house’s chance of winning from its clients. This may be done by simply providing fresh air, comfortable stools and promotions such as free breakfast to attract the players early to the gaming venue and keep them longer. Popkin (1994) stated that slot machines
are arranged in a maze like fashion that makes it difficult to leave and argued that the absence of indicators of time (clocks, daylight) also contribute to retaining players.

Certainly in New South Wales' clubs, some of these characteristics appear to be present, with the extension of trading hours and the use of breakfast promotions to maximise playing time. In addition, player tracking devices provide the gaming venues with useful marketing information that allows them to target players based on certain profiles. Members of a club who insert their membership card into the tracking device, located on the machine, receive bonus points for every dollar spent. These bonus points are redeemable for prizes. However, details of play (net loss, number of button presses, time spent playing) are recorded for these members along with their demographic details and history of play. At some clubs, players receive bonus points for merely attending the club, verified by the player tracking device. This could be interpreted as an attempt to promote continuity of play between sessions.

At the machine level, there has been an increase in the number of machines with bill acceptors which, it could be argued, keep players in front of the machine and minimise the transitional period by negating the need to acquire change.

Popkin (1994) agreed with Cornish (1978) and Griffiths (1993a) about influencing betting behaviour by varying the odds available and by offering low denomination games. He stated that low denomination machines were most often placed closer to the entrance of a gaming venue to attract gamblers. He also claimed that many operators varied the odds on slot machines and set a few machines to give
a generous payback. This promotes the winning environment, helps prevent a bank of machines being empty, and induces players to search for these ‘good’ machines.

Despite all these claims, the only published study cited by Popkin (1994) is the work of neurologist Alan Hirsch (1996) who developed an odour suggested to promote expenditure on slot machines. Hirsch (1996) compared the amounts of money gambled in three slot areas of a casino in Las Vegas (two odorised with pleasant but distinct aromas and an unodorised control area) across three weekends (before, during and after odourisation). For the weekend of odourisation, Hirsch claimed that his ‘secret Odorant 1 formula’ boosted slot machine profits by 45%. He explained this effect with the process of olfactory evoked recall. Popkin (1994) reported that five casinos in the U.S. have used the odour formula but this evidence comes from ‘confidential documents’ he obtained.

Overall, Popkin’s (1994) article reads as a one dimensional and paranoiac view of structural characteristics and gaming venue operations. With regard to characteristics other than schedules of reinforcement, continuity of play and skill, little is provided in the way of empirical evidence for his claims, as is the case with both Cornish (1978) and Griffiths (1993a). These speculations about the role of modern characteristics of gaming implicate their importance in behavioural terms (both as inducement to play and continuous play) but can quite easily be written off as urban myths. For example, the addition of bill acceptors to machines may have more to do with minimising staff numbers at the change booth rather than the more sinister motive of reducing transitional periods and promoting continuous play.
Similarly, a market research company in the Netherlands (Jellinek, 1997) proposed 14 changes to the structural characteristics of gaming machines designed to eliminate the game's attractiveness and ability to promote continuous play. The evidence supporting the 14 points is absent but it is believed to have evolved from self-reports of problem gaming machine players. Most of the points have been discussed above (e.g., it is proposed that bill acceptors be removed, static lighting only on machines, sound limitations with pay-outs) but again appears an overreaction as the empirical support is lacking. The suggested changes were, however, tabled in the South Australian parliament as a model for game design by the 'No Pokies for South Australia' party. Clearly the importance of structural characteristics is gaining momentum and this further emphasises the need for research on structural effects.

There does exist one study that has attempted to research the role of many of these characteristics. Bayus, Banker, Gupta, and Stone (1985) designed a model of slot machine performance on the casino floor utilising profit figures as the dependent variable. The published article provided very little detail about the results or even the 18 independent variables measured. These were all nominal level data and included the categorisation of machines, location on casino floor, type of bank machine belonged to (different shapes), type of pay-off, and symbols on the reels (fruit, cards, etc). However, the exact components of these variables were not given even though (or because) the model apparently achieved a very high goodness of fit statistic. In a post-script to the publication, one of the co-authors (Bradley H. Stone, Vice President of Casino Operations at the Sands Hotel and Casino, Atlantic City, New Jersey) discussed the application of the model;
"At the present, the Sands is continuing to develop this model with the Wharton School. We are, however, presently using the model in the following ways:

(1) The Sands is presently in an expansion mode utilising information determined by the model to design our expansion layout as well as identifying those locations which would appear to be most profitable.

(2) The models are presently being used in order to determine the characteristics and attributes of machine that are being purchased for both the expansion and for the utilisation on an ongoing basis.

(3) The models are currently being used to analyze existing locations, and in a simulation basis this model allows us to develop hypotheticals on machine profitability through the model rather than the costly basis of trial and error by physically moving the machine on the casino floor and waiting several weeks to be able to measure the success of that movement." (p. 32).

Therefore, it can be concluded that an understanding of the effects of slot machine characteristics has implications for the understanding of impaired control over gambling, policy issues regarding game design and the profitability of the gaming venue. Cornish (1978) and Griffiths (1993a) have focussed on the behavioural and cognitive effects of machine characteristics, and in particular continuous play and the promotion of erroneous beliefs about gambling. The recommendations by Jellinek (1997) for changes to structural characteristics have been utilised in policy development and the research by Bayus et al. (1985) has direct application to the gaming industry and the profitability of machines and venues. The crucial component missing from each application is the undertaking and reporting of theory driven research on the hypothesised structural effects.
Chapter 5:

Theoretical Explanations

5.1 Operant Conditioning

There is little published research on the effects of external machine characteristics, such as those mentioned by Cornish (1978) and Griffiths (1993a), on playing behaviour. Studies of the structural characteristics of slot machines have tended to examine those features inherent in all machines; the high continuity (contingency and contiguity) and the variable ratio schedule of reinforcement (e.g., Delfabbro & Winefield, 1999; Dickerson et al., 1992a, 1992b).

The major theoretical approach associated with these structural characteristics has been learning theory, and, in particular, the principles of operant conditioning. The results of these studies have provided mixed support for operant theory explanations of structural effects but, on balance, appear to have greater empirical support than cognitive accounts. Operant theory would therefore appear to offer a useful paradigm within which to explain the effects of the more modern characteristics.

Learning may be broadly defined as a change in behaviour due to experience (Chance, 1994). There are numerous measures of learning including changes in the
topography, strength, speed, rate and latency of a response as well as a reduction in
the number of errors. The core principles of operant learning were derived from
experiments examining voluntary or elicited responses. They are distinct from
traditional classical conditioning studies, which associated an emitted response with
a stimulus (Catania, 1998; Chance, 1994).

Although not all behaviours have been adequately explained under operant
principles, they have generally been demonstrated as robust in studies on a range of
animal and human behaviours and there can be no doubt about the value of operant
procedures in animal and human learning. When conceptualising gambling as a
learned behaviour, several operant principles appear particularly relevant to
understanding poker machine play and the role of structural characteristics.

Thorndike (1898, cited in Skinner, 1953) found that when a response is
followed by a satisfying state of affairs, it tends to be repeated and when followed by
an annoying state of affairs, it tends to disappear. In other words, behaviour is a
function of its consequence, a principle that Thorndike termed the Law of Effect.
This principle formed the basis for Skinner's (1953) expansion of operant learning
principles and the nature of the response-stimulus relationship. Skinner (1953)
identified four operant procedures, two of which were categorised as reinforcers due
to their strengthening (increase the rate) of behaviour and two of which were termed
punishers due to their weakening (decrease the rate) of behaviour.

The two types of reinforcement procedures were termed positive and
negative. In positive reinforcement, a response is followed by the appearance of, or
an increase in, the intensity of a stimulus (R-Sr). The effect of a positive reinforcer is
the strengthening of the response that preceded it and antecedent stimuli set the
occasion for the response. The positive reinforcer is ordinarily something the
organism seeks, however, Skinner (1953) noted "...the only defining characteristic
of a reinforcing stimulus is that it reinforces." (p. 72). In other words, a reinforcer is
defined by its effect on behaviour. Any event, stimulus, act, response or information
which, when made contingent upon the response that preceded it, will serve to
increase the relative frequency or likelihood of occurrence of that response.

Many human R-Sr relationships involve an elicited response and a secondary
reinforcer (Chance, 1994; Lieberman, 1993). Secondary reinforcers are identified by
their association with primary reinforcers through experience. Despite Thorndike's
interest in involuntary behaviours, most of the early operant conditioning studies
conditioned responses that the organism naturally emits utilising a primary reinforcer
(e.g., pecking is a natural response made by a bird when eating). However, shaping
experiments have demonstrated that the principles of operant conditioning can also
elicit behaviours from organisms and that these can be conditioned with a secondary
reinforcer. By reinforcing successive approximations to the desired elicited response,
the desired behaviour may be shaped. Research has also revealed that the rate of
operant learning and the shaping of behaviour are dependent upon a number of
variables (Chance, 1994; Lieberman, 1993; Mazur, 1998).

Chance (1994) noted that one of the variables influencing operant learning is
the contingency between the response and the reinforcing stimulus. Generally, the
greater the degree of contingency between a response and a reinforcer, the greater the
rate of learning. This is mediated to some extent by the R-S contiguity and the type of schedule of reinforcement (Chance, 1994). R-S contiguity refers to the delay between a response and its consequence. The shorter the interval, the faster learning occurs as a delay allows for other behaviours to occur, which in turn affects the R-S contingency. Another variable that affects the rate of operant learning is the condition under which reinforcement occurs. Skinner (1953) identified four simple types of intermittent reinforcement schedules that affect the rate of learning. In general, the most effective type in terms of rate of learning and strength of subsequent behaviour is the variable ratio (VR) type (Catania, 1998; Chance, 1994).

Not all variables affecting operant learning are related to the structure of the contingency. Chance (1994) reported that an individual difference variable that can influence the rate of observed learning is the degree of prior learning or exposure to the response-stimulus relationship. In general, the higher the level of practice or learning trials, the stronger the R-S relationship.

Based on these broad findings, it is not difficult to see why explanations of poker machine play have often adopted an operant conditioning approach. The fundamental characteristics of the poker machine are similar to those factors which influence learning. The poker machine is a continuous form of gambling (with high contingency and low contiguity between ‘handle-pull’ and reward), and provides a variable ratio of reinforcement. Furthermore, the strength of the behaviour is influenced by a participant's prior learning, and this has been recognised by many gaming studies that categorise players in terms of level of involvement or exposure to the R-S relationship (e.g., Delfabbro & Winefield, 1999; Dickerson et al., 1991,
Poker machine play appears as an elicited, contingency-shaped behaviour and therefore any machine characteristic with an established contingency between itself and the reinforcer should influence gambling behaviour. Typically, the secondary reinforcer has been identified as money (Walker, 1992b), and with individual differences explained by history of play, operant conditioning theory appears to set up some rather straightforward hypotheses with regard to the nature of the relationship between machine characteristics and expenditure patterns.

The results of studies conducted by Dickerson et al. (1991, 1992a, 1992b) and Delfabbro and Winefield (1999), however, indicated that poker machine playing behaviour does not unequivocally match operant theory predictions. The relationship between response rates, post reinforcement pauses, the size of the reinforcer and previous learning appears convoluted as indicated by the range of explanations offered in these studies. Inevitably, explanations are sought from outside the paradigm to include both cognitive and individual difference factors. Furthermore, it has been argued that studies examining learning theory explanations of gaming machine play have tended to ignore some fundamental behavioural and structural phenomenon of gaming machine play, such as choice between alternatives and the role of punishment (Cornish, 1978; Griffiths, 1990a; Walker, 1992b).

Thorndike’s Law of Effect noted the importance of response-reinforcement relationship, but also stated that when a response is followed by an ‘annoying state of affairs’ it tends to disappear. Skinner (1953) identified two kinds of annoying states which he termed punishment. In Type II punishment or response cost, the behaviour
is followed by the removal of a positive reinforcer (R-Sp). The effect of this punishment procedure is that it makes the behaviour less likely to occur. This differs from Type I punishment where a response is followed by an aversive stimulus. It is also different to a non-reward situation where the response fails to achieve reinforcement and does not include the loss of a reinforcer.

It could be argued that, by design, poker machine play involves Type II punishment, as the majority of bets are not rewarded. Responses are either rewarded or punished and both the reinforcement rate and the punishment rate are related. For example, if a poker machine has a hit rate of 3, then on average, 1 in every 3 responses is rewarded, and conversely, 2 in every 3 responses are punished. The distribution of wins displayed in Chapter 3.2 supports this, revealing that when playing 20 lines the hit rate is 2.2, indicating that around 45% (1/2.2) of responses will be reinforced with the majority of responses (55%) punished. This is without considering that a win may actually be less than the amount staked and therefore a punisher. It has been argued (Cornish, 1978; Delfabbro & Winefield, 1999; Walker, 1992b) that any learning theory account of playing behaviour needs to examine the influence, or lack of influence, that this form of punishment has on the playing response. In poker machine play, a scenario occurs where the R-Sr and the R-Sp contingencies are related and the rate of punishment most often exceeds the rate of reinforcement. Indeed, this scenario represents a central paradox of most gambling activities (Wagenaar, 1988).

Furthermore, there is a range of alternative behaviours available to the player, including not playing. It has been argued that understanding how the player makes
choices in the gambling environment is essential to understanding the gambling behaviour itself (Cornish, 1978). This is particularly important in learning explanations of structural effects as the range of options available to players continues to expand. It is also an area of gaming that has received little attention from gambling researchers. There are several theories of choice behaviour that predict a response distribution based on the cost and reward of the alternatives that may be applicable to gaming machine play.

The Matching Law is a mathematical equation designed to predict behaviour based on the reinforcement and punishment rate of alternative choices. Based on the work of Hernstein (1961, 1974), it may be expanded to include the quality and size of both the reinforcer and punisher. There are competing formulae derived from different theories of punishment, namely the avoidance theory and the one factor theory.

One assumption behind the avoidance theory of punishment is that the effect of punishment is indirect. Punishing one behaviour produces a reduction in this behaviour because the organism allocates more time to the alternative behaviour. In this instance, punishment of one behaviour can be deemed as additive to another behaviour. This is also true with regard to the relative amounts of reinforcement and punishment of the two alternatives. However, the majority of support exists for the equation based on the one factor theory of punishment (Chance, 1994; Lieberman, 1993; Mazur, 1998). This theory of punishment considers the nature of the relationship between reinforcement and punishment to be subtractive within each alternative; that is, “…punishment and reinforcement have symmetrical (though
opposite) effects on behaviour.” (Chance, 1994, p. 271). Thus, the response pattern of an organism can be predicted by subtracting the quality, rate and size of the punishment from the quality, rate and size of the reinforcer.

The problem with any application of this formula to poker machine play is that it is based on the long-term distributional properties of the game, and poker machines, by design, always provide greater amounts of punishment than reinforcement over time. However, the matching law is not considered a general explanatory theory of choice behaviour and has been demonstrated as inadequate when dealing with VR schedules (Mazur, 1998). Indeed, criticisms of learning explanations of the behavioural effect of punishment have tended to hinge on the concept that punishment is subtractive, ignoring other factors such as the power of the variable ratio schedule of reinforcement (e.g., Walker, 1992b).

There exists strong empirical support that organisms have a preference for the VR schedule even when it is disadvantageous. Catania (1975), Hernstein, (1964) and Mazur (1986) have demonstrated that organisms preferred a variable schedule to a fixed schedule even if it required twice as much work. The strong preference that organisms show for variable alternatives at the expense of substantial time and effort, can be explained by another factor of operant learning; the appeal of an immediate reinforcer over a delayed reinforcer (Catania, 1998; Chance, 1994).

The value of an immediate reinforcer is higher than that of a delayed reinforcer, and in poker machine play it is possible to obtain a large reinforcer after just one response. This preference for variability and immediate reinforcement leads
to risk-prone behaviour and has been demonstrated in ecological learning theory studies and explained as a means of optimising outcomes (Davey, 1989; Mazur, 1998).

5.2 Ecological Learning Theory

Ecological learning theory explains choice behaviour in terms of optimising or maximising total utility, where utility is synonymous with the concept of reinforcement (Davey, 1989). This theory arose out of behavioural exceptions to general learning principles, particularly when studying organisms other than the laboratory rat or pigeon in learning environments different from the operant chamber and T-maze and with reinforcers other than food or water. The ecological approach to learning is based on the assumption that an animal’s behaviour cannot be described in isolation from its environment. Explanatory models of behaviour focus on the biological function or adaptational problem the learning is serving (Davey, 1989).

Optimality models attempt to explain ecological learning behaviour and propose that when presented with choice, decisions made by the organism are based on the Maximisation Principle (Davey, 1989). Examples of ecological approach to research are the studies examining animal foraging behaviour. Conducted in environments that more closely resemble ecologically valid settings than operant chambers, these studies appear to provide a more suitable conceptual analogue to gaming machine play than traditional experimental studies. Instead of conceiving poker machines as operant chambers in the traditional Skinnerian fashion (e.g.,
Skinner, 1953; Stotter, 1980), poker machines may be likened to foraging patches with varying density of prey.

The structural characteristics of food patches are such that they provide a natural variable ratio of reinforcement with reinforcers of different values, and require the organism to make decisions regarding patch selection and patch persistence (Davey, 1989). For example, many animals find that their food is patchily distributed, and these patches can be found situated around their local habitat allowing a range of necessary behaviours to occur. The problem that such an animal faces when feeding is to ascertain the richness of the patch it is currently exploiting, and at what point it should move on to investigate other patches (Davey, 1989).

The maximisation problem facing the animal in patch selection tasks is to calculate the optimal amount of time to spend sampling before exploiting a particular patch. In a two-choice situation, this can be calculated mathematically in terms of what is known as the Two-armed Bandit problem (Krebs, Kacelnik, & Taylor, 1977; Wahrenberger, Antle, & Klimko, 1978, cited in Davey, 1989). This conceptualises the problem as one of the organism being faced with two poker machines and a limited number of coins. Davey (1989) outlined the dilemma and the factors associated with the solution;

"The animal has to discover which of the one-armed bandits is more profitable as quickly as possible. The solution to this optimal sampling problem will depend on two factors: (1) the difference in food distribution (density or richness) between the two alternatives; and (2) the total time available for foraging. If the
animal spends insufficient time sampling, it risks exploiting the poorer alternative; if it spends too long sampling, it risks not taking full advantage of the richer alternative.” (p. 244).

With regard to patch persistence, the maximisation problem facing the animal is to leave the depleting patch at the point where the animal’s average net energy intake per unit time would not be reduced by seeking food in other patches. The Marginal Value Theorem (Charnov, 1976, cited in Davey, 1989) predicts that the organism should stay in a patch until its rate of energy intake reaches a marginal value that is equal to the net rate of intake for the habitat as a whole.

When applying this theory to different organisms in different situations, behavioural ecologists recognised the assumption that animals attempt to maximise their net rate of energy intake, needed to be sensitive to the appropriate currency and other relevant factors, such as competing demands, for each particular organism (Davey, 1989). Thus, for individual species foraging for food, each prey has a benefit and a cost associated with it. For example, a bird may have to decide between a local patch that is rich in low value prey that are easy to catch and another patch some distance away, containing few but higher value prey that are difficult to catch.

In poker machine play, the density and richness of a patch could be analogous to the frequency and size of secondary reinforcement and the time available for foraging could be a composite of time and expenditure limitations. This appears to have some support based on Daley’s (1986) statement about changes in the hit rate of
poker machines over the years (smaller, more frequent wins) and Popkin’s (1994) argument that the gaming room is designed to maximise player time and expenditure.

In terms of explaining the effects of structural characteristics, it would be hypothesised, under traditional operant conditioning principles, that any structural characteristic of the poker machine needs to establish a R-Sr contingency to shape behaviour. Yet, according to ecological learning theory, the structural characteristics may also influence gaming behaviour by offering the opportunity to maximise the net rate of return. For example, all machines offer a prize for playing, and this prize is contingent upon the gambling response. However, if the cost of playing is the same across machines, but the prize on offer differs, then playing the machine with the larger prize should be chosen because of its maximisation potential.

In ecological learning studies of animals and their foraging patterns, both the predictions of the two-armed bandit theory and marginal value theorem have generally been upheld (Cook & Cockrell, 1978; Cook & Hubbard, 1977; Hubbard & Cook, 1978; Kacelnik, 1979; Krebs, Ryan, & Charnov, 1974; Smith & Sweatman, 1974, cited in Davey, 1989). However, the application of these theories to gaming behaviour reveals how unique and complex the poker machine is and how difficult it is to parallel the behaviours of animal foraging and human gambling. These models make assumptions that are generally not met in gaming behaviour. For instance, poker machines are designed so that the energy returned (money) is less than the energy input (e.g., a return rate of 90%). If a player possesses the knowledge of the overall return rate of the gaming room, then playing the poker machines can hardly be considered an optimal strategy for obtaining secondary reinforcers.
However, it may be argued that this sub-optimal behaviour is due to factors such as the intermittent schedule of reinforcement, the immediacy of the reinforcer and the opportunity to win a large prize which has previously been linked to risk-prone behaviour (Davey, 1989; Mazur, 1998). The problem with this explanation is that the crucial difference between a poker machine and a foraging patch is the schedule of reinforcement (RR versus VR), as the machines do not deplete in reinforcers over time. Losing on a machine one day may be followed by a win on the next. Persistence may actually result in the machine becoming repleitive and this contradicts a basic assumption of the marginal value theorem.

Other difficulties with the application of ecological learning theory to poker machine play arise when considering the structural characteristics of machines. The option of responses are much broader with issues surrounding stake size and the multiplier potential of machines, along with the host of complex modern machine characteristics. In addition, the gaming room contains numerous patches that the participant knows a priori to contain rewards and this may affect the selection procedure (e.g., gambler’s fallacy of not playing a machine that has recently paid out, Cohen, 1972). Finally, one of the strengths of ecological learning theory was its recognition of individual organisms and their competing demands, yet the organisms used in much ecological learning theory studies tend to be lower order types such as mice, wasps and birds (Davey, 1989). Subsequently, the responses of the animals studied have been those which are emitted by the animal rather than elicited, as the gambling response is in humans.
5.3 Learning Theory and Gambling

Although the general principles of operant learning have been demonstrated in a range of human behaviours, the application of learning theory principles to gambling behaviour is problematic. The results of studies conducted by Dickerson et al. (1992a, 1992b) and Delfabbro and Winefield (1999) demonstrated that gambling behaviour does not neatly fit the predictions of the traditional operant principles. In addition, the recent theories of choice that deal with the costs/benefits of alternatives (matching law) and optimisation strategies (ecological learning theory) have problems with the sub-optimal nature of gaming machine play and the complexity of the gaming environment. These difficulties have been recognised by the attempt of others to explain gaming behaviour in learning theory terms.

Cornish (1978) and Walker (1992b) have noted the problems with the application of learning theory to gambling behaviour. Inevitably, explanations have failed to wholly account for gambling behaviours and have tended to include references to individual differences and cognitive variables. For example, Cornish (1978) provided one of the more thorough accounts of operant theory explanations of gambling but still could not avoid references to cognition and other internal states.

Cornish (1978) argued that persistent gambling behaviour might be shaped by the inter-relationship between the structural characteristics of the activity such as the contingency, contiguity and schedule of reinforcement. However, he did not provide a detailed analysis of this process for any one form, but instead highlighted the complexities of the issue such as identifying the reinforcer and the consideration of
conjunctive schedules of reinforcement. Furthermore, Cornish (1978) noted another important component of learned behaviours that is absent from gambling behaviour; continuous reinforcement.

In most shaping experiments, continuous reinforcement in the early stages of the process is important for learning to occur. However, continuous reinforcement is distinctly absent in most forms of gambling, instead, initial behaviour is more likely to be punished. He did, however, cite examples of how the gaming venue might attempt to provide continuous reinforcement through prize structuring, near-misses and the variation of odds. Cornish (1978) argued that, once the player has experienced initial reinforcement, the structural characteristics of the machine might then play a role in gambling behaviour, particularly in the promotion of persistent play. However, the account by Cornish (1978) is purely speculative with only minor support coming from Dickerson's (1979) study of off-course betting.

Walker (1992b), in his description of gambling as a conditioned behaviour, also failed to provide a detailed application of operant principles to persistence in gambling. It must be noted that from the outset, Walker (1992b) declared his allegiance to cognitive explanations of gambling and devoted little space to learning theory explanations. As with Cornish (1978), Walker (1992b) indicated the problems with identifying the reinforcer, suggesting that multiple reinforcers such as money and arousal levels may exist. For Walker (1992b), a particular problem of learning theory explanations is that gamblers inevitably lose and this is an aversive situation, which predicts discontinuation of play rather than persistence.
Walker (1992b) also cited other phenomena such as gambler's fallacy, which learning theory has difficulty explaining. He concluded his summary of gambling as a conditioned behaviour arguing that cognitive accounts have greater utility. He argued that descriptions of learning theory through reinforcement contingencies have tended to ignore the relevance of people's subjective expectations or other cognitive variables as explanations of behaviour. The fact that misleading information about relevant features of the gambling process can, as it were, program players to make responses which are objectively inappropriate already suggests the importance of cognitive factors that mediate between stimuli and the responding behaviour (Walker, 1992b).

5.4 Cognitive Theory: Normative Decision Theory

Although learning theory dominated initial investigation into gambling behaviour, there has been a recent growth in the use of cognitive theory to explain structural effects on gaming. In general, cognitive explanations of gambling behaviour have focussed on the rules governing behaviour rather than the contingency-shaped explanations associated with operant conditioning.

Excessive gambling behaviour has received the most attention by cognitive theorists and it has been argued that this behaviour is a result of faulty or erroneous rules. Studies supporting the cognitive approach have observed phenomena not readily explained by learning theory, such as biased evaluations of outcome, illusions of control, gambler's fallacy and irrational thoughts. However, despite strong support for these phenomena (Gboury & Ladouceur, 1989; Griffiths, 1993b, 1994;
Ladouceur et al., 1988; Ladouceur et al., 1991; Walker, 1992a), ecologically valid
studies have questioned their behavioural importance in poker machine play
(Delfabbro & Winefield, 1999; Dickerson et al., 1992a). Nonetheless, cognitive
theory appears to offer a viable explanation for structural effects, particularly when
R-S contingencies are lacking.

Cognitive theory is based on the inherent premise that cognitions, emotions
and behaviours act in an interdependent manner with resulting faulty information
processing, dysfunctional schemata and/or irrational styles of thinking playing a
direct causal role in the behaviour (Medin & Ross, 1997). The common thread
between different cognitive models is the assertion that cognitions affect behaviour,
that covert thoughts can be brought to conscious awareness and monitored, and that
maladaptive cognitions can be altered leading to behavioural change. When gaming
machine behaviour is viewed within the cognitive paradigm, the task becomes one of
identifying the structural characteristic of the game associated with the rules
governing the gambling behaviour.

Skinner (1969) first distinguished between contingency-shaped and rule-
governed behaviours when it was found that not all humans performed similarly
under the various types of reinforcement schedules. It appeared that a host of
individual difference variables, such as previous experience with contingency-shaped
relationships and instructions given to participants, needed to be considered when
analysing complex human behaviours. In other circumstances, participants formed
rules about responding independent of either previous experience or instructions.
This demonstrated a key inadequacy of operant conditioning principles to predict behaviour and paved the way for cognitive models of behaviour.

One cognitive approach utilised to predict rule-governed behaviour in gambling is the Normative Decision Theory (Wagenaar, 1988). In some respects, this is a similar formulaic theory to the matching law and optimality models of choice behaviour as it is also based on long-term distributional properties of the game. In normative decision theory, decisions are modelled as choices among alternatives. The components of the model are not related to the quality, size and rate of reinforcement of the alternatives, but are based on expectancies. The two components of expectancy are the utility (or personal value) of the alternative choices and the estimated probability that this utility will be obtained. These aspects are combined in some way and the combination rule is chosen such that the expected utility equals the mean utility obtained in the long run. This denotes multiplication of the probability and utility.

Wagenaar (1988) provided a simple example of this with respect to lottery gambling. In his example, the cost of the ticket is $10, the only prize is $1,000 and there are 500 tickets. The choice to be made is whether to buy a ticket or not and this can quantified by multiplying the probability of the utility by the value of the utility for each option and subtracting the losing scenario from the winning scenario (much in the same way that the matching law subtracts the punisher from the reinforcer and the two-armed bandit model considers the density and richness of patches). Thus, in this example, there is a 1/500 chance of winning $990 ($1,000 prize minus the $10 ticket cost) and a 499/500 chance of losing $10, which equates to 1.98-9.98 = -8
[(1/500 x 990) – 499/500 X 10). That is, the choice is between participating in the lottery and losing an average of $8 or not participating and keeping the status quo of a nil win or loss.

The problems with applying this equation to gambling are again similar to those of matching and optimisation. Under rational decision-making, gambling should not occur in the first place. The equation is based on the long-term expectancy of events and in all chance gambling situations, the result will always be in the negative. It is also disputed whether gamblers base their decision on the long-term sequence of events or treat each individual gamble as a separate and unique event (Wagenaar, 1988). Furthermore, the model becomes especially complicated when the utility and monetary values are not equated; that is, if utility is interpreted as the subjective value attached to an amount of money. For example, losing $10 may be considered insignificant to some but not to others and therefore possesses different utility values dependent upon a host of circumstances related to the individual. For the gambling researcher, this introduces a range of measurement problems.

The acceptance of gambles with a negative expected value can only be explained within a framework of a normative decision theory when it is assumed that utility and monetary value are not identical. This creates the problem that utility, being a subjective quantity, must be measured independently of value. Wagenaar (1988) noted that measurement of utility was only possible when people conformed to rules and listed several utility axioms that might apply to gamblers. However, he also demonstrated that gamblers violate these rules making the measurement of utility impossible. Therefore, normative decision theory could not be used as a
meaningful context within which to understand the rules of gamblers. Consequently, Wagenaar (1988) suggested that gamblers did not base their decisions on a rational evaluation of probabilities and utilities but on a repertoire of reasoning strategies or heuristics.

5.5 Heuristics and Biases

The heuristic and biases framework of human reasoning considers reasoning as a special mental process, one for which people rely on special-purpose mental rules to draw conclusions (Medin & Ross, 1997). Cognitive heuristics are double-sided and can be both effective in some cases and misleading in others. Error in these rules may result from failure to interpret a problem in terms of the appropriate rules; that is, a failure to see which rules are relevant in a particular instance. People may fail to make any mental match to an appropriate rule or may make use of inference rules that do not apply to a given situation. It may also be that inference rules do not exist for many kinds of reasoning and in such cases, people are assumed to use other kinds of strategies and these too, may be prone to error (Medin & Ross, 1997).

Random situations such as gambling are situations where inference rules can lead to errors in reasoning. Wagenaar (1988) argued that epistemic reasoning could not be used when outcomes were controlled by randomising devices and that the application of perfectly normal modes of reasoning leads to ‘disaster’ when applied to gambling. It was suggested “...gamblers gamble, not because they have a bigger repertoire of heuristics, but because they select heuristics at the wrong occasions.” (p. 116).
Wagenaar (1988) further argued, in a similar fashion to Cornish (1978) Griffiths (1993a) and Popkin (1994), that almost every detail of organised gambling seemed to be designed for the promotion of epistemic reasoning. Players may be aware of the consequences of gambling but the characteristics of gambling disrupt reasoning by providing an illusion that winning is possible, that gambling is cheap to play and that the outcome can be controlled. Heuristics are believed to have the effect of reducing uncertainty by replacing aleatory reasoning with epistemic reasoning, but in chance situations can cause cognitive distortions. Wagenaar (1988) outlined a summary of 16 such cognitive distortions that he believed operate in gambling situations. These were refined by Griffiths (1994, pp. 352-354) to six major distortions in his application of cognitive biases to gaming machine play.

One of the most salient cognitive distortions of gambling is the illusion of control. Langer (1975) defined the illusion of control as an expectancy of success higher than the objective probability would warrant. In essence, her basic assumption was that in some chance settings, those conditions that involved factors of choice, familiarity, involvement and/or competition stimulate the illusion of control to produce skill orientations. These observations have some support from both laboratory-based experiments (e.g., Langer, 1975; Langer & Roth, 1975; Reid, 1986) and field studies (e.g., Griffiths, 1990a).

Other distortions related to the expectancy of outcome include representativeness, illusory correlations and the availability bias. Representativeness applies to random samples of data and is where people expect to find a representative relationship between samples drawn from the population and the population itself
(Tversky & Kahneman, 1971). For instance, when participants are asked to create a random sequence of imaginary coin tosses, they tend to produce sequences where the proportion of ‘tails’ in a short segment is closer to .50 than chance would predict (Tune, 1964). This particular mechanism may well explain the gambler’s fallacy; that is, the expectation that the probability of winning will increase with the length of an ongoing run of losses (Wagenaar, 1988). Illusory correlations are superstitious behaviours when people believe variables covary when in fact they do not. An example of this is the study by Heinslin (1967) who reported that craps players rolled the dice softly if they wanted low numbers and harder if they wanted higher numbers.

The availability bias occurs when a person evaluating the probability of a chance event makes the judgment in terms of the ease with which relevant instances come to mind (Tversky & Kahneman, 1973). For instance, pools winners are highly publicised and casinos often place slot machines next to each other in big groups so that the sound of winning (coins falling into the pay-out tray) can be constantly heard. Both give the idea that wins are regular and commonplace when in fact they are rare.

Complementing the distorted expectancies about the outcome of gambling are attributional distortions after the fact. The notion of flexible attributions refers to cognitive distortions in which gamblers attribute their successes to their own skill and failures to some external influence. Research by Gilovich (1983) demonstrated that gamblers betting on football games transformed their losses into ‘near wins’ and spent far more time discussing their losses and discounting them while bolstering
their wins. It was also reported that gamblers pinpointed ‘fluke’ events that contributed to a loss but were unaffected by identical events that contributed to a win. Gilovich also showed that gamblers displayed hindsight bias (i.e., they are not surprised by the outcome of a gamble and report they predicted it after the event has happened). The same effects have also been found in gambling activities such as computerised bingo in which losses could not be easily explained away (Gilovich & Douglas, 1986). There are also a number of studies using the thinking aloud method (Ericcson & Simon, 1980, 1984) which have confirmed gamblers produce flexible attributions (e.g., Gaboury & Ladouceur, 1989; Ladouceur & Gaboury, 1988; Ladouceur et al., 1988; Walker, 1992a).

Finally, fixation on absolute frequency refers to when people measure success using the absolute rather than the relative frequency of wins. Such people do in fact win a lot compared with most people but because they gamble so much, they actually lose more than they win (Griffiths, 1994).

Essentially, distorted cognitions may be interposed at any stage of the gambling cycle leading the gambler to believe erroneously that they have a greater level of skill or control over events/play than in actuality (Wagenaar, 1988). Distorted cognitions may also lead to selective recall of wins in preference to losses promoting an over-evaluation of success.

Cornish (1978), Griffiths (1993b), and Walker (1992b) have applied these heuristic principles to certain machine characteristics. The argument follows that certain structural components of gaming machines promote the cognitive distortions
described above, misleading the player about the true nature of events, ultimately resulting in increases of gambling expenditure. This may occur via increases in the number of players attracted to gambling and increases in the amount wagered.

Walker (1992b) interpreted the response rate results of poker machine players in the Dickerson et al. (1992a) study in terms of representativeness bias and likened the behaviour to the gambler’s fallacy phenomenon. He explained that even though the outcome of each response under a random ratio schedule was completely independent, players in the Dickerson et al. (1992a) study might have only decreased response rates after large wins because of their erroneous belief in the law of averages. That is, for the machine to maintain an average, it will not provide a win until the player has incurred several losses. This, in turn, promotes the maintenance of response rates during losing streaks, as the players erroneously believe that the losing sequence is eventually going to end. This representative bias has also been associated with both the near-miss (in terms of reinforcing the belief of an approaching win) and the multiplier potential characteristic of poker machines (Griffiths, 1993a).

As discussed previously, the multiplier potential of a poker machine consists of three characteristics; the denomination of the machine, the number of pay-lines and multiplication of bets. Cornish (1978) and Griffiths (1993a) argued that the multiplier potential increases a player’s level of involvement by providing the opportunity to choose the rate of wins and losses. In consideration with representative bias and the illusion of control concept, this structural characteristic appears a potent source of cognitive distortion. Offering poker machine players a
range of pay-lines and bet multiplications allows for the behavioural manifestation of erroneous beliefs about the ability to influence impending wins and losses, and with each extra pay-line and bet multiplication coming at a cost, can lead to increases in expenditure.

Furthermore, the other dimension of the multiplier potential, machine denomination has been implicated as providing a suspension of judgement (Griffiths, 1993a). Suspension of judgement refers to those machine characteristics that disrupt the gambler’s financial system. For example, there exists a range of denominations in modern machines and the recent introduction of low coin denominations (1-cent, 2-cent, 5-cent) may appeal to gamblers as it could be falsely interpreted that there is little money to lose, especially in relation to the large prizes advertised. In Australian gaming venues, some machines are linked to large cashcade jackpots that increase the size of the pay-out ratio and may also contribute to the suspension of judgement. Related to the effect of the machine denomination is the introduction of tokenisation. The use of machine credits instead of actual monetary value may also disrupt the gambler’s financial value system (Griffiths, 1993a).

The bill acceptor, which allows monetary notes (instead of coins) to be accepted by the machine, can also be argued to induce a suspension of judgement. Originally, poker machines required the insertion of a coin equivalent to the denomination, thus a 5-cent machine could only accept a 5-cent piece and each coin inserted increased the number of credits at the same rate. Tokenisation allowed for $1 coins to be inserted in all denominations, and therefore each individual $1 coin inserted would provide 20 credits on a 5-cent machine. Bill acceptors allow for notes
of any size and thus the insertion of one $10 note provides 200 credits
instantaneously on a 5-cent machine.

When considering the inter-relationship between these characteristics, the
heuristics argument provides a persuasive account of the relationship between
machine characteristics, cognitive distortions and gambling expenditure. The large
pay ratio (possible win size:outlay) and the bill acceptor disrupt the gambler’s
financial system, the multiplier potential creates the illusion of skill, the ability to
maximise wins and recoup losses and the structure of the random ratio and near-
misses promote representative bias. Combined, these factors appear to provide a
complete account of the initiation and continuation of betting. However, this
cognitive argument also suffers from numerous problems, not the least of which is
the inability of the theory to predict outcomes, rather than merely offering post hoc
explanations for gambling behaviour.

Wagenaar (1988) noted that the heuristic approach did not indicate which
heuristic would be applied in a given situation. Even more problematic, from the
account above, it is evident that “...several heuristics could be chosen in one and the
same situation, and that these heuristics lead to opposite behaviours.” (Wagenaar,
1988, p. 115). For example, if poker machine players believe they can control
outcomes and are influenced by the pay ratio, then playing the higher denomination
machines (where each credit won is of greater value) that are linked to a cashcade
jackpot would provide behavioural support for these distortions. But other cognitive
distortion principles suggest that the lower denomination machines attract players
because they disrupt the players’ financial system and offer a greater range of
multiplier potential options. Thus, the context of heuristics and biases does not allow for the prediction of actual choices made by individual players. Wagenaar (1988) reported that experimental demonstrations of heuristics and biases have never yielded unanimity among participants and explanations of the individual differences have rarely been attempted.

The number of heuristics is problematic and the theory lacks parsimony. In a post hoc fashion, it appears than any gambling behaviour could be accounted for by one or more heuristic. Walker’s (1992b) application of cognitive theory to the results of the Dickerson et al. (1992a) study is an example of this. Studies that have attempted to test theory driven hypotheses about cognitive distortion in poker machine players have also failed to adequately support this theory. The nature of Walker’s (1992a) study on irrational thoughts in poker machine players versus other gaming machine players was based on the premise that the number of irrational thoughts was related to persistent play and even problem gambling (similarly, Griffiths, 1994 measured the number of irrational thoughts in his study on fruit machine players). Wagenaar (1988) argued that it was not the size of the heuristics repertoire but the selection of heuristics at the wrong occasion that was important. Merely stating that a particular group possesses more irrational thoughts when gambling assigns a unit weighting to each irrational thought without considering the potency of each.

Similarly, the actual behavioural consequence of the irrational thought needs to be measured. Delfabbro and Winefield (1999) reported that players did have expectancies about the outcome of the next bet; that is, they displayed evidence of
gambler's fallacy, but these expectancies did not influence their staking patterns. Hence, Walker's (1992b) comments that until phenomena such as gambler's fallacy are understood in terms of reinforcement, cognitive accounts of poker machine playing behaviour are likely to prevail, appears misguided. If gambler's fallacy does not result in actual behaviour change, then it is unreasonable to expect a theory of behaviour to explain it.

In empirical terms, the net worth of both learning and cognitive theory to predict the relationship between gaming behaviour and the structural characteristics of gaming machine is low. Both theories have problems with the consistent negative consequences of gambling or fail to adequately provide testable predictions. The results of empirical studies investigating both theories are at best ambiguous, but there do appear to be key elements shared by both theories. It is these similarities that may serve to guide the formulation of research hypotheses regarding structural effects.

5.6 Predicting the Relationship between Machine Characteristics and Playing Behaviour

Explaining the role that poker machine characteristics play in gambling behaviour has proven problematic. There is not a substantial body of published research to suggest that the structural characteristics are an important component of the gambling process, yet the number of characteristics implicated is expanding. In addition, any theoretical explanation of these characteristics is either based on learning or cognitive principles and both these approaches have difficulty in making
testable predictions about the more modern, external machine characteristics. Although these theories differ in their core approach to gambling behaviour, considering it as either contingency-shaped or rule-governed, there remains some consistency between the two approaches which may assist the formulation of research hypotheses.

Both theories recognise the role of money as an important motive driving gambling behaviour. Poker machine play cannot exist without money. It is required for initiation of play, it is in constant use during play, it provides a quantifiable measure of the outcome of play for the player, and it is an inherent feature of excessive gambling measures. Money also provides a quantifiable measure of gaming venue and machine performance for the industry. In learning theory terms, money is the classic example of a secondary reinforcer that has acquired its reinforcing properties through experience (Catania, 1998; Chance, 1994). Poker machine play is contingent upon the wagering of money and the gambling response is both reinforced and punished with the presentation or withdrawal of money. The schedule of reinforcement promotes the continuous expenditure of money by intermittently reinforcing the staking-of-money response and the player’s history of play can be measured in monetary terms. Furthermore, the secondary reinforcer of money is itself associated with other reinforcers of poker machine play, such as winning sounds, flashing lights and the size of the credit meter (Griffiths, 1993a; Walker, 1992b).

Studies of the principles of heuristics and biases confirm the importance of money in gaming machine play. Cognitive distortions are believed to disrupt the
gambler's financial system, create expectations about winning and losing money and affect the gambler's perception of previous wins and losses (Griffiths, 1994; Wagenaar, 1988; Walker, 1992b). Thus, the behavioural manifestations of cognitive distortions are inevitably related to the expenditure of money. Indeed, under both theories, any prediction of the structural effects on gambling behaviour should be evident in the expenditure patterns of the gambler. This is not surprising given that the definition of gambling (Chapter 1.1) makes reference to the act of staking money and players have reported the opportunity to win money as a major motivational factor (Chapter 2.5).

However, the utilitarian or economic approach to poker machine play does not have universal support. Others have argued that gambling can be driven by an experiential consumption motive, as it also has symbolic and hedonic purposes. Moody (1992) goes further to suggest that money could be dispensed with altogether. Because the odds are heavily against the gambler, an economic theory of gambling motivation is incomplete and therefore the player can be seen as playing with money rather than for it. Some of the posited symbolic motives for gambling behaviour include the experience of risk-taking and any associated physiological arousal. Others include gambling to escape from boredom, for socialisation, and to maintain a symbolic sense of control over one's destiny (Cotte, 1997).

Griffiths (1999) also questioned the notion that gambling is maintained by winning and losing sequences. In particular, he argued that the assumption of monetary reinforcement, in operant conditioning explanations of gambling, limits the explanatory power of this theory. For example, the Delfabbro and Winefield (1999)
study (reviewed in Chapter 4.4) failed to consider the near-miss phenomenon as a factor related to continuous play. Griffiths (1999) suggested that a biopsychosocial approach should be adopted, and that all reinforcers should be considered (e.g., arousal experienced or the thrill of gambling, social rewards, near misses).

Certainly, Australian poker machine players have reported the existence of other motivational factors aside from the opportunity to win money (Chapter 2.5). However, the role of money appears crucial even if gambling is viewed as experiential consumption. Kusyszyn (1984) stated that even if gambling money were to lose its economic market value, it would still work as an incentive. For example, the effects of risk-taking such as associated arousal are diminished unless money is involved.

Furthermore, the utilitarian versus experiential consumption debate is rooted in the context of maintenance of gambling. The issue does not appear directly related to the measurement of structural effects and, thus, gambling expenditure would appear as an appropriate measure of structural effects.

However, establishing structural characteristics to serve as observed variables and predicting the relationship between these and expenditure based on cognitive or learning principles is more difficult. With the R-Sr and R-Sp relationships intertwined and punishment having a subtractive effect on the properties of the reinforcer (Mazur, 1998), learning theory would predict that playing poker machines should never occur. None of the modern machine characteristics have been examined within the learning theory paradigm, yet some support does exist for learning theory.
explanations of other characteristics, such as the schedule of reinforcement and the high degree of continuity (Delfabbro & Winefield, 1999; Dickerson et al., 1992a, 1992b). Learning theory also provides an explanation for individual differences based on prior exposure to the contingencies (Chance, 1994).

Cognitive theory has been associated with numerous machine characteristics, in particular, the newer features of game design (Griffiths, 1993a). This may be a consequence of cognitive explanations of gambling gaining momentum at a time when machine characteristics were expanding, but cognitive distortion principles do appear to provide a thorough, encompassing explanation of gaming behaviour. However, the explanations tend to be executed in a post hoc fashion and the principles of heuristics and biases have difficulty making research predictions. These principles are often contradictory in behavioural terms and fail to account for individual differences (Wagenaar, 1988). More importantly, there is no empirical support for the many speculations about structural characteristics promoting cognitive distortions, let alone cognitive distortions influencing gaming machine play (Cornish, 1978; Griffiths, 1993a; Wagenaar, 1988).

Underlining the theoretical problems with explanations of structural effects is the absence of research in the area. Although a few studies exist examining those game structures inherent in all machines, there is no empirical evidence suggesting that the more modern characteristics influence gaming behaviour. The effect of the multiplier potential on expected loss (Chapter 2.6) and the temporal relationship between machine characteristics and turnover per machine and per capita expenditure figures (Tables 2.3 and 2.7) provide a basis for research, but do not
demonstrate structural effects. Therefore, in the absence of adequate theoretical explanations for structural effects, it would appear that the first step in determining the role of structural characteristics is empirical observation of the hypothesised structural effect.
Chapter 6:

An Examination of Structural Effects

6.1 Introduction

The structural characteristics of poker machines have been implicated in explanations of gaming behaviour. Typically, investigations have focussed upon those characteristics that are inherent in all machines, such as the ratio schedule of reinforcement and the varying magnitudes of the reinforcers (Delfabbro & Winefield, 1999; Dickerson et al., 1992a, 1992b). These may be termed internal structural characteristics as they are fundamental characteristics of poker machines and form the basis of game design.

However, very little published research has measured the relationship between other structural characteristics and player behaviour. These other structural characteristics are termed external characteristics for the purpose of distinction. They are defined as secondary characteristics of the poker machine and are a relatively recent addition to game design. For example, the multiplier potential of poker machines underwent dramatic changes in 1988. This feature is made up of three characteristics; denomination, pay-lines and bet multiplication. If these characteristics remained constant instead of containing many levels, the poker machine would still function as it has traditionally done. Similarly, if bill acceptors
were removed from machines, the core experience of gaming machine play would remain (i.e., ratio schedule of reinforcement, continuous play, varying magnitude of reinforcers).

It has been suggested that a large number of external structural characteristics influence gaming machine play (Cornish, 1978; Griffiths, 1993a). Some of these characteristics are unique to certain types of slot machines found in certain countries, such as the nudge and hold feature of UK fruit machines, but most are present on poker machines in NSW. In this jurisdiction, the adoption of new machine characteristics by players is considered to be relatively quick (Sutherland, 1997) and, thus, the notion of structural effects appears particularly important.

There has been much theorising of the function that these external characteristics play in inducing and promoting gaming behaviour (Cornish, 1978; Griffiths, 1993a; Jellinek, 1997; Popkin, 1994). The scientific value of these musings is low, as they have largely been based on anecdotal evidence and intuitive reasoning. Little consideration has been given to operationally defining the variables in question or the establishment of mutually exclusive hypotheses based on lawful relations that may be falsified. One of the major weaknesses in the theoretical speculations is the fact that no evidence exists for the assertion that these machine characteristics are related to gaming behaviour.

A review of the structural characteristics literature resulted in a response variable, expenditure, and a long list of possible observed variables. One of the underlying hypotheses in the speculations on structural effects is that machines with
certain features influence expenditure by increasing the wagering patterns of the population (more players betting larger amounts for longer periods). Therefore, if certain machine characteristics do promote gaming expenditure, it would be expected that poker machines with these characteristics would record greater expenditure figures than those without.

There exist three measures of expenditure related to poker machine performance; stakes size, net expenditure and turnover. Stake size refers to the size of each individual bet placed before the spinning of the reels. In a poker machine playing session, it is the first indicator of expenditure, as the player is required to place a bet before commencement of the game. A player’s average stake size is the total expenditure figure divided by the number of button presses (games played or reel spins). Thus, if a player on one machine records a turnover figure of $50 from 80 button presses, the average stake size is 62.50 cents. Stake size is therefore a measure of the rate of expenditure and is of relevance to poker machine performance given the high continuity of the game. Machines that record higher stake sizes indicate increases in the rate of loss, however, this may not necessarily result in increases in net expenditure.

Net expenditure is a measure of expenditure that is given the most consideration by research and industry. For the gaming machine industry, this may be termed profit, or dollar-drop, and represents the aggregate of the individual player’s actual ‘out-of-pocket’ expenditure. Turnover is another common measure of expenditure and is determined by the sum of net expenditure and spent winnings. Thus, if a player spends $20, wins $18 and re-spends this, the turnover figure is $38
and the net expenditure figure is $20. Similarly, if a player spends $20, wins $35 and spends only $15 of this, the turnover is $35 (the initial $20 plus $15 from the winnings) but the net expenditure figure is $0 (total win figure, $35, minus re-spent winnings, $15, minus own money returned, $20).

Turnover figures are influenced by net expenditure and the return rate (the size and number of wins) of the machine. Due to the absence of any logical relationship between the return rate of a machine and the external machine characteristics, it is unsuitable to attempt to explain both net expenditure and turnover expenditure with machine characteristics. That is, no external machine characteristic can influence the random generation of wins, which constitute some portion of the turnover figure. Thus, the two measures of expenditure that bear most significance to any role of external machine characteristics are average stake size and net expenditure.

In the gaming machine industry, aggregated machine data are used to assess machine performance and determine the fate of a particular game (i.e., conversion to different game). These types of data are not capable of supporting any psychological theoretical interpretation of the role of certain machine characteristics. They are the sum total of expenditure figures for numerous individuals, collapsed within each poker machine and are incapable of determining the nature of any relationship between machine characteristics and individual player expenditure. Therefore, an initial study of machine characteristics must be atheoretical or exploratory, with the sole aim of testing and identifying the influence of certain machine characteristics.
A long list of machine characteristics have been implicated to influence these measures of expenditure. From a methodological point of view, the more appealing characteristics are those that are objective and lend themselves to operational definitions, as opposed to some of the latent characteristics, such as machine ‘aura’ and the symbolic interpretation of naming (Griffiths, 1993a). However, there must be at least some logical association between machine characteristics and the measures of stake size and net expenditure.

6.2 Stake Size

As discussed in Chapter 2.6, the multiplier potential of the machine appears to have a direct relationship with the determination of stake size. The multiplier potential of a machine is a composite variable made up of three machine characteristics; denomination, the number of pay-lines and the bet multiplication, all of which the player can adjust to influence the amount staked. The multiplier potential of the machine is, as its name suggests, not an additive combination of these factors but a multiplicative combination. That is, the maximum stake available on a machine is not determined by the denomination (e.g., 5 cents) plus the number of pay-lines (e.g., 9) plus the maximum bet (e.g., 10). In this example, the maximum stake would add to 24 cents, but it is in fact 450 cents (5 X 9 X 10).

Therefore, to measure each multiplier potential component in isolation does not accurately define the variable, as it is a cross product of other variables. In poker machine play, the basis for stake size is the denomination of the machine with the maximum number of pay-lines and maximum bet multiplication interacting with this.
The interaction of maximum number of pay-lines with maximum bet multiplication, and both of these variables in isolation, is not meaningful without controlling for the denomination of the machine. That is, the variables need to be measured in monetary terms, not credits, as two machines with 20 pay-lines each represent different values according to the denomination. Thus, the cross product of the individual variables of the multiplier potential provides four variables of potential importance in understanding stake size.

1. Denomination of the machine (minimum stake). This is a measure of the minimum stake, or cost required per game.

2. Denomination X maximum number of pay-lines (denline). A measure of the cost to play the maximum number of lines with the minimum bet multiplication.

3. Denomination X maximum bet multiplication (denbet). A measure of the cost to play the maximum bet multiplication with the minimum lines.

4. The Denomination X maximum number of pay-lines X maximum bet (maximum stake). A measure of the maximum bet, or maximum stake, permitted on the machine.

Thus, the multiplier potential has four variables that may be related to stake size. For example, if a machine's multiplier potential was made up of the 5-cent denomination with 9 pay-lines and a maxbet of 10, the minimum stake is 5 cents, the cost of staking when playing the maximum number of lines (denline) is 45 cents, the cost of staking when playing the maximum bet (denbet) is 50 cents, and the maximum cost of a stake is 450 cents. The purpose of the following study was to
identify the nature and importance of the relationship between these four variables and stake size.

6.3 Method: Stake Size

6.3.1 Design: Stake Size

The study was designed as a ‘survey’ of poker machines in gaming venues. The items recorded identified the level of the four multiplier potential characteristics (observed variables) and the expenditure measure of average stake size (response variable).

6.3.2 Procedure: Stake Size

Data were collected during the months October and November 1996. Permission was first sought from the participating clubs for access to machines. The clubs provided a key that allowed the researcher to view the game statistics menu on each machines’ monitor. Average stake size was automatically recorded by each machine based on the total number of plays and turnover since initial operation. The observed variables were visible on the cabinet of each machine. This operation was undertaken primarily in the morning, 1 hour before opening or in the case of 24-hour venues, during the early hours of the morning when the number of players was minimal. Thus, the only viable sampling technique was one of convenience due to time constraints, although some attempt was made to ensure that as many different levels of each observed variable were measured.
6.3.3 Statistical Procedure: Stake Size

The multiple regression statistical analysis procedure was chosen as it allows
the assessment of relationships between one response variable and several observed
variables. Unlike ANOVA methods, the presence of continuous observed variables
and the correlation between these is not problematic for regression analysis. Thus,
the flexibility of the regression technique is "...especially useful to the researcher
who is interested in real-world or very complicated problems that cannot be
meaningfully reduced to orthogonal designs in a laboratory setting." (Tabachnick &

For multiple regression analysis of data, it was determined that a sample size
of 203 was needed to achieve an adequate power level (.80) to detect small sized
relationships in the population \(r = .20\), with \(\alpha = .05\), two-tailed test and four
observed variables. In other words, there was an 80% chance that a correlation of \(r =
.20\) would test significant and thus the null hypothesis rejected (Tabachnick & Fidell,
1996). It was decided that a sample of 400 machines would be recruited. This would
allow for two data sets of 200 to be created, for the purpose of replicating the
analysis and assessing the reliability of the model estimates.

6.3.4 Participants: Stake Size

From a convenient sample of eight registered clubs in Sydney and
Wollongong, New South Wales, the average stake size was recorded from 390 poker
machines in operation. However, initial data screening revealed nine cases that
contained spurious data of some kind (e.g., multiplier potential over the $10 set by law, a function of incorrect recording of denomination, pay-lines or bet multiplication). These were deleted leaving 381 cases in total. The data were randomly divided into two sets by the SPSS, with approximately 50% in each sample. The first data set contained 200 cases; the second data set contained 181 cases.

6.4 Participants: Stake Size I

The descriptive information below pertains to the first data set of 200 machines.

Table 6.1
Mean and Range Scores (cents) for Machine Variables (N = 200)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avstake</td>
<td>66.63</td>
<td>58.27</td>
<td>11.84</td>
<td>387.00</td>
</tr>
<tr>
<td>Denom</td>
<td>13.28</td>
<td>28.94</td>
<td>1.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Denline</td>
<td>45.21</td>
<td>56.08</td>
<td>9.00</td>
<td>300.00</td>
</tr>
<tr>
<td>Denbet</td>
<td>86.25</td>
<td>135.44</td>
<td>5.00</td>
<td>1000.00</td>
</tr>
<tr>
<td>Maxstake</td>
<td>392.75</td>
<td>274.17</td>
<td>50.00</td>
<td>1000.00</td>
</tr>
</tbody>
</table>

As displayed in Table 6.1, the mean of average stake size for all machines in the sample was 66.63 cents. The mean denomination, or minimum stake permissible on each machine, was 13.28 cents. The mean denline, which was determined by multiplying the denomination by the maximum number of pay-lines on the machine, was 45.21 cents. This figure represents the average cost of playing the maximum number of lines. The mean denbet, which was determined by multiplying the denomination by the maximum bet multiplication, was 86.25 cents. This figure
represents the average cost playing the maximum bet multiplication with the minimum number of pay-lines. Finally, the mean maxstake was 392.75 cents. This figure is the average maximum stake permissible and was determined by multiplying the denomination by the maximum number of pay-lines by the maximum bet multiplication.

6.5 Results: Stake Size I

All observed variables were highly correlated with the response variable and with each other. Univariate analyses revealed the presence of outliers in all but two of the variables (maxstake and denom). Univariate analyses of variables also revealed positive skewness and positive kurtosis levels that significantly departed from 0 ($p < .05$) for all variables, except maxstake. However, histograms revealed that none of the distributions appeared normal. The major concern were the kurtosis levels, which were all greater than 5. It was decided to transform the three variables that most departed from normality and which also contained outliers; average stake, denline, and denbet

Square root transformation was performed on the problematic variables. This did improve the shape of the distributions, but the general tendency was still one of leptokurtosis and positive skewness. Logarithmic transformations of the raw scores were performed and improved the shape of the distribution beyond that of the square root transformation. The resulting skewness and kurtosis levels were satisfactory, although some remained statistically significant (a function of the size of the data set and the related small standard errors, but the absolute values of these were low).
Although none of the histograms could satisfactorily be considered normal, the logarithmic transformations were accepted due to the large sample size. This minimises the effect of violations from normality (Tabachnick & Fidell, 1996).

The next step was to identify univariate outliers by examining the z-score for each variable. Univariate analysis revealed no outliers present (i.e., no $z > 3.29$, $p < .001$, Tabachnick & Fidell, 1996).

The next test involved running the regression (using the enter method or standard type of regression) and testing for multivariate normality, linearity, and homoscedasticity utilising the scatter plot of standardised residuals. From the scatterplot, one case was identified as an outlier and confirmed with inspection of standardised residual scores. The offending case recorded a standardised residual score of -7.27 ($p < .001$), indicating that the actual score was much lower than the equation would predict. The raw scores of each variable were checked for this case with no discrepancy found, but it is possible that an incorrect entry was recorded at the machine (most likely the average stake size figure). Given the large number of cases, it was decided to remove this case leaving a sample size of 199.

The regression was run again and the scatterplot revealed that the assumptions of multivariate normality, linearity, and homoscedasticity were all met. The largest outlier was $z = 3.24$ ($p > .001$), which was acceptable and retained.

Multicollinearity and singularity were also tested given the high correlations between observed variables. Examination of tolerance figures indicated that the
largest squared multiple correlation was .82, which was acceptable, with no
conditioning index figure greater than 30 (26.39).

Having met the assumptions for multiple regression, the final run was
undertaken specifying correlation, regression coefficient estimates, model fit
statistics, and squared semi-partial correlations. The results are presented in the
tables below.

Table 6.2
Pearson's Correlation and Mean Scores for Machine Variables (N = 199)

<table>
<thead>
<tr>
<th>Variables</th>
<th>LgAvStake</th>
<th>Denom</th>
<th>LgDenline</th>
<th>LgDenbet</th>
<th>Max Stake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denom</td>
<td>.71**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LgDenline</td>
<td>.94**</td>
<td>.67**</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LgDenbet</td>
<td>.80**</td>
<td>.78**</td>
<td>.76**</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Max stake</td>
<td>.69**</td>
<td>.36**</td>
<td>.72**</td>
<td>.71**</td>
<td>-</td>
</tr>
<tr>
<td>Mean</td>
<td>1.72</td>
<td>13.73</td>
<td>1.48</td>
<td>1.67</td>
<td>392.46</td>
</tr>
<tr>
<td>SD</td>
<td>0.29</td>
<td>29.00</td>
<td>0.37</td>
<td>0.43</td>
<td>274.83</td>
</tr>
</tbody>
</table>

** p < .01

Table 6.3
Unstandardised (B) regression coefficient, standardised (b) regression coefficient, t-
statistic (B/SE B), squared semi-partial correlations (sr²), and model fit statistics for
LgAvStake (N = 199)

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>b</th>
<th>t</th>
<th>p</th>
<th>sr²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denom</td>
<td>.00</td>
<td>.04</td>
<td>.92</td>
<td>.36</td>
<td>.00</td>
</tr>
<tr>
<td>LgDenline</td>
<td>.63</td>
<td>.81</td>
<td>19.96</td>
<td>.00</td>
<td>.19</td>
</tr>
<tr>
<td>LgDenbet</td>
<td>.12</td>
<td>.18</td>
<td>3.53</td>
<td>.00</td>
<td>.01</td>
</tr>
<tr>
<td>Max stake</td>
<td>.00</td>
<td>-.04</td>
<td>-.91</td>
<td>.37</td>
<td>.00</td>
</tr>
<tr>
<td>Intercept</td>
<td>.60</td>
<td>10.69</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R² = .91

Adj R² = .91
Unique variability = .20, Shared variability = .71
F = 482.33, p = .00

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Given the large positive correlations between variables, the negative direction of the $b$ coefficient for maxstake indicates that this variable may be acting as a suppressor variable. That is, it is suppressing irrelevant variance in another observed variable, thereby inflating another variable’s coefficient at the expense of its own (Tabachnick & Fidell, 1996). However, all other $b$ coefficients are within the acceptable range, based on the correlations, and in particular the denline coefficient, as it is the likely ‘other’ variable given its large positive result. The only conclusion that can be drawn is that if maxstake is acting as a suppressor variable, it is not considerably influencing any other variable beyond its bivariate relationship with the response variable.

The figures most pertinent to the study’s aim are the $t$-values and unique variance coefficients ($sr^2$). The only two significant predictors of average stake size were the maxline cost (denline) and maxbet cost (denbet) variables. However, the denbet variable did not, by itself, contribute greatly to the overall explained variance (if removed, the size of $R^2$ would only decrease by .01). The sum of unique variance coefficients was .20, with the denline variable contributing the majority of this ($sr^2 = .19$). Although it is not unusual for the sum of unique variances to be much smaller than the $R^2$, it is likely to be more so in this analysis given the large correlations between observed variables. This makes it more difficult to establish unique variance with regression procedures (Tabachnick & Fidell, 1996). Clearly though, the results indicate that the most important predictor of machine average stake size is the cost of playing the maximum number of pay-lines (denline).
It must be remembered that the aim of the study was not to establish a model of average stake size, but to test the importance ($r^2$) of the various components of the multiplier potential feature. The aim of the analysis of the second set of data was to test the stability of these estimates. That is, instead of creating predicted scores with the equation in the second sample and comparing these with actual scores, it was the significance and importance of each variable that needed to be re-tested.

6.6 Participants: Stake Size II

The descriptive information below pertains to the second data set of 181 machines.

Table 6.4
Mean and range scores (cents) for machine variables ($N = 181$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avstake</td>
<td>71.43</td>
<td>66.78</td>
<td>12.28</td>
<td>403.00</td>
</tr>
<tr>
<td>Denom</td>
<td>15.22</td>
<td>30.91</td>
<td>1.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Denline</td>
<td>47.24</td>
<td>57.02</td>
<td>5.00</td>
<td>300.00</td>
</tr>
<tr>
<td>Denbet</td>
<td>110.69</td>
<td>209.69</td>
<td>5.00</td>
<td>1000.00</td>
</tr>
<tr>
<td>Maxstake</td>
<td>411.41</td>
<td>299.62</td>
<td>5.00</td>
<td>1000.00</td>
</tr>
</tbody>
</table>

6.7 Results: Stake Size II

The same analysis was performed on the second data set ($N = 181$). Descriptive information of the variables under study is presented in Table 6.4. There were again high correlations between all variables. With a smaller sample size (due to the approximate nature of the random generator in the SPSS), the regression analysis had adequate power to detect effect sizes of $r = .25$. This was not considered
problematic given that no B weights in the first study were on the borderline of significance at $\alpha = .05$.

The distributions of the two samples were similar with positive skewness and kurtosis for avstake, denline, and denbet. Denom followed this trend, but again was not as severe. Log transformation was performed on the relevant variables and again all skewness and kurtosis figures were below one. The next step was to identify univariate outliers by examining the z-scores for each variable. The range of extreme standardised scores across all variables was -2.030 to 2.74, indicating no significant outliers among the variables ($p > .001$).

The next test involved running the regression and testing for multivariate normality, linearity, and homoscedasticity utilising the scatterplot of predicted versus actual residuals and the standardised residual. From the scatterplot, one case was identified as an outlier and confirmed with inspection of standardised residual scores. The offending case recorded a standardised residual score of -7.07 ($p < .001$), which was for a machine with the same characteristics as the outlier in the first analysis. The machine characteristics were; average stake size 12.28 cents; 5-cent denomination; maxstake 450 cents; denline 45 cents; and denbet 50 cents. Why these two cases recorded lower stake figures than would be predicted remains unclear, but the fate of this case was the same as the first. This left 180 cases in the sample.

The regression analysis was run again with the scatterplot revealing that the assumptions of multivariate normality, linearity, and homoscedasticity were all met.
Furthermore, the largest outlier achieved a $z = 2.92 (p > .001)$, which was acceptable and retained.

Tests for multicollinearity and singularity were also undertaken. Examination of tolerance figures indicated that the largest squared multiple correlation was .86, which was acceptable, with no conditioning index figures greater than 30 (25.96).

Having met the assumptions for multiple regression, the final run was undertaken specifying correlation, regression coefficient estimates, model fit statistics, and squared semi-partial correlations. The results are presented in the tables below.

Table 6.5  
*Pearson's Correlation and Mean Scores for Machine Variables (N = 180)*

<table>
<thead>
<tr>
<th>Variables</th>
<th>LgAvstake</th>
<th>Denom</th>
<th>LgDenline</th>
<th>LgDenbet</th>
<th>Max Stake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denom</td>
<td>.69**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LgDenline</td>
<td>.95**</td>
<td>.63**</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LgDenbet</td>
<td>.82**</td>
<td>.83**</td>
<td>.76**</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Max stake</td>
<td>.79**</td>
<td>.47**</td>
<td>.79**</td>
<td>.76**</td>
<td>-</td>
</tr>
<tr>
<td>Mean</td>
<td>1.72</td>
<td>15.27</td>
<td>1.47</td>
<td>1.69</td>
<td>411.19</td>
</tr>
<tr>
<td>SD</td>
<td>0.33</td>
<td>30.99</td>
<td>0.41</td>
<td>0.49</td>
<td>300.45</td>
</tr>
</tbody>
</table>

** $p < .01$
Table 6.6
Unstandardised (B) regression coefficient, standardised (b) regression coefficient, t-statistic (B/SE B), squared semi-partial correlations (sr²), and model fit statistics for Lgavstake (N = 180)

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>b</th>
<th>t</th>
<th>p</th>
<th>sr²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denom</td>
<td>.00</td>
<td>.05</td>
<td>1.13</td>
<td>.26</td>
<td>.00</td>
</tr>
<tr>
<td>LgDenline</td>
<td>.62</td>
<td>.77</td>
<td>20.53</td>
<td>.00</td>
<td>.17</td>
</tr>
<tr>
<td>LgDenbet</td>
<td>.12</td>
<td>.17</td>
<td>3.27</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Max stake</td>
<td>.00</td>
<td>.03</td>
<td>.76</td>
<td>.45</td>
<td>.00</td>
</tr>
<tr>
<td>Intercept</td>
<td>.59</td>
<td></td>
<td>10.62</td>
<td></td>
<td>.00</td>
</tr>
</tbody>
</table>

R² = .93
Adj R² = .93
Unique variability = .17, Shared variability = .76
F = 582.70, p = .00

Unlike the analysis on the first data set, there was no indication of any suppressor variable in this analysis. With similar results between analyses, the suppressor variable appeared to have exerted an insubstantial influence on the previous result; the same two variables recording significant positive relationships with average stake size and similar sr² figures. Thus, the results of the second sample support the conclusion of the first that the cost of playing the maximum number of pay-lines (denline) is the most important variable of the multiplier potential, with regard to average stake size. The replication of results also provides an indication of the stability of this result.

To obtain a better understanding of the importance of the denline variable, a bivariate regression was performed between that variable and average stake size for all 381 cases. Although there was again evidence of failure to meet the assumptions of normality, neither variable was transformed because of the large ratio of cases:variables, which minimises the impact of a non-normal distribution on the result. The results revealed a significant denline coefficient, B = 1.02 (t = 47.12, p <
.001) with a constant = 21.73, and an adjusted coefficient of determination ($R^2 = .85$).

These results more clearly demonstrate the strong positive linear relationship between denline and average stake size.

6.8 Profit

Machine profit reflects the net expenditure of players. The list of potential machine variables related to profit is greater than that for stake size. Machines that are more profitable are those that attract a greater number of players and/or those that promote greater spending by individuals. The variables chosen for this study were based on the Table 2.3, speculations in the literature, and personal communication with members of the gaming machine industry.

The denline variable was included given its strong relationship with stake size. It is reasonable to expect machines that record higher stake sizes to also record greater profits. As displayed in Table 2.3, the introduction of higher denomination machines and the increase in the maximum stake to $10 in 1988 was temporally related to an increase in machine profitability in 1989. The year 1988 also marked the introduction of the cashcade jackpot, another structural characteristic prominent on NSW poker machines.

The cashcade jackpot offers the player the opportunity to win large cash prizes over and above that available on the machine. This would appear to be a further inducement to play and may promote continual play by increasing the appeal of the game via increasing the pay-ratio (cost of play relative to size of potential win,
Griffiths, 1993a). Not all machines are linked to a cashcade jackpot, which is promoted in venues by a large neon sign indicating the size of the win pool. This win pool has an upper limit (e.g., $1,000) and a lower limit (e.g., $100). A certain percentage (a small figure, around 2%) of each dollar gambled on those machines linked to the cashcade is allocated to the win pool. Thus, as players wager on machines linked to a cashcade jackpot, the pool increases and approaches the randomly chosen win figure (anywhere between the lower and upper limit).

Nevertheless, due to the known upper limit, as the win pool increases so does the probability of an impending win. That is, if the win pool is $998 then, with an upper limit of $1,000, the player is aware that the jackpot must be won in the next few plays. The winner of the jackpot is the player whose bet contribution reaches the random figure first (or ‘pushes’ the cashcade figure over the set prize). Given this, it would be expected that machines linked to a cashcade would record greater expenditure figures than those not linked. These machines should return greater profit figures due to the increased amount of play over non-linked machines. The overall return rate might be the same for a bank of machines connected to a cashcade and a bank not connected, but the volume of play should increase on the cashcade bank, leading to greater machine profit.

The introduction of the bill acceptor has been gradual since the early 1990s. It has been speculated in the literature that this variable is related to gaming expenditure as it reduces the time away from machines, making it easier for continuous play (Popkin, 1994). Personal communication with gaming venues supports this claim but explain the bill acceptor’s hypothesised positive relationship
with profit in terms of player privacy. That is, without a need to visit the cashier, the
player’s total expenditure remains private.

Sutherland (1997) noted that the ‘life’ of a poker machine in NSW is
relatively short compared to other jurisdictions. Related to this is the demand that
experienced players in this state have for new features and new games. Personal
communication with gaming venue staff supported this, and it was suggested that the
age of a machine is related to profit. That is, newer machines will have greater profit
figures than older machines. The hypothesised relationship between a machine’s age
and expenditure levels may be due to consumer demand, but may also be due to
improved graphics, lighting, sound, and special features of the newer games.

Finally, in a study of machine profitability, there is a need to control for the
influence of the gaming venue as it represents a composite variable of factors that
relate to machine profitability. These include the volume of players related to
membership size, the trading hours, the frequency and type of gambling promotions,
the machine/player ratio, and the general management and service of the venue.

6.9 Method: Profit

6.9.1 Design: Profit

The study was designed as a survey of poker machines in gaming venues. A
random sample of machines was generated from monthly club reports, which record
the net profit for each machine (response variable). The structural characteristics (observed variables) were recorded manually from observations of each machine.

6.9.2 Procedure: Profit

Club reports for January 1997, were obtained from six clubs. Each machine’s serial number and location code were recorded, and from this, a random sample of 130 machines from each club (780 in total) was generated through the SPSS. The serial number and location codes were then used to identify the machine in the club for coding of structural characteristics. However, time constraints imposed by some clubs reduced the ability to obtain all target machines. Therefore, at some clubs, the number of machines recruited was lower than expected and an attempt to compensate for this was made by increasing the sample size of machines from other venues with fewer time constraints. This weakened the sampling procedure by incorporating a convenience method with the more robust random sampling method. Furthermore, information was not recorded from some machines due to recent conversions to different games and operation faults.

Since monthly club reports differed in duration (i.e., some clubs used a 31-day month, others used a 28-day month), a daily net figure was calculated for each machine. Also, the age of machines were not available from all clubs. To provide some indication of a machine’s age, the model was used. This created a dichotomous variable, with the newer ‘X-series’ machines representing one level and older machines serving as the other level. The newer series began appearing in clubs in 1995, but it must be stated that this was not an ideal measure and provided a tenuous
operational definition of machine age. All other variables were observed without ambiguity.

6.9.3 Statistical Procedure: Profit

The multiple regression technique was again the statistical choice for data analysis. Given the number of variables and the likelihood of smaller effect sizes than for stake size, it was determined that, for multiple regression analysis, 360 cases would be required for adequate power to detect effect sizes of $R^2 = .15$, at $\alpha = .05$. In order to re-test the model, double this number of cases was sought.

6.9.4 Participants: Profit

From a convenient sample of six registered clubs (five located in Sydney and one in Wollongong, NSW), data were obtained from 780 machines. However, 6 machines contained missing information or spurious data (recording error). These were deleted, leaving 774 cases in total. The data set was randomly divided in two by the SPSS random generator with approximately 50% in each sample. The first data set contained 389 cases; the second data set contained 385 cases.
6.10 Participants: Profit I

The descriptive information below pertains to the first data set of 389 cases.

Table 6.7
Mean and Range Scores for the Daily Profit (dollars) and Denline (cents) Machine Variables (N = 389)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily profit</td>
<td>205.67</td>
<td>139.85</td>
<td>2.32</td>
<td>1160.34</td>
</tr>
<tr>
<td>Denline</td>
<td>51.78</td>
<td>55.66</td>
<td>7.00</td>
<td>500.00</td>
</tr>
</tbody>
</table>

Table 6.8
Frequency of Machine and Venue Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bill Acceptor</td>
<td>37.80</td>
</tr>
<tr>
<td>Cashcade</td>
<td>37.30</td>
</tr>
<tr>
<td>Age (X-series)</td>
<td>44.50</td>
</tr>
<tr>
<td>Club 1</td>
<td>25.40</td>
</tr>
<tr>
<td>Club 2</td>
<td>16.50</td>
</tr>
<tr>
<td>Club 3</td>
<td>15.90</td>
</tr>
<tr>
<td>Club 4</td>
<td>15.40</td>
</tr>
<tr>
<td>Club 5</td>
<td>14.10</td>
</tr>
<tr>
<td>Club 6</td>
<td>12.60</td>
</tr>
</tbody>
</table>

6.11 Results: Profit I

For the first sample of 389 cases, there was a weak correlation between the response variable and denline ($r = .12$) and cashcade ($rpb = .13$). There was a moderate correlation between daily net and the bill acceptor ($rpb = .46$) and machine age ($rpb = .44$). There were weak correlations between most observed variables, however, cashcade and denline correlated moderately ($rpb = .42$), and bill acceptor and machine age correlated highly ($Cramer’s V = .82$).
Examining the z-scores for both continuous variables identified univariate outliers. The only variable containing z-scores greater than ±3.29 was daily net. Three cases were identified. One contained a z-value = 6.96, one a z-value = 3.95 and one a z-value = 3.33. The first was removed, but the others remained since they both were not considerably greater than 3.29 and were similar to each other. Also, Tabachnick and Fidell (1996) stated that discrepant outliers are expected in large sample sizes. This left 388 cases in the first sample.

Univariate analysis of the continuous variables (daily net and denline) also indicated that there was severe positive kurtosis (17.68) and moderate positive skewness (3.46) for the denline variable. This distribution for daily net was statistically non-normal and a histogram presented a positively skewed distribution with positive kurtosis, but the actual size of these figures (kurtosis = 1.65, skewness = 1.20) were not considered large enough to warrant transformation. It was decided to perform a log transformation of the denline variable only.

The transformation of denline sufficiently normalised this variable with both the kurtosis and skewness levels still significant, but below 1.

The next test involved running the regression (using the enter method or standard type of regression) and testing for multivariate normality, linearity, and homoscedasticity utilising the scatterplot of predicted versus actual residuals and the standardised residual. The scatterplot revealed that there was a failure to meet the assumption of homoscedasticity. Related to this, in part, was the presence of outliers in association with the heteroscedasticity. That is, the nature of scatterplot was one of
increases in standardised residuals with increases in standardised predicted values, and the outliers were present at the larger predicted values. Furthermore, the level of heteroscedasticity was considered serious as the spread of standardised values was three times larger for the highest spread than for the narrowest spread (Tabachnick & Fidell, 1996).

The most obvious solution to this problem was the transformation of the response variable, daily net. Although it was considered normal by the skewness and kurtosis levels (given the large number of cases), the combination of a poorly shaped histogram, the significance levels and, most importantly, the level of heteroscedasticity supported the contention that it required transformation. This was performed utilising the square root formula, given the daily net non-normality was not as severe as other variables. Univariate analysis revealed skewness and kurtosis values below 1 and the histogram was congruent with this.

The regression was run again to reveal a scatterplot that met the assumptions of multivariate normality, linearity, and heteroscedasticity. There were however, two outliers present when standardised values were examined containing values of -3.95 and -3.48 ($p < .001$). More importantly, they were ‘true’ outliers with the nearest values around -2.65, and thus were removed. The final scatterplot of 386 cases maintained the assumptions of normality, linearity, and heteroscedasticity, and contained no outliers (largest standardised value = 3).

Multicollinearity and singularity were also tested for and an examination of tolerance figures indicated that the largest squared multiple correlation was .72,
which was acceptable, with no conditioning index figures greater than 30 (highest
13.12).

Having met the assumptions for multiple regression, the final run was
undertaken specifying regression coefficient estimates, model fit statistics, and
squared semi-partial correlations. The results are presented in the table below.

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>b</th>
<th>t</th>
<th>p</th>
<th>(sr^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lgdenline</td>
<td>.39</td>
<td>.37</td>
<td>.74</td>
<td>.51</td>
<td>.00</td>
</tr>
<tr>
<td>Cashcade</td>
<td>.36</td>
<td>.47</td>
<td>.76</td>
<td>.51</td>
<td>.00</td>
</tr>
<tr>
<td>Bill Acceptor</td>
<td>2.06</td>
<td>.71</td>
<td>2.93</td>
<td>.01</td>
<td>.02</td>
</tr>
<tr>
<td>Age (model)</td>
<td>2.12</td>
<td>.65</td>
<td>3.23</td>
<td>.00</td>
<td>.02</td>
</tr>
<tr>
<td>Venue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.05</td>
</tr>
<tr>
<td>Intercept</td>
<td>11.24</td>
<td>.82</td>
<td>13.78</td>
<td>.00</td>
<td></td>
</tr>
</tbody>
</table>

R² = .34
Adj R² = .32
Unique variability = .09, Shared variability = .25
F = 21.35, p = .00

The unique variance figures (\(sr^2\)) indicated that the venue variable was the
most important in the profit analysis. Detailed estimates for each level of this
variable (e.g., B, b and t) are not given as there was no need to present individual
coefficients for each venue because it was an extraneous composite variable than
needed to be controlled. The purpose of the study was not to report the operational
merits of participating clubs, but to establish the relative importance of the machine
variables.
The two machine characteristics that achieved significance were the bill acceptor and machine age. In both cases, a positive relationship was found between these variables and machine profit. That is, newer machines and machines with bill acceptors recorded significantly higher daily profit figures than older machines and machines without bill acceptors. These variables can be considered equally important by the size of their respective $sr^2$ figures (although not contributing as much unique explained variance as the venue variable).

Both the cashcade and the denline variables were also positively related to daily profit, but failed to achieve significance or contribute any substantial unique variance.

As with the stake size analysis, the stability of these results was tested via a second sample.

6.12 Participants: Profit II

The second sample contained 385 cases, meeting the requirement of 360 cases for adequate power to detect effect size of $R^2 = .15$, $\alpha = .05$. Tables 6.10 and 6.11 provide descriptive information of the 385 machines in this sample.
Table 6.10  
Mean and Range Scores for Daily Profit (dollars) and Denline (cents) Machine Variables (N = 385)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily profit</td>
<td>209.23</td>
<td>136.65</td>
<td>-107.03</td>
<td>1154.35</td>
</tr>
<tr>
<td>Denline</td>
<td>48.39</td>
<td>46.80</td>
<td>5.00</td>
<td>500.00</td>
</tr>
</tbody>
</table>

Table 6.11  
Frequency of Machine and Venue Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bill Acceptor</td>
<td>34.30</td>
</tr>
<tr>
<td>Cashcade</td>
<td>34.00</td>
</tr>
<tr>
<td>Age (X-series)</td>
<td>42.10</td>
</tr>
<tr>
<td>Club 1</td>
<td>26.00</td>
</tr>
<tr>
<td>Club 2</td>
<td>17.10</td>
</tr>
<tr>
<td>Club 3</td>
<td>16.40</td>
</tr>
<tr>
<td>Club 4</td>
<td>15.30</td>
</tr>
<tr>
<td>Club 5</td>
<td>13.20</td>
</tr>
<tr>
<td>Club 6</td>
<td>11.90</td>
</tr>
</tbody>
</table>

6.13 Results: Profit II

There were again moderate positive correlations between the response variable and bill acceptor and machine age. There was also a moderate positive correlation between denline and cashcade, and a high correlation between bill acceptor and machine age (Cramer’s V = .80). All other correlations were weak.

Univariate outliers were identified by examining the z-scores for each variable. Both continuous variables, daily net and denline, contained cases with z-scores greater than ±3.29. The daily net variable contained four cases, two of these particularly problematic (z = 6.78 and z = 5.06) and two considered not sufficiently
large enough to warrant action ($z = 3.65$ and $z = 3.56$). The two largest cases were removed leaving 383 cases. For the variable denline, there were also four cases with $z$-scores greater than 3.29. These were all larger than 5 and thus removed, leaving 379 cases in the sample.

Univariate analysis of the continuous variables (daily net and denline) indicated that there was significant skewness for both variables and significant kurtosis for the daily net variable. However, neither figure was particularly large (largest 1.96) and the histogram for the daily net variable showed an acceptable distribution. The histogram for the denline variable was unacceptable and it was decided to perform a log transformation of the denline variable only. This only marginally improved the histogram for this variable, but actually increased the skewness and kurtosis figures. It was decided to leave denline untransformed, whilst remaining cautious about the results.

The next test involved running the regression (using the enter method or standard type of regression) and testing for multivariate normality, linearity, and homoscedasticity utilising the scatterplot of predicted versus actual residuals and the standardised residual. The scatterplot revealed that there was a failure to meet the assumption of homoscedasticity. Related to this, in part, was the presence of outliers in association with the heteroscedasticity. That it, the nature of scatterplot was one of increases in standardised residuals with increases in standardised predicted values, and the outliers were present at the larger predicted values. Furthermore, the level of heteroscedasticity was considered serious as the spread of standardised values was
three times larger for the highest spread than for the narrowest spread (Tabachnick & Fidell, 1996).

The most obvious solution to this problem was, again, the transformation of the response variable, daily net. This was performed utilising the square root formula, given its non-normality was not as severe as other variables. Univariate analysis revealed reduced skewness and kurtosis values and that the bell-shaped properties of the histogram had improved. However, two cases were removed as they contained negative values that could not be transformed using the square root function. These machines recorded a daily net loss rather than a profit. This may have been due to a large prize being won on these machines during the month of the club report. This left 377 cases.

The regression was run again to reveal a scatterplot that met the assumptions of normality, linearity, and heteroscedasticity. There were no outliers present when standardised residual values were examined (-3.08 to 2.84).

Multicollinearity and singularity were also tested for with an examination of tolerance figures indicating that the largest squared multiple correlation was .70, which was acceptable, and no conditioning index figures were greater than 30 (highest 7.67).

Having met the assumptions for multiple regression, the final run was undertaken specifying regression coefficient estimates, model fit statistics, and squared semi-partial correlations. The results are presented in Table 6.12.
Table 6.12
Unstandardised (B) regression coefficient, standardised (b) regression coefficient, t-statistic (B/SE B), squared semi-partial correlations (s2r), and model fit statistics for Saprofit (N = 377)

<table>
<thead>
<tr>
<th>Variables</th>
<th>B</th>
<th>b</th>
<th>t</th>
<th>p</th>
<th>s2r</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lgdenline</td>
<td>.01</td>
<td>.01</td>
<td>.75</td>
<td>.52</td>
<td>.00</td>
</tr>
<tr>
<td>Cashcade</td>
<td>.22</td>
<td>.48</td>
<td>.46</td>
<td>.73</td>
<td>.00</td>
</tr>
<tr>
<td>Bill Acceptor</td>
<td>2.38</td>
<td>.72</td>
<td>3.31</td>
<td>.00</td>
<td>.02</td>
</tr>
<tr>
<td>Age (model)</td>
<td>1.30</td>
<td>.66</td>
<td>1.97</td>
<td>.03</td>
<td>.01</td>
</tr>
<tr>
<td>Venue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.12</td>
</tr>
<tr>
<td>Intercept</td>
<td>9.98</td>
<td>.50</td>
<td>19.92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R² = .29
Adj R² = .27
Unique variability = .15, Shared variability = .14
F = 16.73, p = .00

The results of the second sample revealed similar coefficients to that of the first. The venue variable was again implicated as the most important in the profit analysis. The two machine characteristics that achieved significance were the bill acceptor and machine age. In both cases, a positive relationship was found between these variables and machine profit. That is, newer ‘X’ series machines and machines with a bill acceptor recorded significantly higher levels of profit than older machines and machines without bill acceptors. In addition, both the cashcade and the denline variables were also positively related to daily profit figures but, again, failed to achieve significance.

6.14 Discussion

The purpose of the current study was to test the claim that external machine characteristics are related to expenditure. The results of the first expenditure measure indicate that a significant positive linear relationship exists between the multiplier potential of poker machines and their average stake size. In particular, the most
important component of the multiplier potential in this relationship is the cross product of denomination and the maximum number of pay-lines (denline). The positive linear relationship between denline and stake size was indicated in both sets of data. The only other factor of the multiplier potential to achieve significance was the cross product of denomination and the maximum bet multiplication (denbet). Again, a positive linear relationship existed in both data sets, but the strength of this relationship was much weaker.

Expanding upon this, the bivariate regression result further highlighted the importance of the denline variable's relationship with stake size. It was revealed that this variable was able to account for 85% of the variance in average stake size between machines. This result suggests that the staking patterns of players are highly stereotypical and determined by the machine denomination and maximum number of pay-lines.

An important point to note is that the denline variable of the machine in this study ranged from 5 cents to $3. This upper limit represents roughly one-third of that permissible on machines. The maximum stake permissible on machines is $10 and this rather low upper limit for denline is a function of the other component of the multiplier potential, maximum bet multiplication. Machines allow two ways of multiplying the denomination or minimum stake, either via the pay-lines or via the bet multiplication. The results of the analysis suggest that players prefer the pay-line option to the bet multiplication, but just how far above the $3 limit of the machines in this study the players would go is not known. That is, although a strong positive linear relationship between denline and stake size existed in this study, increases in
the denline variable may or may not continue to demonstrate a linear relationship. There may be a point at which players refuse to purchase more lines, thus creating a curvilinear relationship. Alternatively, gaming machine designers may be aware of this issue and design the multiplier potential around a known maximum denline figure.

Although the results for denomination (minimum stake) and maxstake failed to achieve significance in the regression analysis, the results presented in the correlation matrices warrant further comment. On their own, both these variables may have been related to average stake size, but these effects were minimised when controlling for denline and denbet. The denom variable was implicated in both the denline and denbet variables and its importance must be stated. Its influence was not in its effect on the minimum stake required, but in its relationship to both the pay-lines and bet multiplication features of the multiplier potential. Also, the maxstake variable is of interest, especially with regard to denline. Maxstake was highly, positively correlated with stake size, suggesting that increases in the maximum permissible stake lead to increases in stake size. However, when controlling for the effect of other variables, maxstake failed to achieve significance.

The result for maxstake provides further insight into the effect for denline. As discussed above, the machines in the current study only had a $3 upper-limit for denline, but there were machines with the $10 limit for maxstake. Thus, it cannot be argued that increases in the maximum permissible stake will influence staking patterns alone. Increases in the maximum stake must be kept within the context of increases in the denline variable. This has implications for policy issues regarding
game design and, in particular, the multiplier potential issues raised by Jellinek (1997).

The decline variable, however, was not found to be a predictor of machine profit. In relation to average stake size, the variables in profit were not nearly as predictive. A much lower proportion of variance was accounted for by these variables and the most important predictor was not the machine characteristics tested but the venues. The result for venues is interesting in itself and may reflect operational differences that influence expenditure. For example, the ratio of machines to members, the design of the gaming venue, promotional activities, operating hours, and other management issues may explain this result. However, the venue variable was only included as a control variable and it is the machine variables that are of primary interest.

From both sets of profit data, it was revealed that the bill acceptor and machine age have a positive linear relationship with machine profit. The bill acceptor was found to be the more important of the two, possessing a stronger relationship and accounting for a greater proportion of variance. This machine characteristic is an extension of the tokenisation feature that started appearing on machines in the early 1990s. It allows the player to insert money in note form directly into the machine rather than acquiring coins. Of the machines in the current sample, only around 35% possessed a bill acceptor and there is an extra cost associated when purchasing machines with this feature (around $2,500-$3,000). However, the bill acceptor has only been available on machines for a few years and the 35% figure indicates that
this feature is gaining in popularity. The positive linear relationship with profit may explain the growing popularity of the bill acceptor with gaming venues.

The bill acceptor feature was found to be highly correlated with machine age (Cramer's $V = .82$). This suggests that the newer X-series machines are more likely to be fitted with a bill acceptor than older models. Machine age was actually a measure of machine model and was a dichotomous variable with the newer X-series machines coded higher. However, the reported significant effect for machine age was not due to this correlation with the bill acceptor, or vice versa, as this was controlled in the statistical analysis. Thus, the results suggest that the newer machines are more profitable than older machines, confirming the speculations of Sutherland (1997) and claims by staff at gaming venues. Explanations for the relationship between machine age and profit are many and varied. It may have arisen from the need for novel stimuli by the loyal poker machine players of NSW, or from the improvements in graphics of the newer models. The way in which this variable was measured confounds any interpretation of the result, but does suggest that machine age is a variable of interest in future studies.

The failure of both the cashcade and the denline features to achieve significance is also of interest. With a larger prize on offer from machines linked to a cashcade jackpot, it was expected that these machines would be more profitable through sheer volume of play. That is, machines linked to the cashcade provide the opportunity to win a prize that is not present on 'stand-alone' machines and, representing greater value, were expected to attract more play increasing their
profitability. However, the prize of the cashcade feature does come at a cost to machine profit and it appears that this cost is negating any increased usage effect.

Alternatively, it may be the case that the cashcade jackpot is not a feature of interest to players. By design, machines linked to a cashcade provide a reduced return rate from the machine itself. That is, a stand-alone machine may provide a return rate of 92% to the player, but when linked to a cashcade, only provide a return rate of 90% as the missing 2% is utilised to offset the cost of the cashcade. For some players, this lower return rate may act as a deterrent to playing cashcade machines. There are many assumptions inherent in this interpretation that are yet to be proven. One of which is that players are aware of, or can detect, such a small reduction in return rate, but it is one possibility for the non-significant cashcade result.

In light of the result for average stake size, the denline results in the profit analysis suggest that stake size is not related to machine profit. The denline variable was highly predictive of stake size, but for both sets of profit data failed to achieve significance. Thus, with the denline variable of the machines in the profit analysis also reflecting each machine's average stake size, it can be concluded that a machine's profit is not related to its average stake size. Machines with higher levels of the denline variable (and therefore a higher average stake size) were not significantly more profitable than machines with lower levels of the denline variable. This may suggest that the staking pattern of players is not related to their overall net loss, but there is a need for caution when interpreting these aggregated machine results to individual player behaviour.
It must be remembered that the results of the present study provide no support
that machine characteristics are related to individual expenditure. The analysis was
based on aggregated machine data (which was not calibrated) and only indicate a
relationship between poker machine performance and expenditure. Furthermore, the
multiple regression technique is a correlation method and there remains the
possibility that untested variables may explain the result; that is, other variables may
correlate with those tested confounding the results. Additionally, some of the
distributions did not meet the assumption of normality. Although their deviance may
be considered minor, Wilcox (1998) argued that even a minor deviance from
normality could cause underestimates of effect sizes. Although replication of each
regression model was undertaken to serve as a reliability measure of the estimates
obtained, the repeat analyses were also subject to the same distributional problems.

Furthermore, it must be re-iterated that any theoretical interpretation of the
results, as they currently exist, is misguided as the design of the research was not
formulated with the intent of testing psychological theories of gambling behaviour.
There has been much speculation about this relationship, but no empirical evidence
has been provided to support the claim. The results of the current study identify
potentially relevant variables and provide a foundation for theoretical explanations
about the role that these characteristics have on individual expenditure patterns, but
as they currently stand, cannot be used to interpret individual gaming behaviour.

The above investigation of the relationship between structural characteristics
and machine performance represents a major contribution to the literature on
machine characteristics. Methodologically, it represents a new level of ecologically
valid gaming research and sets a benchmark for future studies. The data recorded were from real players, playing with their own money in an ecologically valid setting, with an absence of observer effects. Empirically, it provides the first evidence that structural effects exist and exposes the relationship between certain machine variables and two measures of expenditure (stake size and profit). Finally, and perhaps most importantly, it paves the way for theoretical investigations into the relationship between machine characteristics and individual expenditure.
Chapter 7:

The Relationship between Machine Characteristics and Individual Expenditure

7.1 Introduction

The results of the previous study provided the first empirical evidence that a relationship exists between machine variables and expenditure patterns. Others have alluded to this structural effect (e.g., Bayus et al., 1985; Cornish, 1978; Delfabbro & Winefield, 1999; Griffiths, 1993a; Jellinek, 1997; Popkin, 1994), but it has largely remained uninvestigated. The results also defined the machine variables worthy of further investigation and, hence, contribute not only to the current body of literature, but also provide a solid basis for future studies on structural effects.

The previous study demonstrated that structural characteristics could be studied in an ecologically valid manner, adhering to the principles set out by Anderson and Brown (1984) and Dickerson (1993). The use of machine data satisfied not only the criteria for ecological validity, but also improved the external validity of results by eliminating observer effects, a problem inherent in most field research (Robson, 1993). Thus, the merits of the methodology employed are also of significance to future gaming machine studies.
However, the methodology employed could not fully elucidate the nature of the relationship between structural characteristics and expenditure. Analysis of aggregated machine data provided an adequate comparison of poker machine performance, but could not indicate whether the observed structural effects were due to increases in the number of players on a machine or individual players increasing expenditure on machines with certain features. Hence, an analysis of the expenditure patterns of individual players is needed.

With evidence for the existence of structural effects and a list of implicated machine variables, theory driven hypotheses may be formulated with regard to individual player expenditure. Several explanatory models of gambling behaviour were discussed in Chapter 5. These have their origins in the ‘contingency-shaped versus rule-governed’ argument.

In broad terms, the traditional operant approach emphasised the contingency associated with machine variables (Chance, 1994; Lieberman, 1993; Mazur, 1998) and ecological learning theory extended this to also consider the contextual factors related to the organism’s ecological niche and lifestyle (Davey, 1989). Cognitive accounts placed further emphasis on conditions related to the human organism, but emphasised internal factors such as expectations of outcomes and erroneous beliefs (Griffiths, 1994; Medin & Ross, 1997; Wagenaar, 1988).

Although the difficulties with applying each approach to gambling was discussed, all theories are capable of contributing elements to the formulation of research hypotheses about the relationship between machine variables and individual
expenditure. The traditional operant approach emphasised the contingency between the response and the reinforcing stimulus, explaining the null effect of the punisher by the power of the ratio schedule of reinforcement (Catania, 1998; Chance, 1994; Mazur, 1998). Ecological learning theory explained choice behaviour with an optimisation principle and consequently emphasised an organism's motivation to maximise reinforcement (Davey, 1989). This optimisation approach considers the response cost and a host of other factors, such as resource availability and competing demands. The generality of both learning theories also permitted hypotheses about individual differences. Both explanations would predict stronger effects for those players with greater experience (i.e., greater learning), but the optimality models also included a much broader range of individual difference variables, again, relevant to the organism's ecological niche and lifestyle.

Cognitive accounts have focussed on human exceptions to contingency-based predictions and introduced rules as a factor in the modelling of human behaviour (Medin & Ross, 1997). Normative decision theory explained choice in terms of the expected utility and estimated probability of alternative responses (Wagenaar, 1988). These decisions were derived from expectancies about the long-term sequence of events and, similar to ecological learning theory, also considered negative outcomes or response cost scenarios.

The principles that comprise the heuristic and biases argument focussed on the occurrence and effects of erroneous beliefs promoted by machine characteristics (Griffiths, 1994; Wagenaar, 1988; Walker, 1992b); that is, the structural
characteristics of poker machines induce cognitive distortions or inappropriate heuristics that affect expenditure behaviour.

An evaluation of the scientific merit of each theory favours the utilisation of hypotheses made in accordance with traditional operant conditioning principles. This theory provides testable predictions with a relatively parsimonious explanation, compared to both ecological learning and cognitive theory. The number of factors associated with an organism's ecological niche is large, as is the list of possible heuristics making a priori identification difficult. In particular, the problem with the cognitive account included not only the identification of the heuristic that will be promoted by a structural characteristic, but also the operational definition and measurement of the heuristic, and predicting the direction of its effect. Furthermore, this cognitive account failed to adequately provide explanations about individual differences, unlike operant conditioning theory.

The contingency-shaped explanation also possesses a higher degree of generality than the cognitive approach. It has proven a more fecund research approach than either of the alternative theories and indeed, both ecological learning theory and the notion of rule-governed behaviour owe their existence to traditional operant conditioning principles (Davey, 1989; Skinner, 1969).

Finally, the strongest support for the contingency approach is the empirical evidence. Operant conditioning explanations have been the major theoretical approach associated with the structural characteristics of poker machines. The ecologically valid research on Australian poker machine players by Dickerson et al.
(1992a, 1992b) and Delfabbro and Winefield (1999), although with some inadequacies, have indicated support for operant conditioning explanations of gaming behaviour. In particular, explanations of the relationship between certain structural features (schedule of reinforcement, size/frequency of reward) and response patterns (stereotypical behaviour) more closely reflect the current area of inquiry into modern machine characteristics. In addition, these studies have failed to find support for the role of cognition in explaining the variance in individual gambling responses.

According to the principles of operant conditioning, structural characteristics will have an effect on individual expenditure if a contingency exists between and the feature and the reinforcer. For example, during the course of play, a player will encounter machines with various levels of the denline and denbet variables. Their staking patterns should vary in accordance with these levels, provided there exists a contingency between the rate, quality, or size of reinforcement (i.e., money wins) and the machine variable.

The null effect of Type II punishment in a gambling situation is explained by the power of the variable ratio of reinforcement and the pay ratio of the game. That is, risk-prone behaviour has been demonstrated when situations provide intermittent reinforcement and an opportunity for a large reward coupled with a small response cost (Davey, 1989; Mazur, 1998). Furthermore, individual differences in the effect of machine variables are explained by differences in previous exposure to the contingency relationship.
7.2 Hypotheses

The previous study found a positive linear relationship between denline, denbet, and average stake size. The contingency relationship between denline, denbet, and wins does appear to be a feature of poker machine design. Increases in the denline variable will provide increases in the frequency and size of the reinforcer, and increases in denbet will provide increases in the size of the reinforcer. However, the reinforcement properties of the denline variable are confounding and it cannot be ascertained if any observed effect is due to the increase in the size of the reinforcer (associated with an increase in denomination) or the increase in the frequency of the reinforcer (associated with an increase in the number of lines).

Since the multiplier potential must now be considered in terms of reinforcement properties rather than monetary value, the components of the multiplier potential should be examined individually and not in combination with the machine denomination, as in the previous study. That is, the three components of the multiplier potential (denomination, maximum number of pay-lines, and maximum bet multiplication) need to be measured and tested in isolation. This provides two R-Sr relationships that manipulate the size of reinforcement (denomination and maxbet) and one R-Sr relationship that manipulates the frequency of the reinforcement (maxline). The increase in frequency of the reinforcer, associated with the maximum number of pay-lines, is evident by the analysis of machine hit rates in Chapter 2.2 and the distribution of wins under a random ratio schedule (Figures 3.3 and 3.4).
Furthermore, based on operant conditioning theory, the strength of any structural characteristic effect should differ between players based on their level of experience or prior learning (Catania, 1998; Chance, 1994; Mazur, 1998). One common measure of experience in operant conditioning studies is the degree of prior exposure to the contingency, usually measured in terms of previous trials. In poker machine play, this may be measured by the player’s history in terms of the number of games played (i.e., the number of previous handle-pulls or button presses). Machine manufacturers refer to this as the player’s ‘stroke’.

In gambling studies, a player’s history is considered analogous to their level of involvement and is typically considered in terms of the size of past losses, years of play, and frequency of play (Dickerson, 1993; Dickerson & Baron, 2000). However, neither of these variables could be considered an accurate measure of previous exposure to a contingency relationship. For example, losing $1,000 with an average stake size of $5 would require 200 responses, whereas losing $1,000 with a $1 staking pattern requires 1000 responses (controlling for the number and size of wins). Thus, the respective levels of involvement are identical in monetary terms ($1,000), but the levels of exposure to machine contingencies (stroke) are different. Similarly, the years of play and frequency of play do not accurately reflect levels of learning.

With regard to profit, in the previous study both the age of the machine and the bill acceptor were found to be predictors of this measure of gambling expenditure. The term profit is applicable to poker machine performance but is an inaccurate description of individual player expenditure. The term net loss refers to a player’s out-of-pocket loss and more closely reflects the player’s equivalent of
machine profit. Thus, it would be predicted that the age of the machine and the bill acceptor would be related to an individual player's net loss.

However, neither the age of the machine nor the bill acceptor can be argued to have an established R-Sr contingency. This is problematic for learning theory and, similarly, these characteristics cannot be considered within optimality models as features that maximise reinforcement. The bill acceptor has been argued under cognitive distortion explanations to provide suspension of judgement and may play a role in the disruption of the gambler's financial value system. Although the age of the machine was poorly measured in the previous study, it was implicated as a variable that might affect individual expenditure patterns. The age of the machine is a variable that has not been considered previously by gambling researchers and cannot be explained in terms of reinforcement properties. It was included in the previous study based on the literature (Sutherland, 1997) and communication with gaming venue staff. The results of the previous study supported the view that on average, the newer games were more profitable.

Cognitive explanations may account for this effect, especially if the age of the machine is related to improved presentation and/or the promotion of a cognitive distortion (e.g., suggesting to the player that newer games are 'richer' than older machines). However, it can only be hypothesised that under operant conditioning principles, there will be no relationship between the bill acceptor, the age of the machine, and individual players' net loss.
It was shown in the previous study that the denomination and maximum number of pay-lines combination was almost perfectly related to a machine's average stake size ($R^2 = .85$). However, this variable failed to achieve significance as a predictor of machine profit. Essentially, this indicates that the multiplier potential characteristic of a poker machine does not relate to its profitability and, hence, should not influence individual expenditure patterns in terms of net loss. However, as discussed above, this variable now needs to be considered in terms of reinforcement properties, as each component that comprise the multiplier potential demonstrates a contingency between itself and the reinforcer (in either frequency or size). Thus, in accordance with learning theory, the three components of the multiplier potential (denomination, maximum number of pay-lines, and maximum bet) should account for some of the variance in individual net loss patterns across machines. Once again, the level of prior learning, operationally defined by the player's stroke, should explain effect size differences between individuals, with a greater effect size present in those players with a greater stroke.

7.3 Method: Overview

7.3.1 Design

To adequately test the above hypotheses, a repeated measures design of player expenditure over numerous machines is required. This may be done via laboratory experiment, self-report questionnaire, direct observation, or video recording of play (e.g., Delfabbro & Winefield, 1999; Dickerson et al., 1992a, 1992b). However, these methodologies are limited by associated factors of poor
ecological validity, reliance on memory, and observer effects. In keeping with standards set by the previous study, an alternative approach was undertaken, utilising computer tracking of playing behaviour.

7.3.2 Procedure

With the assistance of a gaming machine manufacturer and a registered club, all player and playing data were obtained via the club’s computer tracking system. As participants inserted their membership cards into poker machines, their stake size and net loss patterns were recorded by the tracking system. The insertion and withdrawal of the membership card identified each measurement occasion. At the conclusion of play, the tracking machine updated the history of play for each player. This history of play information is the only data stored by the club and used for club promotions. It contains an individual’s playing information since membership commenced. Along with the initial date of membership for each player, the player history information also provided the sex of the player, their date of birth, the number of days played, the number of games played (button presses or stroke), and the total dollar loss since membership to the club commenced.

The expenditure information for each measurement occasion required a staff member from the club to download this data at the end of each day’s trade. This provided individual player information regarding the identification of the machines played (serial and location number), the stake size, and net loss for each occasion of play. This information, not normally obtained by the venue, required re-programming of the tracking system by its manufacturer.
Measurements of machine characteristics were also obtained from club records. That is, the gaming venue held descriptive files on their machines providing the serial and location numbers, the denomination (denom), maximum number of pay-lines (maxline), bet multiplication (maxbet), bill acceptor (billaccp), and the date installed (machinge).

The scale of measurement for machine variables was identical to the previous study, with the exception of machine age. Previously, this was a dichotomous variable based on machine model (X-series), with older machines coded 0, and newer machines coded 1. However, with the date of installation available, the number of days the machine has been in the gaming venue was calculated (lowest machine age used due to new machines being added during study). This continuous variable has a reverse direction to the previous study, with the older machines identified by higher scores.

7.3.3 Statistical Procedure

Typically, analyses of repeated measures data are undertaken with repeated measures ANOVA. However, an alternative procedure, multilevel modelling, has recently gained acceptance as a more accurate method of dealing with data of this structure (Goldstein, 1995). This procedure acknowledges the inherent hierarchical structure of the data associated with the repeated measures design, which may be defined as measurement occasions nested within players.
Multilevel models are also known as multilevel regression models and conceptually can be viewed as a hierarchical system of regression equations (Hox, 1995). These models consist of two basic components, a fixed and a random part (Woodhouse, Rasbash, Goldstein, & Yang, 1996). The fixed part of the model provides mean coefficient estimates from each explanatory variable and the random part of the model partitions the variance for both levels of the hierarchy, which may be modelled individually. With regard to the present hypotheses, the estimates of interest are the fixed effects and the level-2 variance. The equation for this multilevel model may be expressed as,

$$y_{ij} = (a + b_{xij}) + (u_j + v_{pxij} + e_{ij})$$

*Equation 7.1.* Two-level multilevel model.

The fixed and random parts of the model are indicated by both sets of parentheses respectively. This equation is an extension of the standard regression equation, where $y =$ response variable, $x =$ observed variable, $a =$ constant, $b =$ effect size (unstandardised regression coefficient or regression slope) and $e =$ error. An explanation of the parameters in the above model is best demonstrated with an example related to the current research objectives.

The first aim was to identify the variables that predict the stake size ($y$) of any occasion of play for any player ($ij$). One possible predictor ($x$) of this is the denomination of the machine associated with the occasion of play from any player ($ij$). Thus, the expression $b_{xij}$ can be considered as the coefficient ($b$) for the variable denomination ($x$) for any occasion from any player ($ij$). There will be some error

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(unexplained variance) associated with any prediction based on this coefficient and this error is located in the random part of the model. The subscript $e_{ij}$ provides a measure of the ‘between occasions within player’ error and the subscript $u_{ij}$ represents the ‘between players’ error (level-1 and level-2 respectively).

The second aim of the study was to determine whether the coefficient ($b$) was the same for each player. In other words, the hypothesis in this example predicts that there is variance between players in the effect size ($b$) for denomination. Players represent level-2 of the hierarchy and the subscript $\nu_{ij}$ provides an estimate of the variance ($\nu$) between players ($j$) for the effect of denomination from the fixed part of the model ($x_{ij}$). The variance between players for any effect size (the estimate $\nu_{ij}$) can also be modelled using other explanatory variables.

In the present study, the second aim was not solely to identify variance between players in the effect that denomination has on their average stake size, but to also explain this variance. There is obviously a need to establish that variance exists in the first instance, hence, the estimate $\nu_{ij}$. That is, from the hypotheses, it is predicted that a significant covariance exists between players’ history (measured by the player variable stroke), and their effect size for denomination. This adds a fourth parameter estimate to the random part of the model, which is not shown in the Equation 7.1 (as it affects the other subscripts and produces a rather unwieldy equation).
It must be noted that the aims of the current study do not take full advantage of the multilevel modelling capabilities. At this stage, the aims of the study relate to variable testing, rather than the actual modelling of variance in player stake size and net loss. There are a host of other estimates that may be determined which, though interesting from an exploratory viewpoint, do not contribute to the testing of hypotheses.

Although there exist two response variables from each player, no predictions about the covariance between these variables are made and the technically simpler individual analysis of each data set is preferred over the multivariate approach (Duncan, Jones, & Moon, 1996). The methodology may be considered as a repeated measures design but should not be likened to the structure of data in more common repeated measures studies. The benefit of the multilevel approach over repeated measures ANOVA is that it does not require the design to conform to a particular balanced structure and provides a simpler conceptual understanding of the data (Goldstein, 1995; Plewis, 1996). This makes the procedure particularly appropriate for ecologically valid research in which the design does not meet the assumptions associated with statistical analyses derived from the experimental approach. For example, in the current design, there may be variation in the number of measurement occasions provided by the players and this is an acceptable condition in multilevel modelling, but unacceptable with the repeated measures ANOVA method.

Furthermore, standard statistical tests lean heavily on the assumption of independence of the observations and if this assumption is violated, the estimates of the standard errors of the conventional statistical tests are too small. This may result
in many spuriously significant findings (Hox, 1995). By design, the structure of multilevel data violates this assumption and may include a further problem with the combination of variables from different levels. Hence, the multilevel technique was designed to analyse variables from different levels simultaneously, using a statistical model that includes the various dependencies (Hox, 1995). Thus, by considering the current data in hierarchical terms rather than repeated measures ANOVA terms, the standard set of multilevel modelling techniques, "...that allow any pattern of measurements while providing statistically efficient parameter estimation" (Goldstein, 1995, p. 6), can be applied.

7.3.4 Participants

In total, 23449 measurement occasions from 1500 club members were recorded over 24 days between 24 January, 1998 and 25 March, 1998. The club operated 7 days per week, held a membership base of around 16000 adults, and contained 197 poker machines. The size of the data set was intentionally large to allow for the deletion of cases that did not fit certain criteria whilst maintaining an adequate sample size. For example, the 14 participants that had no prior history of play before their first measurement occasion were deleted (and their 462 measurement occasions). That is, each player's history was fixed and not updated over the course of the study.

Furthermore, 31 players (and their 1639 measurement occasions) were deleted due to errors associated with certain machines played. Typically, these machines tended to be older and incompatible with the modern tracking device.
However, the major deletion of players was undertaken to enhance parameter estimates for statistical purposes (discussed below). Only those players with 10 or more playing occasions were included in the sample. This saw the data set reduced to 533 players, who provided 18077 measurement occasions from 177 machines.

The data set was randomly divided in two by the SPSS, with approximately 50% in each sample to allow for repeat analysis, as in the previous study. The first data set contained 9205 playing occasions from 266 participants. The second data set contained 8872 occasions from 267 participants. Both these data sets were retained for the stake size analysis. However, further deletion of cases was undertaken for the net loss sample.

The net loss expenditure variable was operationally defined by the recording of a loss for any measurement occasion (from the second profit analysis in the previous study). There was no logical reason to expect any machine characteristics in the current study to explain a player win. The size of any win is randomly determined, but the size of any loss is determined by the player. Thus, those occasions where players recorded wins (net profit), or neither wins nor losses (breaking even), were deleted (similar to the Dickerson et al., 1992a, criterion for persistence-when-losing). Also, if this left any player with less than 10 playing occasions, the whole data set for that player was deleted.

For the first net loss data set, this left 7028 measurement occasions from 228 players, and for the second, 6482 occasions from 220 players. The total number of machines in both samples remained the same (177). Although the size of the deleted
cases may appear large, it is simply the result of the data being available before recruitment and the non-random stratified sampling method applied after data collection.

With regard to sample size and the power of the test, the procedure for multilevel analysis is somewhat complex. Mok (1995) found that, with hierarchical data, the efficiency of estimates in balanced designs with a sample size $n$, is best served, in general, by a greater number of level-2 units to level-1 units. Thus, if the total sample size (i.e., level-1 units) is 2000, it is statistically more efficient to have 200 level-2 units than 100. However, it is dependent upon the estimates of interest. For fixed effects, 800 level-1 units or greater provide estimates within 1 standard deviation of their true value. For level-2 variance estimates, the data structures with a 10 or greater level-1:level-2 ratio reduce the possibility of bias. However, none of the current sets of data can be considered balanced and the applicability of Mok’s (1995) findings to non-balanced data is questionable.

Bosker, Snijders, and Guldemand (1999) discussed the issue of power and suggested that in cases where data structure are not balanced, the average ratio may be utilised. However, in the original data set of 21348 cases from 1455 players, the average ratio is inappropriate since the distribution of level-1 units within level-2 units is positively skewed, with a mode = 1, median = 6, and mean = 14.67. That is, the most frequently occurring ratio was 1 and the majority of players (53.1%) provided six or less level-1 units. The problem this raises is not for fixed effect estimates but for the level-2 parameters. Each participant is given an effect size coefficient for each explanatory variable (up to five for the net loss data) and
although multilevel modelling is capable of providing all estimates even if only one occasion is recorded, the stability of these estimates increases with a greater number of level-1 units.

In ordinary regression analysis, a common rule of thumb is to require 10 observations for each coefficient that is estimated (Hox, 1995). Hence, in keeping with this, those players that provided less than 10 measurement occasions were deleted from the original data set. Although this greatly reduced the original sample size, all data sets contained more than 6000 level-1 units and a ratio of level-1:level-2 units of at least 10 from over 200 participants (satisfying Mok, 1995).

7.3.5 Apparatus

Currently, there exist five statistical packages designed for multilevel modelling, with MLn, HLM and VARCL the most common. A review of these programs by Kreft, de Leeuw, and van der Leeden (1994) suggested the MLn (Rasbash & Woodhouse, 1996) program due to its extreme efficiency and interactive flexibility. This DOS-based program was run on a Pentium II 400 MHz with 128 megabytes of RAM.

7.4 Participants: Stake Size I

There were 121 males (45.5%) and 145 females (54.5%) in the first data set (N = 266). The tables below provide descriptive information of players and
machines. The first table provides information related to the data collected during the measurement occasions. The second table contains the player history information.

Table 7.1

*Measures of Central Tendency and Range for Avstake (cents, N = 9205) and Machine Variables (N = 177)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avstake</td>
<td>67.10</td>
<td>91.60</td>
<td>43.00</td>
<td>1.00</td>
<td>1000.00</td>
</tr>
<tr>
<td>Denom</td>
<td>14.16</td>
<td>29.09</td>
<td>5.00</td>
<td>1.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Maxline</td>
<td>8.81</td>
<td>4.31</td>
<td>9.00</td>
<td>1.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Maxbet</td>
<td>15.37</td>
<td>15.64</td>
<td>10.00</td>
<td>3.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

As displayed in Table 7.1, the average stake size, determined from the 9205 measurement occasions, was 67.10 cents. There was, however, much variance between each occasion as indicated by the large standard deviation (91.60 cents) and the large range (1 cent-$10).

The average denomination for the 177 machines was 14.16 cents, the average maximum number of pay-lines was 8.81, and the average maximum bet multiplication was 15.37.
Table 7.2
*Measures of Central Tendency and Range for Player Variables* (N = 266)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement occasions</td>
<td>34.61</td>
<td>37.23</td>
<td>22.00</td>
<td>10.00</td>
<td>246.00</td>
</tr>
<tr>
<td>Age (years)</td>
<td>53.08</td>
<td>16.33</td>
<td>55.55</td>
<td>18.32</td>
<td>85.85</td>
</tr>
<tr>
<td>Total playing days</td>
<td>157.08</td>
<td>140.54</td>
<td>127.00</td>
<td>1.00</td>
<td>872.00</td>
</tr>
<tr>
<td>Days per week</td>
<td>1.33</td>
<td>1.05</td>
<td>1.11</td>
<td>0.01</td>
<td>7.00</td>
</tr>
<tr>
<td>Total net loss ($)</td>
<td>884.33</td>
<td>14406.02</td>
<td>3856.00</td>
<td>-258.00</td>
<td>107989.00</td>
</tr>
<tr>
<td>Net loss per day ($)</td>
<td>54.80</td>
<td>63.72</td>
<td>31.59</td>
<td>-64.50</td>
<td>403.74</td>
</tr>
<tr>
<td>Total stroke</td>
<td>140097.60</td>
<td>175192.51</td>
<td>175192.51</td>
<td>116.00</td>
<td>1538394.00</td>
</tr>
<tr>
<td>Stroke per day</td>
<td>842.91</td>
<td>526.54</td>
<td>720.24</td>
<td>14.50</td>
<td>2784.14</td>
</tr>
</tbody>
</table>

From Table 7.2, the average number of measurement occasions provided by the 266 participants was 34.61. Their average age was 53.08 years, their average number of playing days since membership was 157.08, and their average days per week of play were 1.33. The average total net loss since membership for this sample was $8,884.33. The range indicates that not all players had incurred a net loss (-$258, a net profit) and that the highest net loss incurred was $107,989. The average total stroke for this sample was 140097.60, indicating the average number of times the participants had ‘pulled the handle’ or pressed the buttons on the poker machine. Both net loss per day and stroke per day since membership are also given.

7.5 Results: Stake Size I

7.5.1 Preliminary Analysis: Stake Size I

Initially, a data set containing the aggregated average stake size per machine was constructed from the 9205 measurement occasions, providing an average stake
size figure for each machine (N = 177). These were correlated with the relevant observed variables, in a similar analysis to the previous study. That is, the stake size results of the previous study were based on the staking patterns of n players over a sample of 381 poker machines from eight clubs (divided into two data sets, N = 200 and N = 181).

Given that the data in the current sample were recorded from a specific group of players (266 club members only with at least 10 measurement occasions) over 177 machines in the one club, the correlations were undertaken to test the assumption that these players and their expenditure patterns were representative of at least this larger data set. Although multiple regression analysis was undertaken in the previous study, simple Pearson product moment correlations serve the purpose of indicating the strength and direction of the relationships without the need to meet the assumptions for regression. The denline and denbet variables were created as in the previous study and the variables left untransformed.

This basic analysis of untransformed data provided some support for the generality of the machines and players tested in this one club. Compared to the results from the previous study, which included an immeasurable number of players and 381 machines from eight clubs, the results were consistent in both direction and strength. The denline variable recorded a high and positive (r = .97) correlation with stake size (previously r = .94 and r = .95), and denbet achieved a moderate positive correlation (r = .58) with stake size (previously r = .80 and r = .82). Therefore, the staking patterns of the players in the current study reflect those from the larger sample.
7.5.2 Multilevel Analysis: Stake Size I

The MLn program was utilised to assess the distributional properties of the data obtained from the 9205 measurement occasions. Histograms revealed all test variables (i.e., avstake, denom, maxline, and maxbet) were non-normal in both skewness and kurtosis.

Inherent in MLn is a transformation procedure that produces Normal Equivalent Deviates (NED). This is a method of re-scoring by assigning equivalent normal distribution scores for a standard normal distribution with mean = 0 and standard deviation = 1 (Rowe, 1998; Woodhouse et al., 1996). All variables were transformed using the NED method and provided improved histograms, although not perfect. This was not considered problematic as, given the large size of the data set, the effects of minor deviations from normality and a few outliers would minimally affect power (Tabachnick & Fidell, 1996).

The first stage of modelling required the creation of a ‘candidate’ variable called ‘cons’, which takes the default value of 1 for all level-1 units. This allows for subsequent estimates of the variance in the random part of the fitted model. In regression terminology, this variable represents a constant or the estimate of intercept.

A simple two-level variance components model, using Navstake (normalised average stake size) as the response variable, was performed to determine the partitioning of variance between the levels. This model is presented in Table 7.3.
Table 7.3
Variance Components Model for Navstake

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.071 (.054)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Random</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Level-2</td>
<td>.755 (.067)*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.252 (.004)*</td>
</tr>
</tbody>
</table>

*p < .05

-2log (lh) = 14596.10

The results presented in Table 7.3 indicate that there were 1.007 units of variation in average stake size. Of this, 25% (.252) was located at the between occasions within players level (level-1). The remaining 75% (.755) of variation in average stake size occurred at the between players level (level-2).

The variance estimates from both levels achieved significance indicating that there is significant variance in average stake size between occasions within player and between players. Calculating $t$-values (estimate/SE) derived the significance of these figures. That is, if $t > 1.96$, then $p < .05$, two-tailed test. The log-likelihood ratio statistic (14596.10) provides a base measure of the ‘goodness of fit’ against which to judge the effects of including further terms in conjunction with $t$-values. This is a more accurate measure of the significance of estimates, particularly those associated with the random parameters and, as this estimate is based on the chi-square distribution, with non-normally distributed samples (Hox, 1995; Woodhouse et al., 1996).

The explanatory variables implicated from the previous study were then entered into the fixed part of the model. This was done singularly in order to assist interpretation by obtaining a relevant log-likelihood ratio statistic for each fixed
effect (Full Maximum Likelihood estimation used) and to determine the effect of each individual variable on the random parameters. It also assists the iterative process of the MLn program (Rowe, 1998; Woodhouse et al., 1996). The first variable entered was machine denomination.

Table 7.4
*Model Estimates adjusted for Ndenom*

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.031 (.045)</td>
</tr>
<tr>
<td>Ndenom</td>
<td>.457 (.007)*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Random</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Level-2</td>
<td>.518 (.046)*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.174 (.003)*</td>
</tr>
</tbody>
</table>

* *p < .05
-2log(lh) = 11180.10
χ² = 3416.00 (df = 1, p < .001)

There was a significant positive relationship between machine denomination and average stake size. The overall goodness of fit for the model was also significant, further indicating that this variable should be retained for level-2 analysis. The amount of variance in average stake size explained by the machine denomination was determined by the reduction in the overall variance.

Previously, there were 1.007 units of variation, but after the denomination variable was fitted, this was reduced to .692, indicating that denomination accounted for 31.28% of the total variance in average stake size (this figure is similar to the squared multiple correlation figure R² in multiple regression). The fact that the level-1 variable denomination reduced both level-1 and level-2 variance indicates that the composition of level-2 (players), with respect to this variable is not identical. That is,
denomination explains not only the variance in stake size within occasions between players, but also the variance in stake size between players. This is understandable since some players would only play higher denomination machines, some only lower denomination machines. From the remaining variance in the random parameters, machine denomination accounted for 30.95% of the variance at level-1 and 31.39% of the variance at level-2. The next explanatory variable entered was maxline.

Table 7.5
*Model Estimates adjusted for Nmaxline*

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.033 (.044)</td>
</tr>
<tr>
<td>Ndenom</td>
<td>.534 (.008)*</td>
</tr>
<tr>
<td>Nmaxline</td>
<td>.140 (.007)*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Random</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Level-2</td>
<td>.507 (.045)*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.167 (.003)*</td>
</tr>
</tbody>
</table>

* * p < .05  
-2log(lh) = 10794.20  
χ² = 385.90 (df = 1, p < .001)

A similar result to denomination was obtained for maxline. There was a significant positive relationship between maxline and average stake size. This machine variable also significantly improved model fit under the chi-square distribution. However, it only accounted for a further 2.60% of the total variance in the stake size with a greater proportion accounted for at level-1 (4.02%) than at level-2 (2.12%). The results for the explanatory variable maxbet are presented below.
Table 7.6
Model Estimates adjusted for Nmaxbet

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.033 (.044)</td>
</tr>
<tr>
<td>Ndenom</td>
<td>.540 (.009)*</td>
</tr>
<tr>
<td>Nmaxline</td>
<td>.139 (.007)*</td>
</tr>
<tr>
<td>Nmaxbet</td>
<td>.010 (.006)</td>
</tr>
<tr>
<td>Random</td>
<td></td>
</tr>
<tr>
<td>Level-2</td>
<td>.506 (.050)*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.167 (.003)*</td>
</tr>
</tbody>
</table>

* $p < .05$

$-2\log(lh) = 10792.00$

$\chi^2 = 2.20 \ (df = 1, \ p = .14)$

The explanatory variable maxbet was not a significant predictor of average stake size. This variable did not significantly improve the goodness of fit, and only reduced the total variance by 0.15%. Thus, this parameter failed as an explanatory variable of average stake size and was not retained for further analysis.

The final parameters in the fixed part of the model support the hypotheses that the machine variables denomination and maxline are related to player average stake size (Table 7.5). Specifically, these machine variables were able to account for 33.73% of the variance between occasions within players (level-1), with denomination the most important, accounting for 30.95% of this variance.

As indicated by Woodhouse et al. (1996), when fitting multilevel models “...we should ensure at an early stage that a basic assumption is valid, namely that the level-1 residuals have constant variance.” (p. 33). This is the equivalent of the assumption of homoscedasticity in multiple regression modelling and the test is identical. Thus, the standardised level-1 residuals were plotted against the standardised predicted values. The resulting plot supported the assumption of
constant variance. There was some weak heteroscedasticity present, suggesting that errors of prediction increased as the size of the prediction decreased, but the amount was negligible.

Plotted residuals also provided evidence that the assumption of multivariate normality was met with the variables retained in the current model and that there were no outliers in the distribution ($z < 3.29, p > .001$).

To test the next hypotheses regarding variation between players in the effect size of both machine variables, each was set to vary randomly across level-2. First, the denomination variable was entered at level-2.

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.051 (.044)</td>
</tr>
<tr>
<td>Ndenom</td>
<td>.578 (.020)*</td>
</tr>
<tr>
<td>Nmaxline</td>
<td>.157 (.007)*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Random</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level-2</td>
</tr>
<tr>
<td>Ndenom/Ndenom</td>
</tr>
<tr>
<td>Level-1</td>
</tr>
</tbody>
</table>

* $p < .05$
-2log(lh) = 9742.54
$\chi^2 = 1049.46$ ($df = 1, p < .001$)

The result for denomination at level-2 indicated that there was significant variation between players in the effect that this machine variable had on average stake size. Further confirmation of this effect was obtained with the significant chi-
square figure, indicating a significant improvement in the model fit with the addition
of this parameter. The machine variable maxline was then entered at level-2.

Table 7.8
Model Estimates adjusted for Nmaxline Variance at Level-2

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.046 (.044)</td>
</tr>
<tr>
<td>Ndenom</td>
<td>.587 (.021)*</td>
</tr>
<tr>
<td>Nmaxline</td>
<td>.177 (.015)*</td>
</tr>
<tr>
<td>Random</td>
<td></td>
</tr>
<tr>
<td>Level-2</td>
<td>.503 (.045)*</td>
</tr>
<tr>
<td>Ndenom/Ndenom</td>
<td>.080 (.010)*</td>
</tr>
<tr>
<td>Nmaxline/Nmaxline</td>
<td>.033 (.005)*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.132 (.002)*</td>
</tr>
</tbody>
</table>

* p < .05
-2log(lh) = 9408.79
χ² = 333.75 (df = 1, p < .001)

The Nmaxline/Nmaxline parameter indicated that there was significant
variation between players in the maxline coefficient. In other words, the effect size
for maxline varied significantly across players.

With significant variance between players for the effect of both machine
variables, the final hypothesis was tested. That is, the variance between players in
machine variable effect sizes can be explained by the player’s history, as measured
by the number of previous games played (stroke). In an attempt to model this
variance, the players’ stroke figures were allowed to covary, in the first instance,
with the denomination coefficients at level-2.
Table 7.9
*Model Estimates adjusted for Nstroke/Ndenom Covariance at Level-2*

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.039 (.044)</td>
</tr>
<tr>
<td>Ndenom</td>
<td>.589 (.021)*</td>
</tr>
<tr>
<td>Nmaxline</td>
<td>.176 (.015)*</td>
</tr>
<tr>
<td>Random</td>
<td></td>
</tr>
<tr>
<td>Level-2</td>
<td>.501 (.045)*</td>
</tr>
<tr>
<td>Ndenom/Ndenom</td>
<td>.083 (.010)*</td>
</tr>
<tr>
<td>Nmaxline/Nmaxline</td>
<td>.032 (.005)*</td>
</tr>
<tr>
<td>Nstroke/Ndenom</td>
<td>.035 (.014)*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.132 (.002)*</td>
</tr>
</tbody>
</table>

* p < .05
-2log(ll) = 9404.16
χ² = 4.63 (df = 1, p = .03)

This result indicates that as stroke increases, the slope or coefficient for denomination also increases. That is, for those players with a greater number of past games played, the effect of denomination on their average stake size was greater. The players’ stroke figures were then allowed to covary, with their maxline coefficients at level-2.

Table 7.10
*Model Estimates adjusted for Nstroke/Nmaxline Covariance at Level-2*

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.038 (.044)</td>
</tr>
<tr>
<td>Ndenom</td>
<td>.590 (.021)*</td>
</tr>
<tr>
<td>Nmaxline</td>
<td>.173 (.015)*</td>
</tr>
<tr>
<td>Random</td>
<td></td>
</tr>
<tr>
<td>Level-2</td>
<td>.513 (.046)*</td>
</tr>
<tr>
<td>Ndenom/Ndenom</td>
<td>.082 (.010)*</td>
</tr>
<tr>
<td>Nmaxline/Nmaxline</td>
<td>.032 (.005)*</td>
</tr>
<tr>
<td>Nstroke/Ndenom</td>
<td>.040 (.013)*</td>
</tr>
<tr>
<td>Nstroke/Nmaxline</td>
<td>-.018 (.010)</td>
</tr>
<tr>
<td>Level-1</td>
<td>.132 (.002)*</td>
</tr>
</tbody>
</table>

* p < .05
-2log(ll) = 9401.31
χ² = 2.85 (df = 1, p = .09)
The parameter estimate Nstroke/Nmaxline failed to achieve significance, but more importantly failed to contribute significantly to the overall model fit. Thus, the parameter estimates specified in Table 7.9 provides a final summary of significant results.

7.6 Participants: Stake Size II

The second data set (N = 267) comprised 130 males (48.7%) and 137 females (51.3%). The tables below provide descriptive information of players and machines. Table 7.11 displays information related to the data collected during the measurement occasions. Table 7.12 displays the player history information.

Table 7.11
Measures of Central Tendency and Range for Avstake (cents, N = 8872) and Machine Variables (N = 177)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Min.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avstake</td>
<td>63.04</td>
<td>77.52</td>
<td>41.67</td>
<td>1.00</td>
<td>923.32</td>
</tr>
<tr>
<td>Denom</td>
<td>14.16</td>
<td>29.09</td>
<td>5.00</td>
<td>1.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Maxline</td>
<td>8.81</td>
<td>4.31</td>
<td>9.00</td>
<td>1.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Maxbet</td>
<td>15.37</td>
<td>15.64</td>
<td>10.00</td>
<td>3.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Table 7.12
Measures of Central Tendency and Range for Player Variables (N = 267)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Min.</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement occasions</td>
<td>33.23</td>
<td>35.53</td>
<td>21</td>
<td>10</td>
<td>299</td>
</tr>
<tr>
<td>Age (years)</td>
<td>51.07</td>
<td>16.38</td>
<td>55.33</td>
<td>18.20</td>
<td>85.38</td>
</tr>
<tr>
<td>Total playing days</td>
<td>145.65</td>
<td>144.81</td>
<td>112</td>
<td>1</td>
<td>859</td>
</tr>
<tr>
<td>Days per week</td>
<td>1.24</td>
<td>1.06</td>
<td>1.01</td>
<td>0.03</td>
<td>6.34</td>
</tr>
<tr>
<td>Total net loss ($)</td>
<td>7299.85</td>
<td>12175.38</td>
<td>3038</td>
<td>-1237</td>
<td>109650</td>
</tr>
<tr>
<td>Net loss per day ($)</td>
<td>48.02</td>
<td>62.94</td>
<td>31.17</td>
<td>-247.41</td>
<td>433.62</td>
</tr>
<tr>
<td>Total stroke</td>
<td>113040.20</td>
<td>136760.45</td>
<td>60594</td>
<td>183</td>
<td>890679</td>
</tr>
<tr>
<td>Stroke per day</td>
<td>751.75</td>
<td>488.15</td>
<td>638.14</td>
<td>54.29</td>
<td>2950.70</td>
</tr>
</tbody>
</table>
7.7 Results: Stake Size II

7.7.1 Preliminary Analysis: Stake Size II

Machine data were aggregated and the denline and denbet variables created as in the preliminary analysis for the first data set. The results indicated a high, positive correlation between denline and average stake size \( r = .95 \), and moderate, positive correlation between denbet and stake size \( r = .63 \). These results were similar to those of the previous study based on 381 machines from eight clubs.

7.7.2 Multilevel Analysis: Stake Size II

The data were transferred to MLn where the distributional properties of each variable were assessed. Histograms revealed all variables were non-normal in both skewness and kurtosis. All variables were transformed using the NED method, which improved the bell-shaped properties of the histograms.

The statistical procedure for the first data set introduced the explanatory variables individually in order to assess the effect of each, in terms of the chi-square statistic and variance reduction. This procedure also provided a measure of the stability of the results and the effect of adding and removing one explanatory variable on the other estimates. The estimates and their standard errors were presented to three decimal places to assist interpretation. This same procedure was undertaken with the second data set for average stake size, but only the base variance
components model and the final summary table of significant results (to two decimal places) are presented.

Table 7.13
Variance Components Model for Navstake (second data set)

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.02 (.05)</td>
</tr>
<tr>
<td>Random</td>
<td></td>
</tr>
<tr>
<td>Level-2</td>
<td>.74 (.07)*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.31 (.01)*</td>
</tr>
</tbody>
</table>

* p < .05
-2log (lh) = 15916.30

Table 7.14
Model Summary of Significant Estimates for Navstake (second data set)

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.02</td>
<td></td>
</tr>
<tr>
<td>Ndenom</td>
<td>.62*</td>
<td>342.40***</td>
</tr>
<tr>
<td>Nmaxline</td>
<td>.17*</td>
<td>428.60***</td>
</tr>
<tr>
<td>Random</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level-2</td>
<td>.47*</td>
<td></td>
</tr>
<tr>
<td>Ndenom/Ndenom</td>
<td>.08*</td>
<td>844.80***</td>
</tr>
<tr>
<td>Nmaxline/Nmaxline</td>
<td>.03*</td>
<td>203.60***</td>
</tr>
<tr>
<td>Nstroke/Nmaxline</td>
<td>-.03*</td>
<td>7.50**</td>
</tr>
</tbody>
</table>

* p < .05, ** p < .001, *** p < .001
-2 (lh) = 11011.60

The results for the second data set were similar to the first. Denomination and maxline were significantly and positively related to average stake size, accounting for 35.23% of the variance between occasions within players. Again, the denomination variable accounted for the major proportion of this variance (31.92%). There was also significant variation between players in the effect size for both denom and maxline. Again, maxbet was not a significant explanatory variable (t = .80, p >
.05; \chi^2 = .70, p = .40). The use of the step method and the replication of these results attest to the stability of these estimates.

However, the player variable stroke did not covary with denom (\chi^2 = .10, p = .75) but did covary with maxline. Unlike the previous result for denom, the direction of this relationship was negative. As the players' stroke figures increased, their coefficients for maxline decreased. The different results for the stroke variable across both data sets suggests that this variable is not a stable explanatory variable of the variance between players in structural effects.

7.8 Discussion: Stake Size

The results most relevant to the hypotheses are the fixed effects and the amount of variance explained at level-1. This level indicates the variance in expenditure between occasions within players and best describes the notion of structural effects. The results for average stake size suggest that the variable denomination is the machine characteristic most strongly related to between occasions within player staking. This variable was able to explain 30.95% and 31.92% of the variance between occasions within players, in both data sets. Thus, as players move from machine to machine, their stake size is influenced by the denomination of each machine.

It was also hypothesized that the maxline variable would be positively related to stake size. For both average stake size data sets, this hypothesis was supported. However, the amount of variance explained at level-1 by this variable was low. For
the first data set it was 4.02%, and for second data set, 4.86%. Thus, it could be argued that the maximum number of pay-lines on a poker machine does influence player stake size, but the overall relationship is not strong. The significant result in the fixed part of this model for this variable may be explained by the power of the test. That is, the effect size was very small, reaching significance due to the statistical power associated with the large sample sizes (Tabachnick & Fidell, 1996).

The results failed to support the hypothesis that the machine variable maxbet is positively related to player staking patterns between occasions. It failed to achieve significance in both data sets. Thus, it may be concluded that as players move from machine to machine, their staking patterns are related to the denomination of the machine and, to a lesser extent, the maximum number of pay-lines.

The results for the random parameters also indicated that there was significant variance between players in the level of each structural effect. For example, one player’s stake size may be highly related to the machine’s denomination and maxline whilst another’s is not. In an attempt to explain this variance between players, the player history variable stroke was utilised as a predictor.

The analysis of the relationship between stroke and structural effect size yielded ambiguous results. Under the operant conditioning explanation, it was predicted that the strength of this relationship would be stronger for the more experienced players (greater stroke) due to greater learning. However, a stable covariance between the player history variable, stroke, and the player effect size for
both machine variables was not reported. For the first data set, the effect for
denomination was positively related to stroke and no significant covariance was
found between stroke and maxline. However, in the second data set, these results
were reversed with a significant negative covariance between stroke and maxline
revealed, and no relationship between denomination and stroke. The only conclusion
that can be drawn is that no stable relationship exists between stroke and either
machine effect.

At its simplest level, the results support the notion of structural effects in
individual wagering patterns. Two of the three components that comprise a
machine's multiplier potential, the denomination and the maximum number of pay-
lines, are positively related to a player's average stake size. This also suggests that
the aggregated machine results obtained for this expenditure measure previously
(Chapter 6) were due to increases in individual player stake size per machine, and not
due to machine variables attracting players defined by their stake size.

7.9 Participants: Net Loss I

There were 104 males (45.6%) and 124 females (54.4%) in the first data set
for net loss ($N = 228$) who provided 7028 measurement occasions. The tables below
provide descriptive information of players and machines.

The machine variable bill acceptor was a dichotomous variable and not
included in the tables. Of the 177 machines, 124 (70.1%) were fitted with a bill
acceptor and 53 (29.9%) were not.
Table 7.15
Measures of Central Tendency and Range for Net Loss (dollars, N = 7028) and Machine Variables (N = 177)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Loss ($)</td>
<td>23.18</td>
<td>63.19</td>
<td>10.00</td>
<td>1.00</td>
<td>3365.00</td>
</tr>
<tr>
<td>Denom</td>
<td>14.16</td>
<td>29.09</td>
<td>5.00</td>
<td>1.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Maxline</td>
<td>8.81</td>
<td>4.31</td>
<td>9.00</td>
<td>1.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Maxbet</td>
<td>15.37</td>
<td>15.64</td>
<td>10.00</td>
<td>3.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Machage (days)</td>
<td>503.73</td>
<td>470.08</td>
<td>352.00</td>
<td>1.00</td>
<td>2011.00</td>
</tr>
</tbody>
</table>

Table 7.15 differs from those for stake size in two ways. First, the net loss variable is measured in dollars, not cents, and thus the mean loss per occasion was $23.18. Second, the machine variable machage (machine age) is included. This variable was measured in days, with a higher figure indicating an increased age or longer period on the gaming room floor.

Table 7.16
Measures of Central Tendency and Range for Player Variables (N = 228)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Occasions</td>
<td>38.48</td>
<td>38.88</td>
<td>25.00</td>
<td>10.00</td>
<td>246.00</td>
</tr>
<tr>
<td>Age (years)</td>
<td>52.99</td>
<td>15.91</td>
<td>55.68</td>
<td>18.32</td>
<td>84.48</td>
</tr>
<tr>
<td>Total playing days</td>
<td>167.77</td>
<td>144.62</td>
<td>135.00</td>
<td>1.00</td>
<td>872.00</td>
</tr>
<tr>
<td>Days per week</td>
<td>1.42</td>
<td>1.08</td>
<td>1.30</td>
<td>0.06</td>
<td>7.00</td>
</tr>
<tr>
<td>Total net loss ($)</td>
<td>9512.63</td>
<td>15061.80</td>
<td>4559.00</td>
<td>-258.00</td>
<td>107989.00</td>
</tr>
<tr>
<td>Net loss per day ($)</td>
<td>54.64</td>
<td>62.51</td>
<td>33.44</td>
<td>-64.50</td>
<td>403.74</td>
</tr>
<tr>
<td>Total stroke</td>
<td>151742.40</td>
<td>182114.22</td>
<td>94684.00</td>
<td>116.00</td>
<td>1538394.00</td>
</tr>
<tr>
<td>Stroke per day</td>
<td>850.22</td>
<td>498.42</td>
<td>741.43</td>
<td>14.50</td>
<td>2592.72</td>
</tr>
</tbody>
</table>
7.10 Results: Net Loss I

7.10.1 Preliminary Analysis: Net Loss I

A set of data containing the aggregated (sum) net loss per machine was constructed from the 7208 measurement occasions, providing a profit figure for each machine ($N = 177$). These were correlated with the relevant observed variables, denline, bill acceptor, and machine age (machage) in a similar fashion to the study of machine performance and profit ($N = 389$ and $N = 385$). The denline variable recorded a weak, positive relationship with profit ($r = .26$), which was stronger than the two previous results ($r = .12$ and $r = .24$). The result for the bill acceptor was $rpb = .36$, which was slightly weaker than the two previous results ($rpb = .46$ and $rpb = .45$), and the result for machine age was $r = -.24$, which was also weaker than the two previous results ($rpb = .44$ and $rpb = .39$).

The comparison of correlations for net loss does not reflect the results for machine profit as closely as the comparisons for stake size. The current machine data were aggregated from 7208 playing occasions generated by 228 players across 177 machines in one club. The comparison data set was generated from $n$ playing occasions by $n$ players across 389 machine and 385 machines in six clubs.

The deviation in correlations between studies is not severe. Indeed, the results for the bill acceptor and denline from the current sample are similar to the previous findings. Although a weaker relationship was found for machage, this may be due to differences in the scoring of this variable (as reflected by the different direction).
Previously, it was machine model that was used to measure age, but the current data used the more accurate definition based on installation dates. Nonetheless, any difference between results suggests that the sample of players in the current set may not be representative of a greater population and, therefore, caution must be exhibited when generalising the results from the multilevel analysis.

7.10.2 Multilevel Analysis: Net Loss I

Histograms of the continuous variables revealed both skewness and kurtosis. All variables were transformed using the NED method, resulting in improved histograms. As with the results for average stake size, each parameter was entered individually. Table 7.17 displays the base variance components model and Table 7.18 the final summary table of significant findings. All estimates demonstrated stability leading to the figures in Table 7.18.

Table 7.17
*Variance Components Model for Nnetloss (first data set)*

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.06 (.05)</td>
</tr>
<tr>
<td>Random</td>
<td></td>
</tr>
<tr>
<td>Level-2</td>
<td>.49 (.05)*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.50 (.01)*</td>
</tr>
</tbody>
</table>

* p < .05
-2log (lh) = 15824.60
Table 7.18
Model Summary of Significant Estimates for Nnetloss (first data set)

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate</th>
<th>$\chi^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.11</td>
<td></td>
</tr>
<tr>
<td>Bill Acceptor</td>
<td>.20*</td>
<td>101.10***</td>
</tr>
<tr>
<td>Ndenom</td>
<td>.12*</td>
<td>32.10***</td>
</tr>
<tr>
<td>Nmaxline</td>
<td>.06*</td>
<td>14.70***</td>
</tr>
<tr>
<td>Nmaxbet</td>
<td>.03*</td>
<td>4.30*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Random</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Level-2</td>
<td>.39*</td>
<td></td>
</tr>
<tr>
<td>Bill Accp/Bill Accp</td>
<td>.05*</td>
<td>54.00***</td>
</tr>
<tr>
<td>Ndenom/Ndenom</td>
<td>.02*</td>
<td>56.90***</td>
</tr>
<tr>
<td>Nmaxline/Nmaxline</td>
<td>.01*</td>
<td>6.10*</td>
</tr>
<tr>
<td>Nstroke/Ndenom</td>
<td>.03*</td>
<td>5.60*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.47*</td>
<td></td>
</tr>
</tbody>
</table>

* $p < .05$, ***$ p < .001$

$-2\log (lh) = 15549.40$

The significant fixed parameter estimates in Table 7.18 display the four machine variables related to net loss. All were positive indicating that, on average, a greater net loss was recorded on those occasions involving machines possessing a bill acceptor and higher levels of denomination, maxline, and maxbet. Machine age, however, failed to achieve an adequate significance level ($t = -.69$, $p > .05$, $\chi^2 = .80$, $p = .37$).

The total amount of variance explained by the significant fixed parameters was low (5.05%). Furthermore, the machine variables bill acceptor and denomination were able to explain a greater proportion of variance at level-2 (3.23% and 5.03%) than at level-1 (1.37% and 0.15%), but again all figures were low. Although maxline and maxbet did explain a greater proportion of variance at level-1, both figures were extremely low (0.11% for maxline, 0.60% for maxbet).
Significant variation in effect size between players was revealed for bill acceptor, denom, and maxline, but not for maxbet ($t = 1.72 \ p > .05, \chi^2 = 3.00, \ p = .08$). The player variable stroke was found to significantly covary with denomination only. The results indicate that the effect of denomination on net loss was stronger for those players with a greater stroke figure.

7.11 Participants: Net Loss II

There were 105 males (47.7%) and 115 females (52.3%) in the second data set ($N = 220$) who provided 6482 measurement occasions. The tables below provide descriptive information of players and machines. Of the 177 machines, 124 (70.1%) were fitted with a bill acceptor and 53 (29.9%) were not.

Table 7.19

*Measures of Central Tendency and Range for Net Loss (dollars, $N = 6482$) and Machine Variables ($N = 177$)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Loss ($)</td>
<td>21.02</td>
<td>48.40</td>
<td>8.00</td>
<td>1.00</td>
<td>1334.00</td>
</tr>
<tr>
<td>Denom</td>
<td>14.16</td>
<td>29.09</td>
<td>5.00</td>
<td>1.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Maxline</td>
<td>8.81</td>
<td>4.31</td>
<td>9.00</td>
<td>1.00</td>
<td>25.00</td>
</tr>
<tr>
<td>Maxbet</td>
<td>15.37</td>
<td>15.64</td>
<td>10.00</td>
<td>3.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Machage (days)</td>
<td>503.73</td>
<td>470.08</td>
<td>352.00</td>
<td>1.00</td>
<td>2011.00</td>
</tr>
</tbody>
</table>
Table 7.20
Measures of Central Tendency and Range for Player Variables (N = 220)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement</td>
<td>29.46</td>
<td>28.52</td>
<td>21.00</td>
<td>10.00</td>
<td>252.00</td>
</tr>
<tr>
<td>Occasions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>51.72</td>
<td>16.13</td>
<td>52.25</td>
<td>19.76</td>
<td>85.38</td>
</tr>
<tr>
<td>Total playing days</td>
<td>152.66</td>
<td>146.73</td>
<td>120.00</td>
<td>1.00</td>
<td>859.00</td>
</tr>
<tr>
<td>Days per week</td>
<td>1.29</td>
<td>1.08</td>
<td>1.04</td>
<td>0.03</td>
<td>6.34</td>
</tr>
<tr>
<td>Total net loss ($)</td>
<td>7964.19</td>
<td>13037.03</td>
<td>3243.00</td>
<td>-1237.00</td>
<td>109650.00</td>
</tr>
<tr>
<td>Net loss per day ($)</td>
<td>50.18</td>
<td>67.73</td>
<td>31.40</td>
<td>-247.41</td>
<td>433.62</td>
</tr>
<tr>
<td>Total stroke</td>
<td>123161.09</td>
<td>141338.52</td>
<td>69198.00</td>
<td>183.00</td>
<td>890697.00</td>
</tr>
<tr>
<td>Stroke per day</td>
<td>786.96</td>
<td>488.28</td>
<td>682.03</td>
<td>63.90</td>
<td>2950.70</td>
</tr>
</tbody>
</table>

7.12 Results: Net Loss II

7.12.1 Preliminary Analysis: Net Loss II

The decline variable recorded a weak, positive relationship with profit \((r = .29)\), which was stronger than the two previous results \((r = .12 \text{ and } r = .24)\). The result for the bill acceptor was \(r_{pb} = .32\) (previously \(r_{pb} = .46 \text{ and } r_{pb} = .45\)), and for machine age \(r = -.26\) (previously \(r_{pb} = .44 \text{ and } r_{pb} = .39\)).

Again, the results for the current study compared to previous results were distinct enough to warrant caution about any generalisation of results in the multilevel analysis.

7.12.2 Multilevel Analysis: Net Loss II

All continuous variables were again transformed using the NED method. As with the results for all previous multilevel analyses, each parameter was entered
individually. All estimates demonstrated stability except for machage (discussed below). The variance components model and final model are presented in Tables 7.21 and 7.22 respectively.

Table 7.21
Variance Components Model for Nnetloss (second data set)

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.13 (.05)</td>
</tr>
<tr>
<td>Random</td>
<td></td>
</tr>
<tr>
<td>Level-2</td>
<td>.49 (.05)*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.51 (.01)*</td>
</tr>
</tbody>
</table>

* p < .05
-2log (lh) = 14724.80

Table 7.22
Model Summary of Significant Estimates for Nnetloss (second data set)

<table>
<thead>
<tr>
<th>Fixed</th>
<th>Estimate</th>
<th>χ2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>.04</td>
<td></td>
</tr>
<tr>
<td>Bill Acceptor</td>
<td>.09*</td>
<td>45.70***</td>
</tr>
<tr>
<td>Nmachage</td>
<td>-.03*</td>
<td>.20</td>
</tr>
<tr>
<td>Ndenom</td>
<td>.17*</td>
<td>66.60***</td>
</tr>
<tr>
<td>Nmaxline</td>
<td>.10*</td>
<td>39.70***</td>
</tr>
<tr>
<td>Random</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level-2</td>
<td>.42*</td>
<td></td>
</tr>
<tr>
<td>Bill Accep/Bill Accep</td>
<td>.02</td>
<td>7.30**</td>
</tr>
<tr>
<td>Ndenom/Ndenom</td>
<td>.03*</td>
<td>37.60***</td>
</tr>
<tr>
<td>Nmaxline/Nmaxline</td>
<td>.02*</td>
<td>26.80***</td>
</tr>
<tr>
<td>Level-1</td>
<td>.48*</td>
<td></td>
</tr>
</tbody>
</table>

* p < .05, ** p < .001, *** p < .001
-2log (lh) = 14503.20

The significant fixed parameter estimates in Table 7.22 display the four machine variables related to net loss. Three were positive, indicating that greater net losses were recorded on those occasions involving machines with a bill acceptor and higher levels of denomination and maxline. The result for machine age was negative,
indicating the greater the age the machine the lower the net loss figure. However, this figure achieved significance using the method of dividing the estimate by the standard error (producing $t = -2.53, p < .05$), but not with the $\chi^2$ figure ($p = .66$). Given that the Full Maximum Likelihood estimation procedure was used, and the crudeness of $t$-statistic, the chi-square value should be given more weight (Hox, 1995). That is, as in the previous data set, the machege variable failed as a predictor variable of net loss.

The result for machege is interesting in that it achieved significance ($t$-value) only after the explanatory variable denomination was entered. This highlights the benefit of introducing variables singularly by providing not only a relevant chi-square statistic, but also an indication of the relationship between observed variables. That is, there appears to be some interaction effect between machine age and denomination or, in other words, the effect of machine age is not the same for all denominations.

Unlike the result for the first net loss data set, maxbet failed to achieve significance in the final model for fixed parameters ($t = 1.46, p > .05, \chi^2 = 2.10, p = .15$).

The total amount of variance explained by the significant fixed parameters was again low (5.11%). Similarly, the amount of explained variance at both levels was low, with the largest figure being for the denom variable, explaining 7.15% at level-2 and 0.81% at level-1.
Significant variation in effect size between players was revealed for bill acceptor, denom, and maxline indicated by the chi-square statistics. Unlike the previous study, the player variable stroke was not found to significantly covary with any of these.

7.13 Discussion: Net Loss

The results for the net loss data were less suggestive of structural effects than those reported for stake size. Although several machine variables were revealed as significant predictors of net loss, these could only explain minimal amounts of variance between occasions within players. The machine variable bill acceptor explained the largest proportion of variance at level-1, which was 1.37% in the first data set. Thus, although it may be concluded that certain machine structural characteristics are positively related to the size of a player’s net loss, the actual size of these structural effects is very small. It would appear that the power of the analysis was great enough for very small effect sizes to achieve significance. This, at least, allays the concerns about sample size and power discussed previously.

Subsequently, with the absence of any sizeable structural effect, the estimates in the random part of the model become somewhat inconsequential. There was variation between players in effect sizes for the bill acceptor, denom, and maxline variables, however, again the size of these effects did not reliably covary with the player variable stroke. These results can only be interpreted as adding weight to the conclusion that the machine characteristics examined were not related to player net loss.
The multilevel analysis on individual playing data does, however, contribute to the understanding of previous findings. The machine variables in the analysis of performance figures (Chapter 6) accounted for around 30% of variance in machine profitability. This suggests that the relationship between machine profitability and the machine variables studied were due to these variables attracting a greater number of players or larger spending players, rather than influencing individual player expenditure within the playing occasion.

7.14 Conclusion

Both the present and previous studies have made a significant contribution to the knowledge of gaming behaviour. Not only do these studies represent the first analysis of structural effects, but they are also the first to utilise machine and computer tracking data for inferential statistical analysis. For both studies, the major interest lie not only in explained variance, but also in the portions of unexplained variance. It is from these results that future investigations into playing behaviour will advance.

Primarily, the aim of the current study was to determine whether a relationship exists between machine variables and the expenditure patterns of individual players. In general, analysis of the four data sets provides empirical evidence in support of this. With regard to the type of expenditure that is influenced by machine variables, the results indicate that a greater proportion of variance in average stake size can be explained by machine variables than for net loss.
The results for both sets of net loss data suggest that the machine variables studied were only able to account for very small amounts of variance. This implies that the results of the previous study on machine performance were due to structural characteristics attracting players, rather than influencing actual play on machines. However, for stake size, there does appear to be a significant and sizeable relationship between machine characteristics and this measure of expenditure.

Despite the fact that the size of significant estimates were low for net loss, they may still be of importance when the number of machines and poker machine players is considered. For example, if the effect size for the bill acceptor was found to be 2 cents, this may seem an inconsequential amount for individual players. However, when considering the number of machines, the number of occasions and the number of players in Australia, this figure may contribute a large amount to the national gambling expenditure figure.

A secondary aim of the current study was to determine whether individual differences in the strength of any relationship were related to player history. The results confirm that there are significant variations between players in the size of structural effects, however, it cannot reliably be concluded that an individual's history of play is a predictor of this. This was found for both measures of expenditure, but it is the significant results for stake size that have the greatest theoretical implications.

The theoretical bases for all hypotheses were the principles associated with operant conditioning. The strength of this theory, in comparison to learning theories
of choice and cognitive accounts, was that it offered behavioural explanations for machine effects without the need to consider the response cost, and also offered a parsimonious explanation of individual differences.

In particular, it was hypothesised that an established contingency between machine variables and reinforcement rate (in terms of both size and frequency of reinforcement) would predict structural effects. Furthermore, it was hypothesised that the various levels of prior learning between players would explain individual differences in the strength of any contingency. However, the results obtained cannot be interpreted as supporting operant conditioning explanations of gaming behaviour. This may be due to shortcomings with both the theory and the methodology of the current study.

A major problem with operant conditioning explanations is the reported result for the denomination variable. Explaining the effect that denomination has on stake size with the ‘size of reinforcement’ principle, conflicts with the null result for the maximum bet multiplication variable. If increases in the size of reinforcement adequately explain the relationship between denomination and stake size, then the question must be asked as to why this principle did not apply to the maxbet variable.

The multilevel analysis of ecologically valid data provides some direction toward the solution of this problem. Unlike experimental analyses, which require conformity to a balanced design, the current study allowed participants to engage in their ‘natural’ playing patterns. From the results for stake size, it was revealed that machine denomination was able to account for equal amounts of variance at both the
occasion level and the player level. However, the maxline variable was clearly accounting for variance at the occasion level. This implies that the denomination of a machine is also a player level variable (like stroke in the current study or gender, age, income, etc.). In other words, players may be defined by the denomination of the machines they play. This interpretation is similar to Griffiths’ (1991) observation of fruit machine players in amusement arcades, where machines of different denominations appealed to different players based on gender and age.

If denomination is conceptualised as both a machine and a player variable, the descriptive and theoretical interpretation of the above results are altered. It also challenges the interpretation that the previous study’s results were due to individual changes in stake size. It would appear that a machine’s average stake size is due to a combination of attracting different players (based on denomination) and also its ability to influence individual players stake size (based on pay-lines). The challenge that conceptualising denomination as a player variable holds for contingency-based explanations of other variables, is that it suggests sensitivity to the response cost. That is, players may be controlling the size of the response cost via control of the denomination variable, rather than accepting the R-Sr contingency of denomination-wins. Therefore, explanations that encompass the response cost phenomenon may offer a more suitable explanation of the results.

The simple contingency principle of operant conditioning does not consider a schedule where both reinforcing and punishing stimuli are associated with the same response. It also fails to predict differential response effects for the frequency and size of reinforcement. Both of these phenomena have been the domains of choice
theories, such as ecological learning and the matching law (Chance, 1994; Davey, 1989; Lieberman, 1993). These theories utilise mathematical equations, which were considered inadequate explanations of poker machine play due to the negative or subtractive behavioural consequence of Type II punishment (measured in terms of size and frequency). In poker machine play, there exist a greater number of punished trials than reinforced, and under choice explanations, the gambling behaviour is itself an anomaly.

It was previously argued that poker machine play provided the opportunity to obtain a large reinforcer immediately at a relatively small response cost and, in combination with the ratio schedule of reinforcement, fostered a condition that promoted continuous risk-prone behaviour (Davey, 1989; Mazur, 1998). This may explain the appeal of games of chance, and therefore the control of machine denomination exhibited by players may be a means of controlling the size of the response cost. Control of the frequency of response cost can only be governed by the number of pay-lines played, and therefore the optimisation problem facing the poker machine player may need to be conceptualised as one of minimising response cost in this risk-prone behaviour, and not one of maximising reinforcement. This is conducive with the findings of other studies suggesting that players are aware that a loss will be incurred and adopt a strategy to maximise playing time (Walker, 1992b).

Assuming the player is controlling the size of punishment via the denomination variable, then playing the maximum number of pay-lines response may be considered as optimal behaviour for minimising the frequency of punishment. Previously, playing more pay-lines was considered only in terms of increasing the
frequency of reinforcement, but there is also the related effect of reducing the frequency of the response cost. Individual differences in effect sizes between players would still be considered an artefact of prior learning, but other player level variables, such as resource availability in terms of time and money, may also be explanatory factors (Davey, 1989).

One underlying assumption of this explanation is that all rewards are considered wins regardless of the actual net position. That is, staking 20 cents and winning 15 cents still has a reinforcing effect, despite an actual loss. This may be justified with the addition of secondary reinforcers associated with all rewards (audio and visual stimuli).

However, even if the emphasis remains largely on the frequency of reward/punishment, there still remains a greater number of punished trials than reinforced trials in gaming machine play. Figure 3.4 indicated that, when playing 20 lines on a machine, around 45% of reinforcers occurred after one response. That is, the majority of responses were still punished and the average rate of reinforcement was less than 1/2 (1/2.2, or 1 reinforcer for every 2.2 responses). This may appear close enough to more reinforcement than punishment, but providing this ratio remains less than 1/2, the mathematical equations of choice theory predict aversion (Chance, 1994; Mazur, 1998). Another inadequacy of choice explanations in poker machine play is that the frequency and size of reward/punishment are not independent events, with each extra pay-line increasing the frequency of the reinforcer and the size of the punisher.
As is the case with post hoc analyses, the alternative interpretation of results outlined above suffers from the problem of ignoring null effects and other explanations may equally apply to the results with this approach. For example, cognitive distortion principles (Griffiths, 1994; Wagenaar, 1988), outlined in Chapter 5.5 could be applied to the maxline variable. Increases in the frequency of reinforcement may provide the illusion of a net gain via a greater number of wins. This may disrupt the gambler’s financial system and promote the erroneous belief of being in an overall net win position and that the machine is favourable to the player. However, cognitive explanations cannot account for individual differences and the results demonstrate significant variance between players in the effect size for maxline. Cognitive explanations would also need to account for the null effect of the maxbet variable.

The only theoretical conclusion that can be drawn from the above results is that the operant conditioning predictions were not supported. The machine variable with an established R-Sr contingency, in terms of reinforcement frequency (maxline), was related to average stake size, but the machine variable with an established R-Sr contingency, in terms of reinforcement size (maxbet), was not related to average stake size. The result for the denomination variable suggests that the size of reinforcement is important, but this relationship is tenuous in light of equal amounts of explained variance at both levels. It would appear to both influence a player’s stake size and be utilised by players to control stake size. This introduces the notion of response cost, which is problematic for learning explanations.
The results of the current study, however, are commensurate with findings from the gaming industry. The results for the multiplier potential characteristics appear to reflect the matrix of responses presented in Chapter 2.2. From this 5 x 5 matrix, it can be seen that the majority of games played (41.23%) were played with the maximum number of pay-lines and minimum bet multiplication. Although these figures were for one machine only, there is evidence supporting the representativeness of this example (Gibson, 1997). Thus, the figures in the matrix are congruent with both the significant effect for maxline and the null effect obtained for the maxbet variable. That is, the size of the maxline variable is important in determining stake size and the size of the maxbet is inconsequential.

Subsequently, this also suggests that it is the frequency of reinforcement that is important and that the size of reinforcement does not influence staking patterns. Under this assumption, the significant effect for denomination may be explained by a correlate with the maxline variable. That is, as denomination increases, so too does the cost of playing the maximum number of pay-lines.

This identifies the important component of the multiplier potential as the maximum number of pay-lines and, under the principle of reinforcement, emphasises the role of frequency in accounting for average stake size variance. It also creates a scenario where a player can be defined by a range of denominations and the maxline/minbet configuration of play, which is stable across the varying denominations played. For example, a player with a preference for lower denomination machines, playing the minimum bet multiplication on a 1-cent machine with 9 lines, generates a stake size of 9 cents. Playing the minimum bet
multiplication on a 2-cent machine with 9 lines generates a stake size of 18 cents. Both the maximum number of pay-lines and minimum bet multiplication have been controlled in this example and a linear relationship would appear for the machine variable denomination (as found in the current study).

However, this linear relationship is misleading and may not be due to the denomination variable providing increases in the size of reinforcement, but due to the cost associated with maintaining or maximising the frequency of reinforcement on higher denomination machines (via the maxline response). Statistically, this is not an interaction effect and would not be present in correlational analyses of machine variables (neither of which were reported in either study). Of course, the motive behind the shift to higher denomination would need to be determined and may very well be due to the desire to increase the size of reinforcement.

The information from the machine manufacturer also suggests that one of the problems with the present study was the measurement and testing of each component of the multiplier potential. Previously (Chapter 6.2), the multiplier potential was considered in terms of monetary value (i.e., in terms of the machine’s denomination), rather than in terms of reinforcement properties. In the previous study, the denomination variable failed to achieve significance and the best predictor of stake size was the cross-product of denomination and the maximum number of pay-lines. The denline variable is a measure of the cost of playing the maximum number of pay-lines, which it is argued here, is what the variable denomination has measured in the current study. In addition, the cross-product of denomination and maxbet achieved significance in the previous study, however the effect size was much
weaker and the amount of unique variance attributed to this factor was negligible (0.01%).

In the current study, the purpose of testing each component of the multiplier potential individually was to test explanations of the multiplier potential effect in reinforcement terms. It can be argued that the key component of the multiplier potential is the maximum number of pay-lines and, therefore, the key component of the reinforcement rate is the frequency of the reinforcement and not the size of the reinforcement. This is evident by the null effect for maxbet, the significant effect for maxline, and the understanding that denomination measures the cost of staking the maximum number of pay-lines.

The failure to support operant predictions for both measures of expenditure may also be explained by conditions unique to the study. First, it could be argued that the sample of members from one club were not representative of the greater population of poker machine players. In general though, the preliminary correlation analyses provided figures consistent with those of the previous study.

Although it was argued that the use of computer tracking equipment improved the reliability of the data obtained (however, like the previous study, there was no calibration of the tracking system), some error can be associated with the measurement of variables. For example, the player’s history was based on play at only one club and did not measure lifetime experiences. It is likely that the majority of players had a much more extensive poker machine playing history than that recorded by the tracking data. However, it is the relative amount of experience that is
essential and, although this may have been affected, it was perhaps to a lesser extent than that of actual differences.

There were also problems associated with the measurement of machine variables. The measurement of the bill acceptor recorded only if this variable was present on a machine, not if it was actually utilised by the player. It is unreasonable to expect the bill acceptor to be utilised on each occasion it is encountered and this is potentially problematic for any substantive interpretation of this variable’s result. This possibly reduced the effect of the bill acceptor and, if measured accurately in terms of use, might have provided a more significant effect for bill acceptor and net loss relationship. Even if the present results for bill acceptor were accurate, causative interpretations suffer due to this measurement problem.

As with all variables, there remains the possibility that each machine variable was correlated with another unmeasured variable. Just as it was suggested that denomination in stake size might represent the cost of playing the maximum number of lines, some other interpretation or correlate may explain the result. Like multiple regression, multilevel analysis is a sophisticated correlation technique and, thus, causation is difficult to establish, particularly when the predictor variable is correlated with another criterion.

In the case of denomination, it was previously noted (Chapter 6.2) that increases in machine denomination were inextricably linked to increases in the minimum stake required. In other words, it is impossible to stake 5 cents on a 10-cent machine and therefore, the significant linear effect for denomination may be a result
of this forced increase. Hence, without consideration of the discussion of
denomination as the cost of playing the maximum number of lines, explanation of
the denomination effect in the current study is confounded by two related causes;
increases in the size of reinforcement and increases in the minimum bet required.

Resolution of this problem may be found by considering other playing
behaviours. The latter 'forced increase' explanation assumes that players stake the
minimum amount on all machines or maintain a set stake size, which is influenced by
the denomination increase. This was not evident in a simple descriptive analysis of
the data set. From the sample of all players originally 'surveyed', the average stake
size for the 4531 occasions of play on 1-cent machines was 32 cents. This amount
could be staked on the larger denomination machines (2, 5, and 10-cent), which
would eliminate the recorded significant effect that denomination has on stake size.
In addition, as discussed above, players may be defined by the denomination of the
machine played and this indicates some control of the forced increased in minimum
stake imposed by this variable.

However, this problem highlights a question not answered by the study that
may influence the result. Understanding why the player left one machine for another
could explain some of the variance recorded. The simplest answer is that they were
dissatisfied with the return rate and wanted to 'try their luck' on another machine,
which does not influence the interpretation of the results. No machine imposes any
upper limit on the net loss amount and all machines have a minimum loss of $1.
However, there always remains the possibility that a player left in search of a
machine that allowed a greater stake size. This does not appear plausible in light of
the data suggesting players bet with the minimum bet multiplication. The argument also creates the hypothesis that a machine’s maximum permissible stake size is a predictor of its average stake size, which was tested and unproven in the previous stake size study.

There is a paucity of published research examining average stake size as a measure of expenditure (Delfabbro & Winefield, 1999). Indeed, the majority of literature on machine variables has focussed on their relationship with net loss and continuous play. Given that the average stake size of a playing occasion is only weakly correlated to net loss (from the data of 21340 playing occasions, $r = .08$), the importance of this variable in poker machine playing behaviour may be questioned. However, stake size represents the first stage in the actual gambling behaviour before any loss has occurred. A player’s average stake size affects the rate of loss and, as shown in Chapter 2.3, modern machines have the capacity for much higher rates of losses than their predecessors. The results of the current study suggest that certain machine characteristics influence the controllability of this, particularly the maxline variable, and future studies should incorporate stake size as a behavioural measure of gaming machine play.

The virtues of ecologically valid research have previously been extolled and should also be considered in future studies. These designs, however, can appear complex and make the interpretation of the results somewhat difficult. In an experimental design, physical rather than statistical control of the variables would be undertaken. For example, in a pre-experimental stage, naïve participants could be differentially exposed to the machine contingencies providing the various levels of
learning. During the experimental stage, participants would be required to play a series of poker machines, each differing on only one variable. Their stake size and net loss figures could be recorded for each machine and any variance attributed to the observed variable. In addition, the strength of the effect for each player could be compared to the number of previous trials governed by the pre-experimental condition.

The multilevel analysis of ecologically valid data undertaken in the above study provided a similar interpretation, but has the benefit of providing further insight into expenditure behaviour. Typically, ecologically valid research requires a survey design, which has associated problems of measurement error due to memory and social desirability bias. This is perhaps more evident in a stigmatised behaviour. The present study addressed these issues by utilising data obtained with minimum player intrusion via a computer tracking system. In any social research field, this represents a source of quality information and for gaming research, in particular, a new level in design and analysis.

It would appear that future research on machine variables would best be served by defining the components of the multiplier potential in terms of denomination, as in the previous study where pay-lines and bet multiplication were defined by the cost of playing the maximum of each. The large amounts of unexplained variance at both the machine and the player level provide scope for inclusion of other variables. However, this would need to be subject to theoretical reasoning and the present study suggests that if learning theory is utilised, then
recognition of the response cost associated with a particular variable should also be considered.

It is also doubtful that one general theory of machine effects could be applied to the myriad of machine variables. Cognitive theories have much intuitive appeal, but their scientific merit is questionable. The generality of the heuristics and biases approach is both a benefit and hindrance, as it fails to meet a basic requirement of any good theory, that of falsification. There is also the issue of adequately explaining individual differences.

The major strength of current research is its empirical investigation of the role of structural characteristics. As the poker machine has evolved, there have been an increasing number of publications speculating on the effect of modern machine characteristics, but no attempt to test these claims. The results of the present study establish that there is significant variance between occasions within players and between players, which provides a solid foundation for future research in the area. Despite the variables tested recording null effects for the net loss measure of expenditure, there are numerous other machine variables which may explain the between occasions variance. There also remains a large amount of unexplained variance in stake size at both the machine level and the player level, which may be modelled.
Chapter 8:

Modelling Player Expenditure

8.1 Introduction

The importance of the previous studies cannot be overstated. The results provide empirical support for the growing body of literature on structural effects (e.g., Bayus et al., 1985; Cornish, 1978; Delfabbro & Winefield, 1999; Griffiths, 1993a; Jellinek, 1997; Popkin, 1994) and consolidate a platform from which future models of gaming behaviour may be formulated.

The analyses in both studies were utilised for the purpose of identifying and examining relevant variables rather than explaining or modelling total variance. The first, multiple regression analysis, was an exploratory test of the relationship between machine variables and aggregated stake size and profit. The use of aggregated machine data may be of benefit to some sectors of the gaming machine industry in terms of machine performance, but does not allow any substantial interpretations of player behaviour. A substantial portion (90%) of the variance in stake size between machines was accounted for by the multiplier potential, however, only around 30% of the variance in profit was accounted for by the variables tested.
The second, multilevel analysis, extended the findings of the first by testing theory driven hypotheses with individual player expenditure data. The multiplier potential of a machine accounted for around 30% of the total variance in stake size, and the variables tested in the net loss analysis were only able to account for 5% of the variance in this measure. However, a major finding of these analyses was the significant variance identified and partitioned between occasions within players and between players. These findings alone generate numerous possibilities for future psychological studies into gaming machine playing behaviour.

Figure 8.1 represents a schema of the multilevel analysis undertaken. Although this model was constructed with the assistance of a path analysis program (AMOS), it should not be interpreted in the same manner. The schema is presented as a base model to assist the explanation of future gaming research.

The estimates displayed in Figure 8.1 are the significant results for the first stake size analysis. Both denom and maxline were level-1 variables and found to be positively related to stake size (fixed effect). The effect size for these variables was also found to significantly vary between players (e.g., denom/denom at level-2). The level-2 player variable, stroke, was found to be positively related to the variance of denom/denom, but not maxline/maxline.

The estimates on the right-hand side of the model reflect the amount of unexplained variance remaining at each level.
Figure 8.1. Multilevel schema of significant relationships for average stake size (first data set).
Any of the multilevel models in the previous study (i.e., from the four data sets) may be presented in a similar manner. The logical extension to these models of individual expenditure patterns is the inclusion of further variables at both levels. However, extensions to the model are hindered by lack of support for the explanatory approach adopted. The principles of operant conditioning could not adequately explain the results at either level and the inclusion of further variables is difficult to justify without theoretical reasoning.

An alternative explanatory approach given consideration in the literature is cognitive theory. However, the limitations of this approach, especially when explaining level-2 variance, have been discussed. It was suggested in Chapter 7.14 that it is unlikely one theory could adequately explain all machine effects and, thus, the scope of potential predictor variables remains large.

The results of the multilevel analyses not only provided an indication of the partitioning of variance, but also a guide to the type of variable to be included in future research. From the final results for average stake size, approximately 25% of the remaining unexplained variance was at level-1 (between occasions within players), with 75% at level-2 (between players). For the net loss measure of expenditure, the variables tested in the study explained a minimal amount of variance and the remaining variance was more evenly partitioned, with approximately 55% at level-1 and the remainder at level-2. Clearly, for average stake size, the bulk of unexplained variance is residing at level-2 and model fit would dramatically improve with the inclusion of appropriate player difference variables. For net loss, the
inclusion of variables related to both levels appear as equally important in future modelling.

8.2 Machine Level

In general, structural effects have been suggested to influence expenditure via their ability to attract a greater number of players and/or to influence player expenditure patterns within a session (Cornish, 1978; Griffiths, 1993a; Popkin, 1994). One characteristic of poker machines that is consistently given attention in the literature relates to the schedule of reinforcement and the ability to provide an immediate, large reinforcer at little expense. This encapsulates machine variables such as hit rate, return rate, speed of play, and win size. All of these features affect reinforcement and are typically explained under operant conditioning principles (Delfabbro & Winefield, 1999; Dickerson et al., 1991, 1992b; Mazur, 1998; Skinner, 1953; Stotter, 1980). Two of these, hit rate and return rate, have particular relevance to the unexplained variance reported in the previous study.

The hit rate of a machine is the average frequency of reinforcement, determined by random ratio schedule of reinforcement. The return rate refers to the size of reinforcement, with the average on NSW machines set to return at least 85% of all bets. Both Cornish (1978) and Griffiths (1993a) acknowledged the importance of these in their discussions on the roles of structural characteristics and, indeed, these features are central issues in the majority of publications on gaming machine playing behaviour (Delfabbro & Winefield, 1999; Dickerson et al., 1991, 1992a; Skinner, 1953; Stotter, 1980). The studies by Dickerson et al. (1991, 1992a) and
Delfabbro and Winefield (1999) represent the only ecologically valid attempts to investigate operant conditioning predictions about the relationship between response rates, hit rates, and return rates of poker machines. These studies examined play rates and persistent playing behaviour and, in general, were considered to support predictions regarding the characteristics of schedule-induced behaviours and individual differences based on levels of learning.

Choice theories of learning, such as optimisation and the matching law, extend the principles of operant conditioning to more complex environments, such as the gaming room, and appear applicable to explanations of behaviour between occasions (Catania, 1998; Davey, 1989; Lieberman, 1993). These theories suggest that a higher hit rate leads to greater reinforcer frequency and greater persistence, relative to another schedule. Similarly, higher return rates provide greater reinforcer size and, once again, relative to another schedule, will lead to greater persistence. In other words, all things being equal (i.e., the response cost, other machine variables, competing demands, resource availability), and given a choice between two schedules, an organism will prefer the one with larger and more frequent reinforcement.

In poker machine play, the hit rate and return rate variables are not only between occasions level variables, but also within occasions level variables. That is, variance in these variables exists not only between machines, but also within each game. Therefore, when considering these features in the modelling of variance between occasions, both the hit rate and return rate for a period of play within the occasions need to be measured. This will provide a more accurate result, rather than
utilising an average measure for the occasion or some overall hit/return rate of the
machine determined by the manufacturer over 1 million plays.

This approach is similar to that undertaken by Dickerson et al. (1992b) who
measured net position at the end of each minute of play. This creates numerous
observed variables and can be more conveniently measured in terms of a set number
of initial button presses, rather than every minute of play. Given that each occasion
of play represents a sampling of the schedule, initial results will have the greatest
salience. For example, the size of the net loss for any occasion of play may best be
predicted from the hit rate and return rate of the first few button presses.

Related to the reinforcement properties of the hit and return rate is the speed
of play, or immediacy of reinforcement. Most machines are set to a reel speed of
approximately 3 seconds, although there is some variance among machines due to
differences in manufacturers and gaming room settings. Under operant conditioning
principles, immediacy of reinforcement is a crucial component of learning as a rapid
event frequency strengthens the R-Sr association (Catania, 1998; Chance, 1994;
Mazur, 1998). In gaming terms, faster speeds of play also allow winnings to be re-
gambled immediately and losses to accrue faster. This is evident by its inclusion in
the expected rate of loss Equation 2.1.

However, a problem with this variable is that it assumes a positive linear
relationship between speed of game and learning. That is, the faster the game, the
stronger the learning and the more persistent the play. Modern poker machines only
simulate the mechanical action of reels and have the capability to provide the
outcome of play almost immediately, yet the manufacturers of machines do not
design games this way. In the absence of published literature, discussions with the
designers of games suggested that reel speed can, in fact, be too fast as well as too
slow, with players having a preference for a set speed of play (i.e., around 3
seconds). This suggests a curvilinear relationship between reel speed and
expenditure, which peaks at 3 seconds. It also suggests a unique characteristic of
gambling behaviour over other schedule-related activities, namely the anticipation of
outcome rather than simply the frequency and size of reinforcement.

With regard to the size of the reinforcer, machine variables such as
denomination and bet multiplication were considered in terms of their influence on
the size of reinforcement in the previous studies. However, three other machine
variables are also related to the size of the reinforcer, maximum prize on a stand-
alone machine, maximum prize on a machine linked to the cashcade jackpot, and the
bonus feature of the machine.

The maximum prize on a stand-alone machine in NSW is restricted to
$10,000 but, again, there is variance between machines. However, this variable is
more likely to attract players than influence their expenditure patterns. To win the
maximum prize on a stand-alone machine, a player must stake the maximum amount
and the results of both previous studies indicate that this is not the case. That is, the
maximum stake of a machine was not a predictor of stake size in the first study and
maximum bet multiplication was not a predictor in the second study. In addition,
information from a gaming machine manufacturer (Gibson, 1997) suggests that the
combination of maximum pay-lines and minimum bet multiplication is common and, therefore, players do not appear to be playing for the maximum prize.

The cashcade variable may also be credited with attracting players rather than influencing expenditure, although a case could be argued for its inclusion at the occasion level in further modelling. This variable was not included in the second study for two reasons. First, it was not shown in the first study to be related to a machine's profitability and second, the club in the second study only linked $1 machines to the cashcade (confounding any interpretation). Previously, cashcade was measured dichotomously, whether it was present on a machine or not, but this may not be an accurate measure of its effect, particularly with regard to individual players.

The size or amount of cashcade prize linked to a machine may have importance, if only in terms of attracting players and machine performance. The feature of the cashcade that may be important to the player is the status of the jackpot; that is, the position of the accumulated amount to the final amount. For example, if a cashcade worth $1,000 has accumulated to $950, then this indicates to the player that a large reward is more immediate than if it were $200. Persistent play may then result on a cashcade-linked machine, as the probability of winning the cashcade prize is greater. Furthermore, the player whose stake 'pushed' the accumulated amount over the randomly set prize amount wins the cashcade prize. Therefore, staking larger amounts increases the player's chance of winning the prize. In a simple two-player scenario, if one staked 10 cents and the other $10, then the latter player has increased their probability of winning the jackpot. Thus, the
The cashcade jackpot feature may influence both the stake size and the net loss amount of players in some circumstances (i.e., when the cashcade is approaching its maximum value). This is a much more difficult measure of cashcade, but may explain some of the unaccounted variance in the previous study.

The bonus feature on poker machines provides the opportunity for a player to win a larger prize than that offered during the normal course of play. Although the actual size of the prize is not greater than the maximum prize on offer, this feature provides the opportunity to win a large prize more frequently than would otherwise occur during the normal course of play. In Chapter 2.2, it was noted that the range of hit rates for bonus features vary from 1/35 to 1/243 when playing the maximum number of pay-lines (derived from the specifications of 46 machines). It was also noted that there are three types of bonus features on Australian poker machines: no-response features, second-screen features and no features.

The important component of the bonus feature is that it may provide incentive for continuous play by offering larger rewards for persistence. In addition, as mentioned in Chapter 2.2, these features require different responses from the player, with some inducing higher levels of player involvement. This introduces cognitive explanations about skill and the illusion of control (Griffiths, 1994), as the achievement and outcome of bonus features remain randomly determined.

The common trait of the machine variables discussed above is their role in the promotion of continuous play and the opportunity to win a large, immediate reinforcer at little expense. Another trait of the modern poker machine is its
increased ability to multiply wins and recoup losses (Cornish, 1978; Griffiths, 1993a, Popkin, 1994). In the previous study, the components of a machine’s multiplier potential (denomination, pay-lines, and bet multiplication) were considered in terms of this ability, but there exists one other machine variable that also possesses this attribute.

The gamble feature allows players to risk their win up to 5 times (maximum set by law). Typically, this is in the form of double-or-nothing, although there is some variance between machines. For example, on some machines, a player can risk half or the full amount of their win, and on some machines they can double or quadruple their win with appropriate changes in the probability and size of a win (i.e., \( p = .25 \) instead of \( p = .50 \)). This feature can be considered to promote player involvement, an illusion of control, and persistence despite no apparent effect on the overall result (i.e., on \( p = .50 \), players would win half the time and lose half the time).

Empirically, the only study to use the gamble feature as a behavioural measure is Ladouceur et al. (1991). In this study, it was the number of double-ups that were measured and used to compare behaviour across two settings. However, testing the prediction that the gamble feature promotes continuous play via increases in level of involvement requires a more detailed examination of usage by players. This would overcome similar criticisms to that of the measurement of the bill acceptor in the previous study. Data from Australian poker machines (Gibson, 1997) indicate that the double-up feature is not popular, the rate of doubling-up varies greatly across machines, and it can be as low as 2.17% for some machines. This raises doubt about its ability to explain net loss variance between occasions.
Numerous other machine variables could be argued under the cognitive paradigm for inclusion in any model extension. Popkin (1994) and Griffiths (1993a) outlined several not considered here, including the colour, naming, symbol characters, winning sounds, and attractive lighting. Others (e.g., Hurlburt et al., 1980; Reed, 1986) emphasised the importance of the near-miss and the list of potential variables does not appear to be limited by any theoretical constraint. For this reason, cognitive theory remains inadequate. Although the predictions of operant conditioning were not supported in the previous study, the theory has greater scientific merit and, at least in terms of machine variables, only those with some relationship to reinforcement should be included in any theory driven model.

It would appear that the two most important variables, in relation to reinforcement, are the hit rate and return rate. The other variables mentioned, (speed of play, maximum prize on offer, cashcade, gamble option) are all possibilities, but are auxiliary characteristics and have problems theoretically. Like the bill acceptor, machine age, and the multiplier potential variables in the net loss analysis, their contribution to the total variance is likely to be limited due to their tenuous relationship with the reinforcer. The bonus feature also has a tenuous relationship with reinforcement, nevertheless, it should be included not only because it may explain variance between occasions, but, as discussed below, may also prove a significant player level variable.
8.3 Player Level

As displayed in Figure 8.1, the partitioning of variance in the multilevel model acknowledged that there was not only variance in each measure of expenditure between occasions within players, but also between players. For average stake size, the majority of the unexplained variance (75%) was at this level, whereas for net loss, there was slightly less variance at this level than the between occasions level, although still a significant amount (45%). This is simply identifying that players differed in their average stake size and net loss per occasion, and there are a range of possible variables that may account for this variance.

As with the modelling of variance between occasions, the modelling of the variance between players involves two types of individual difference variables. One type concerns general explanatory variables of player differences in expenditure per occasion, and the other type relates to player differences in the effect size of each machine variable. This difference is similar to testing main effects and interaction effects in multi-way ANOVA. The fixed part of the model estimates the effect of both machine and player variables and represents main effects, but the modelling of the interaction between these variable is undertaken in the random part of the model (player level). These interactions may best reflect psycho-structural relations (Griffiths, 1993a), which were defined as an individual's relation to a structural characteristic.

In the previous study, player stroke was the only variable considered as a predictor of machine effect size, but it could have also been used as a general
explanatory variable in the fixed part of the model. In Figure 8.1, it can be seen that
the level-1 variable denom is also represented at level-2 by denom/denom. This
indicates that significant variation between players exists in the effect that denom has
on stake size. The path, in Figure 8.1, from stroke to denom/denom, indicates that a
player’s stroke is significantly and positively related to the denom effect.

However, absent from Figure 8.1 is a path from stroke to the response
variable, average stake. This parameter estimate represents a main (or fixed) effect
for stroke and was deliberately set to zero in the previous study because no
hypothesis was made with regard to this estimate.

The previous study also showed that some of the machine variables were also
player level variables, indicated by the reduction in variance at level-2. For example,
machine denomination was shown to significantly account for variance in stake size,
both between occasions within players and between players. This identified a
difference between players in the denomination of the machines played and
accounted for a significant portion of the variance in stake size between players
(around 31% for both data sets). Thus, if denomination is considered a player level
variable, future modelling will need to incorporate this variable at level-2.

The bonus feature may also be both a machine variable and a player variable.
That is, the type of bonus feature on a machine may influence expenditure between
occasions and may also appeal to particular players, thereby defining it as both a
level-1 and a level-2 variable.
As mentioned in Chapter 2.2, some bonus features may increase the level of involvement of players by requiring a response that seemingly influences the outcome. For example, machines with free spins/free games automatically play out this feature, but machines with a second-screen require a decision and response from the player. Players, who believe they possess some skill or ability to influence the outcome, may be attracted to machines that increase their involvement and enhance the illusion of control concept (Griffiths, 1994).

Although machine variables may possibly account for differences between players, the majority of variance between players is likely to be explained by more common psychological individual difference variables. As mentioned in Chapter 1.2, the gambling literature contains many studies assessing the relevance of traditional psychological differences, such as personality, mood, and level of involvement. They are mostly comparison studies between impaired control gamblers and regular gamblers, but the findings may still have relevance to future modelling of structural effects.

The task for any theoretically sound modelling becomes one of arguing for the inclusion of individual difference variables as a general explanatory variables in the fixed part of the model, or as predictors of psycho-structural interactions. However, it is likely that an individual difference variable is theoretically appropriate as both an explanatory variable in the fixed part of the model and as an explanatory variable of psycho-structural relations. In the absence of adequate published literature on psycho-structural relations to assist with the identification of relevant
variables, all implicated player variables should be examined in both the fixed and random parts of the model.

As with potential occasion level variables, numerous player level variables can also be included in future modelling of player expenditure patterns. Once again, it must be remembered that, from the multilevel analysis of the previous study, there are two types of variation at the player level; expenditure variation between players and structural effect size variation. This serves as a guide in identifying potential explanatory variables.

Expenditure variation suggests that, for example, one player loses $20 on average per occasion, whilst another player loses $40 on average per occasion. This may be an artefact of socio-economic status differences, such as income and participation in other leisure time activities. However, it may also be argued that psycho-structural variation is indicative of individual differences in subjective control of expenditure. For example, players whose expenditure patterns show strong linear relationships with certain machine variables are exhibiting less control over their expenditure behaviour, when compared to others with weak or absent relationships. That is, their expenditure behaviour is dictated by factors related to the machine.

This argument is well supported in both the general psychological literature and in specific gambling-related studies. It reflects a key argument of behaviourism that emphasises the role of contextual cues or situational determinants in behavioural variance (Catania, 1998; Mazur, 1998). It is also supported by the studies of
Dickerson et al. (1991, 1992a, 1992b) and Delfabbro and Winefield (1999), which suggested regular players exhibited ‘automatic’ or habitual playing patterns. The conceptualisation of structural effects as the latent construct impaired control should not be considered as providing a measure of problem gambling. The conceptual analogue is that of behavioural self-control in gambling, but there is no evidence to suggest that structural effects are indicative of gambling-related harm.

By conceptualising structural effects as impaired self-control, the task becomes one of identifying psychological individual difference variables that may explain variance in control. Dickerson and Baron (2000) outlined a structural equation model of choice/control that provided a summary of individual difference variables as predictors of impaired control in gambling. The measurement of impaired control was undertaken by a self-report questionnaire, the Scale of Gambling Choices (Baron, Dickerson, & Blaszczynski, 1995), but the model may be considered as a general psychological conceptualisation of self-control. In fact, the model was derived from findings in the area of self-control and alcohol consumption, which exemplifies its generality. As Dickerson and Baron (2000) stated;

"Much of the work in this area parallels the important developments with regard to control and alcohol use (e.g., Heather & Robertson, 1983; Heather, Miller & Greeley, 1991) emphasising that self-control over gambling behaviour is not ‘lost’ but varies according to the presence or absence of a variety of situational cues and emotional experiences (Corless & Dickerson, 1989). Ongoing work to develop a self-report measure of self-control, the Scale of Gambling Choices (Baron, Dickerson, & Blaszczynski, 1995) is also indebted to the development of the
Impaired Control Scale (ICS) (Heather, Tebbett, Mattick, & Zamin, 1993) used in alcohol research.” (p. 10).

Dickerson and Baron (2000) demonstrated the applicability of principles from impaired alcohol consumption to impaired gambling, and created their model based on findings from gambling research. Hence, there is validity for its use in identifying relevant predictor variables in the modelling of structural effects and gambling expenditure. However, just as Dickerson and Baron (2000) refined the model from self-control of alcohol use to self-control of gambling behaviour, the model also needs to be refined for self-control of expenditure behaviour.

One obvious consideration is that impaired control, as defined by the SGC, encompasses a broader range of behaviours than impaired control defined by machine effects on expenditure. Hence, some of the predictors of the SGC are related to behaviours such as initiating play and relationships with significant others, which may bear no relevance to expenditure per occasion or the strength of machine effects. Furthermore, Dickerson and Baron’s (2000) model has some sophisticated analytical characteristics that may not apply to control as measured by machine effects.

The Dickerson and Baron (2000) model is non-recursive and emphasises the interdependence between the diagnostic criteria for impaired control in gambling (SGC, or any other measure of impaired gambling for that matter) and level of involvement in gambling. This is because the heterogeneity of the diagnostic content in problem gambling, when used as the response variable, renders difficult the task of ensuring independence of other predictor variables. The issue is one of problem
gambling being measured by level of involvement items and the circularity this creates between the two variables. However, with control measured by structural effect size, this measurement problem does not exist as machine effects are not measured by level of involvement variables. Hence, the circularity of this relationship is eliminated and independence of predictor variables established.

However, self-control, as measured by machine effects, also forces greater limitations over the interpretation of results. Dickerson and Baron (2000) stated that impaired control does not necessarily lead to harmful behaviour. It is simply a measure of self-control without a necessary linkage to gambling-related harm. A person may well engage in gambling activities and derive great pleasure from it by experiencing and reporting loss of control without necessarily experiencing harmful impacts. Nonetheless, Dickerson and Baron (2000) proposed that, in general, there was validity in the expectation that a person whose regular gambling evidences impaired self-control were likely to be at increased risk of the harmful impacts. These harmful impacts are included in the DSM-IV (American Psychiatric Association, 1994) diagnosis of pathological gambling and defined in the items of the SOGS (Lesieur & Blume, 1987).

The measurement of impaired control by machine effects does not share this validity and, therefore, any results cannot reliably be extrapolated to a discussion of gambling-related harm. It should also be emphasised that the measurement of expenditure is per occasion of play, and does not reflect session spend or any other aggregated measure of expenditure. At this stage, the aim remains one of identifying the machine and player variables that influence expenditure at the machine level,
which may then inductively lead to an examination of session expenditure and
between session variations.

To satisfy this aim, Dickerson and Baron’s (2000) model may assist in the
identification of player level predictor variables in an endeavour to extend the
multilevel model exemplified in Figure 8.1. First, they identified basic demographic
variables, such as gender and age, which have been implicated in other studies of
gambling control (Dickerson, Baron, & O’Connor, 1994; Mark & Lesieur, 1992).
They also outlined a series of individual difference variables that might be applied in
further multilevel modelling, one of which, level of involvement, has already briefly
received mention and testing in the previous study.

Level of involvement in gaming machine play was measured in the previous
study by the number of games played (button presses or stroke) for each player.
Dickerson and Baron (2000) argued that level of involvement was a function of
frequency of play and expenditure amounts, and that these variables are related to
self-reports of impaired control of gambling (Boreham, Dickerson, & Harley, 1996;
Corless & Dickerson, 1989; Dickerson, 1993). In the previous study, the frequency
of play, the total of previous losses and the average loss per playing day, were
recorded by the tracking system’s player history function, but not used in the
analysis. The correlation matrix below displays the Pearson’s product moment
coefficients for these variables and for the total number of plays (stroke) based on the
original data set of 1455 players.
Table 8.1
Pearson’s Correlations of Level Involvement Variables (N = 1455)

<table>
<thead>
<tr>
<th></th>
<th>Avdaypweek</th>
<th>Total loss</th>
<th>Loss per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Loss</td>
<td>.42***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss Per Day</td>
<td>.09***</td>
<td>.62***</td>
<td></td>
</tr>
<tr>
<td>Total Stroke</td>
<td>.60***</td>
<td>.62***</td>
<td>.25***</td>
</tr>
</tbody>
</table>

*** p < .001

From the coefficients in Table 8.1, it is evident that the number of games played measure (total stroke) used in the previous study is also an adequate measure of frequency of play and total loss. The failure of stroke to account for effect size differences between players in the previous study and the high correlation between this variable and Dickerson and Baron’s (2000) measures of level of involvement, suggest that frequency of play and total loss will also fail as explanatory variables of machine effect size.

However, the previous study did not include any level of involvement variable in the fixed part (i.e., did not test for main effects). The correlation between stroke and loss per day is weak and, from this, future modelling of expenditure should include at least loss per day and either stroke, frequency of play, or total loss as variables in both the fixed and random parts of the model.

Another individual difference variable implicated in Dickerson and Baron’s (2000) model of impaired control was the composite variable negative emotions. Dysphoria and anxiety were included in Dickerson and Baron’s (2000) structural equation model because both were consistently nominated by regular players responding to social impact surveys as being a common precipitant of a gambling session. For example, 9% used gambling as an escape from feeling depressed, and
30% were more likely to gamble after a frustrating day (Dickerson, Baron, Hong, & Cottrell, 1996). In addition, a study of gaming machine players in Victoria, Australia, (Ohtsuka, Bruton, Borg, & Deluca, 1997) found that the subjective mood of both men and women players was a significant predictor of impaired gambling control (as measured by the SOGS). This precipitation of further gambling has been confirmed among populations of problem gamblers attending therapy (Blaszczynski & McConaghy, 1994; Blaszczynski, McConaghy, & Frankova, 1990).

Of greater importance to the current model are the direct observation studies of gaming machine players which confirmed that dysphoric mood immediately prior to starting a session predicts persistence-when-losing (Dickerson et al., 1992a). Prior depressed mood was also found to be a significant positive predictor of persistence in an experimental study of male gaming machine players (Kyngdon & Dickerson, 1999). Therefore, measures of both depression and anxiety prior to play should be included as player level variables in future multilevel models of player expenditure.

Dickerson and Baron (2000) also highlighted two other variables believed to moderate negative mood. Social support and coping style have been shown to be related to impaired control of gambling. Social support, particularly with regard to the main intimate relationship or spouse, has been identified as a key component in the development of gambling-related problems in all survey studies completed in Australia. In addition, for a large group of women gaming machine players, Quirk (1996) found that a preference for emotion focussed over problem oriented coping strategies was strongly associated with greater impaired control, as measured by the SOGS. However, these variables appear to have little relevance in explaining
expenditure per occasion or effect size variation, and are perhaps better predictors of a session start or session length, rather than within session behaviour. It would need to be argued that both the level of social support and coping style of a player influence expenditure per occasion of play or the psycho-structural relationship. At present there is no evidence to support this claim.

Personality variables have also been implicated in the Dickerson and Baron (2000) model. Impulsivity (Blaszczynski & Steele, 1996; Blaszczynski et al., 1997) and sensation-seeking (Breen & Zuckerman, 1997) have been suggested as possible predictors of excessive gambling.

Earlier studies have provided some suggestion of the interaction between the experience of excitement during a session of betting and personality type (Dickerson et al., 1987). Furthermore, the personality variables of extroversion and sensation-seeking were found to be significant and strong negative correlates of persistence in an experimental study by Kyngdon and Dickerson (1999). Hence, both impulsivity and extroversion may serve as adequate predictors of the level of psycho-structural relationships, and should be included in further multilevel modelling.

Another variable that may influence the psycho-structural relationship is alcohol consumption. The Kyngdon and Dickerson (1999) experimental study of young male gaming machine players who also regularly drank alcohol found that the experimental group, who had a prior intake of three standard drinks, persisted at gaming twice as long when losing than the control placebo group. The results match the findings of a survey study of gaming machine players while playing and drinking
in hotels, which found a consistent theme of alcohol use contributing to impaired control of gambling behaviour (Baron & Dickerson, 1999). Self-control over other forms of gambling is also influenced by the player’s consumption of alcohol (O’Connor, Dickerson, & Phillips, 1995; Sjoberg, 1969).

Thus, there exist several individual difference variables that may influence average expenditure per occasion and the psycho-structural relationship between player and machine variable. Level of involvement (average loss per day, stroke/frequency of play/total loss), negative mood prior to play (depression, anxiety), personality (impulsivity, extroversion), and alcohol consumption prior to play are all variables that may be included in future multilevel modelling. The variables implicated by Dickerson and Baron (2000) are more likely to explain psycho-structural relations, rather than differences in average expenditure per occasion, with the exception of gender and player age, which may explain both. There may also be other variables not mentioned by Dickerson and Baron (2000), such as income and the use of self-imposed pre-determined limits on expenditure before machine play. The previous study indicated that players utilised the denomination of the machine in an attempt to control loss and stake amounts and, hence, the presence of budgetary constraints, whether internal or external in nature, may explain player differences.

Finally, a measure of general impaired control of gambling (e.g., the SGC) should be included as a player level variable to test its relationship with machine effects. This would allow greater scope in the application of results to the relationship between structural effects and impaired control of gambling.
The inclusion of extra variables at both the machine and player level extends
the model displayed in Figure 8.1. There now exists a greater number of relevant
variables at both level-1 and level-2. However, increasing the number of variables is
not the only consideration in future modelling. The addition of new variables
requires changes to the design of the research from the previous study and also
requires a different approach with regard to parameter estimates and modelling
constraints.

8.4 Design and Modelling Constraints

The major difference between the previous study and future modelling is the
shift from testing the relationship between modern machine variables and
expenditure to that of modelling, or accounting for variation in player expenditure.
This raises a number of issues with regard to design and analysis of future research.

The variables at the occasion level now include the multiplier potential of the
machine (measured by denline), the type of bonus feature (measured by the
categories suggested in Chapter 2.2), the hit rate, and return rate pattern within the
occasion (a pilot study will need to define the measurement of these).

The variables at the player level include gender, player age, budgetary
constraints (pre-determined limit), level of involvement (average loss per day,
stroke/frequency of play/total loss), negative mood prior to play (depression,
anxiety), personality (impulsivity, extroversion), alcohol consumption prior to play,
and impaired control of gambling (SGC). It becomes apparent that, with the
inclusion of these extra variables, not all data can be obtained via a computer tracking system.

The machine variables, denline and bonus feature can be measured as before, but hit rate and return rate will require a different approach. The computer tracking system is flexible and may have the ability to provide this information with some modification. Failing this, direct observation by the experimenter, in a similar method to the Dickerson et al. (1991, 1992a) studies, or video-taping of play, as utilised by Delfabbro and Winefield (1999) may be employed. Video-taping has the added benefit of recording all behaviours, which may be of use post hoc, or in future modelling.

The individual difference measures will need to be implemented pre-testing. Level of involvement measures will contain less error if obtained from the tracking system, rather than from player self-report, but the other measures will require a pre-testing questionnaire. This methodology is not ideal, but still maintains ecological validity and the tracking system can provide information about a player's past expenditure behaviour to test the reliability of expenditure behaviour under test conditions.

The multilevel model thus far has assumed two levels, occasions and player, which is satisfactory when only one gaming venue is involved. However, if more than one gaming venue is utilised for player recruitment, the hierarchical structure of the data alters. In the first multiple regression analysis, several clubs provided data and a series of 'dummy' variables were created to control for gaming venue level
effects. In multilevel analysis, a similar procedure may be undertaken with a third level identified by the venue in which the behaviour occurred. This creates another source of variance that may also be modelled with the inclusion of venue level variables, such as in-house promotions, the number of poker machines, and the services provided by the club (e.g., drink service at machines). This will require further adjustments to Figure 8.1, by adding the variables in level-3 and creating hypotheses about main and interaction effects with the response and other observed variables. But for now, the assumption remains that all data can be derived from one venue and this venue and its players are representative of a greater population (as suggested by the preliminary analysis of the previous data sets).

Even if only one venue is used, as in the previous study, the type of parameter estimates will still differ from those displayed in Figure 8.1. This is due to the shift from variable testing to variance modelling. It was previously mentioned that player level variables needed to be included in the fixed part of the model. This will determine any main effects for player variables that were absent in Figure 8.1. In addition, rather than testing only interaction effects between individual difference variables and machine variables, the covariance between a machine variable effect and its intercept provides another source of player variation that may prove insightful. For example, Table 8.2, below, is the final result for the first average stake size data set. Table 8.3 displays the result, with the estimates for stroke in the fixed part and the covariance between denomination and the intercept.
Table 8.2  
*Final Summary Table Stake Size (first data set)*

<table>
<thead>
<tr>
<th></th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.039 (.044)</td>
</tr>
<tr>
<td>Ndenom</td>
<td>.589 (.021)*</td>
</tr>
<tr>
<td>Nmaxline</td>
<td>.176 (.015)*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td></td>
</tr>
<tr>
<td>Level-2</td>
<td>.501 (.045)*</td>
</tr>
<tr>
<td>Ndenom/Ndenom</td>
<td>.083 (.010)*</td>
</tr>
<tr>
<td>Nmaxline/Nmaxline</td>
<td>.032 (.005)*</td>
</tr>
<tr>
<td>Nstroke/Ndenom</td>
<td>.035 (.014)*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.132 (.002)*</td>
</tr>
</tbody>
</table>

* p < .05  
-2log(lh) = 9404.16  
χ² = 4.63 (df = 1, p = .03)

Table 8.3  
*Model Estimates adjusted for Nstroke/Ndenom Covariance at Level-2*  

<table>
<thead>
<tr>
<th></th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-.042 (.047)</td>
</tr>
<tr>
<td>Ndenom</td>
<td>.588 (.021)*</td>
</tr>
<tr>
<td>Nmaxline</td>
<td>.175 (.015)*</td>
</tr>
<tr>
<td>Nstroke</td>
<td>-.035 (.045)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Estimate (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td></td>
</tr>
<tr>
<td>Level-2</td>
<td>.503 (.045)*</td>
</tr>
<tr>
<td>Ndenom/Cons</td>
<td>-.049 (.016)*</td>
</tr>
<tr>
<td>r</td>
<td>-.241</td>
</tr>
<tr>
<td>Ndenom/Ndenom</td>
<td>.082 (.010)*</td>
</tr>
<tr>
<td>Nmaxline/Nmaxline</td>
<td>.032 (.005)*</td>
</tr>
<tr>
<td>Nstroke/Ndenom</td>
<td>.029 (.014)*</td>
</tr>
<tr>
<td>Level-1</td>
<td>.132 (.002)*</td>
</tr>
</tbody>
</table>

* p < .05  
-2log(lh) = 9393.10  
χ² = 15.69 (df = 2, p = .004)

From Tables 8.2 and 8.3, it can be seen that stroke was not a significant predictor of average stake size (t = .78, p > .05; χ² = .52, p = .47), but was still a significant predictor of the denomination effect (Nstroke/Ndenom). This exemplifies the earlier discussion on variables not necessarily being suitable for inclusion in both tables.
parts of the model. The covariance between denomination and the intercept (\(N_{\text{denom}}/\text{Cons}\)) indicates a significant negative relationship between denomination effect size and the actual machine denomination. That is, as players moved to machines of higher denominations, the variance between players' denom effect size was reduced. In other words, the effect that denomination has on players' stake size varies between players, but this variance is not constant across denominations. Rather, the variance between players is greatest on the lower denomination machines. The correlation coefficient \((r = -.241)\) merely provides another estimate of this relationship, but the important figure is the reduction in the goodness of fit statistic (centring was utilised in Table 8.3 because the minimum denomination value was 1 cent, and not the assumed 0 for the intercept).

Thus, based on the results from the two previous studies and the discussion above, a future model of expenditure becomes more complex than that described in Figure 8.1. This is due not only to the increase in the number of variables at both levels, but also due to the extra design and modelling considerations associated with the aim.

Figure 8.2 provides an example of a future model for average stake size, with the inclusion of one extra variable at level-1, two extra variables at level-2, and the appropriate parameter estimates for the effective modelling of player expenditure. This is a two-level model (i.e., no venue level), and not all hypothesised variables are included, due to the size and complexity of the schema.
It is important to note that the paths from the level-2 variables include both fixed effects with the response variable and structural effects with machine characteristics. However, absent from the schema are the covariance estimates between each machine variable effect and its intercept, displayed in Table 8.3. The inclusion of these estimates will need to be considered in the actual multilevel analysis to achieve a complete understanding of player expenditure patterns.

The model displayed in Figure 8.2 is based on the principles of operant conditioning, research findings from the gaming literature, information from the gaming industry, and the results of the studies in Chapters 6 and 7. When tested in an ecologically valid setting, it will provide information relevant to gaming researchers, various industry sources, policy makers, and the understanding of problem gambling.
Figure 8.2: Multilevel schema for stake size.
Glossary

**Bet Multiplication** A machine characteristic that allows the player to multiply their stake. By doing so, the player also multiplies the size of any win incurred by the same amount.

**Bill Acceptor** A gaming machine characteristic that allows money to be inserted in note form. Also known as a note acceptor.

**Bonus Feature** A gaming machine characteristic that provides a special game for a limited time. Its presentation is randomly determined by the symbol combination. The bonus feature game may involve a different game or a special prize structure.

**Card Machine** Describes gaming machines in NSW that do not possess spinning reels, but simulate card games such as blackjack and poker.

**Cashcade** The name given to the prize system that links a series of machines together. This prize is separate from the one already offered within a machine. Also known as cashcade jackpot or progressive links.

**Credit Variation** A figure determined by the multiplication of the maximum number of pay-line and maximum bet multiplication.

**Denbet** A figure determined by the multiplication of denomination and the maximum bet multiplication.

**Denline** A figure determined by the multiplication of denomination and the maximum number of pay-lines.

**Denomination (Denom)** Refers to the value of each credit on a gaming machine. Also indicates the minimum amount that may be staked.
**Gamble Feature** A machine characteristic that allows the player to re-gamble a win on a different game within the machine. Usually, this different game is based on a double-or-nothing outcome (e.g., the player must choose a red or black playing card).

**Gaming Machines** Mechanical, electrical or electronic devices into which coins or tokens are placed and from which prizes are won.

**Hit Rate** The frequency in which a paying combination of symbols appears on a gaming machine (in relation to the number of responses made).

**Machine Profit** The net amount wagered on a machine. Calculated by subtracting the amount won on a machine from the total amount wagered.

**Maxbet** The maximum bet multiplication on a machine.

**Maximum Stake** Refer *Multiplier Potential*.

**Maxline** The maximum number of pay-lines on a machine.

**Minimum Stake** Refer *Denomination*.

**Multiplier Potential** A figure determined by the multiplication of denomination, the maximum number of pay-lines and maximum bet multiplication. Also indicates the maximum stake size of a machine.

**Net Loss** Describes the net amount spent by the player. The amount wagered (turnover) minus the amount won.

**Pay-line** The combination of winning symbols across reels recognised by a machine.

**Player Tracking** Also termed computer tracking. Refers to the gaming machine device that has the capability of recording an individual players playing information.

**Poker Machines** Australian slot machines, characterised by five spinning reels and playing card symbols on each reel.

**Return Rate** The percentage of money wagered on a machine that is returned in wins. Also referred to as carded percentage.
**Slot Machines** Type of gaming machine characterised by three or more spinning reels, each containing symbols of various worth that provide prizes at random.

**Stake Size** The size of each bet placed prior to the start of each game.

**Stand-alone Machine** A poker machine that is not linked to a cashcade jackpot.

**Stroke** The pressing of a button or pulling of a handle to commence play.

**Tokenisation** A machine feature that has standardised the coinage on each machine. It allows for the insertion of one coin ($1) and converts this into credits related to the machines denomination size.

**Turnover** The total amount wagered on all bets, including re-gambled wins.
References


Dickerson and L. Sylvan (Eds) *Gambling in Australia* (pp. 28 – 44). Sydney:
Croom Helm.


Hernstein, R. J. (1961). Relative and Absolute Strength of a Response as Function of
Frequency of Reinforcement. *Journal of the Experimental Analysis of
Behaviour, 4*, 267-272.

Hernstein, R. J. (1964). Aperiodicity as a Factor in Choice. *Journal of the
Experimental Analysis of Behaviour, 7*, 179-182.

Experimental Analysis of Behaviour, 21*, 159-164.

Hong, Y. Y. & Chiu, C. Y. (1988). Sex, Locus of Control and Illusion of Control in
Hong Kong as Correlates of Gambling Involvement. *The Journal of Social
Psychology, 128*, 667-673.


with Concurrent Variable Ratio and Random Ratio Schedules of
Reinforcement. *Psychological Reports, 47*, 635-639.


Canberra: AusInfo.

Unpublished Honours Thesis. Melbourne: Department of Psychology,
Monash University.


An Operant Analysis of Gaming Machine Play

John Edward Haw

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This thesis would not have been completed without the support of my supervisor, Professor Mark Dickerson. His knowledge and standing in the gambling research field were invaluable resources. The assistance from the gaming industry, required for data collection, was the direct result of Professor Dickerson’s outstanding reputation. His personal support throughout the project was a constant source of inspiration and his flexible supervision style made the candidature enjoyable.

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Finally, I would like to acknowledge the assistance of Karen Cayoun for her tireless efforts in reading this thesis. Although all mistakes remain my own, there is no doubt that these have been greatly reduced by her keen eye and knowledge of grammar.
Statement of Authentication

The work presented in this thesis is, to the best of my knowledge and belief, original except as acknowledged in the text. I hereby declare that I have not submitted this material, either in whole or in part, for a degree at this or any other institution.

[Signature]

John Lee
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Abstract

The notion of structural effects in gaming machine play is increasingly gaining importance in the gambling literature. The development of gaming machines in Australia has seen a large number of machine characteristics become an inherent part of poker machine play. However, there is an absence of studies examining their effect. Two studies were undertaken examining the relationship between the structural characteristics of poker machines and player expenditure patterns. The first study examined aggregated player data from over 1000 poker machines. The results suggest that both measures of expenditure utilised, stake size and net profit, are related to structural characteristics. This finding provided a foundation for the theoretical discussion of individual player behaviour encompassing both learning and cognitive paradigms. The second study examined the expenditure patterns of 533 individual players in an ecologically valid setting. The results indicate that player stake size is related to certain structural characteristics but player net loss is not. These results failed to support the predictions of operant conditioning. A model of structural effects is proposed and the theoretical implications for future studies of gaming behaviour are discussed.
Chapter 9:

Conclusion

The modelling of player expenditure has made a significant contribution to both the study of structural effects and the study of gambling in general. This aspect of gaming machine play has been a theoretically and empirically impoverished area of research over the past 40 years. However, there now exists a detailed description of the structural characteristics, empirical evidence supporting the notion of structural effects, and a model for future testing.

The process leading to this model was multi-dimensional in its approach, based on an integration of gambling-related sources. The model discussed in Chapter 8 was developed from psychological theory, the gambling literature, government sources, information from the gaming machine industry, and the two major empirical studies undertaken. Each of the eight chapters, leading to the final model, have contributed to its formulation and the understanding of machine effects.

In Chapter 1, gambling was defined as "...the staking of money of uncertain events driven by chance" (Productivity Commission, 1999, p. 10). This definition is integral to the later empirical studies that measured gambling behaviour by two types of expenditure; average stake size and profit/net loss. It was also noted that scientific explanations of gambling behaviour emerged around the beginning of the last
century, and that the dominant psychological explanations of gambling have centred upon cognitive and behavioural principles, personality and emotional factors.

However, it was argued that despite the abundance of publications on gambling behaviour, the explanatory power of the net result was weak. One of the most important findings from studies of gambling behaviour is that of methodological considerations and, in particular, the concept of ecological validity. A model of choice/control for poker machine play (Dickerson & Baron, 2000) was utilised to explain the basic principles inherent in this concept. It was also suggested that there exists a need to identify contextual structures and all relevant factors associated with the gaming experience. Based on the discussion by Dickerson and Baron (2000), it was concluded that significant contributions to the understanding of gambling behaviour required ecologically valid research. Furthermore, the popularity and conditions of poker machine play in Australia warranted psychological investigation into this form of gambling.

The multilevel model, displayed in Figure 8.2, was created from the specifications of Australian poker machines. Chapter 2 presented a thorough description of both the design of poker machines and the characteristics of Australian poker machine players. Internal machine characteristics, such as return rate and hit rate, were discussed along with the newer characteristics examined as machine variables in the later studies. The description of Australian poker machine players profiled their gambling characteristics, demographic variables, and individual differences according to their various levels of play (regular, infrequent, and non-gamblers).
Table 2.2 and Figure 2.2 illustrated the potential of psycho-structural relationships in modern gaming machine play by highlighting the complexity of responses now available. The evolution of game design and the complexity of responses available on modern machines were discussed in terms of learning theory and response-stimulus relationships. In addition, data were used to provide a general assessment of the relationship between gaming expenditure and structural characteristics (Table 2.3, Table 2.7 and Equation 2.1). It was concluded that the development of the poker machine in Australia has grown at a rate faster than the understanding of gaming machine play and that the notion of structural effects was an area of gambling worthy of further investigation.

The importance of Chapter 2 is evident throughout the following chapters. It identified the area of investigation and also provided a detailed description of poker machines, which has been absent in other research. It also provided a comprehensive review of poker machine play, the context in which it occurs, and the characteristics of the players. This was essential for a thorough account of structural effects.

Before conducting any research on structural effects, the methodological issues relevant to gaming machine research were considered (Chapter 3). The context in which the activity takes place, the use of simulated gaming devices, generalising research findings across forms, the categorisation of participants, the issue of betting with others’ money, and the operational definition of playing behaviour were all examined in a review of selected gaming machine studies. A critique of the literature supporting the ecological validity of laboratory studies was also undertaken.
It was detailed, in Chapter 3, that an often-overlooked component of gaming machine play is the random ratio schedule of reinforcement. Poker machines are frequently cited as an example of the variable ratio schedule of reinforcement and the differences between these two types of intermittent schedules of reinforcement on betting behaviour were discussed. Original data collected from a machine operating in a gaming venue were analysed to illustrate these differences. The Figures 3.1-3.4 represent the first time that the actual (random ratio) distribution of reinforcement on an Australian poker machine have been presented and compared with a variable ratio schedule of reinforcement.

The methodological issues raised in Chapter 3 provided a framework for the evaluation of gambling studies. An in-depth critique of Australian studies that met the conditions of ecological validity was undertaken in Chapter 4. Primarily, Dickerson et al. (1991, 1992a, 1992b), Delfabbro and Winefield (1999) and Walker (1992a) were reviewed. These studies involved structured observational studies of 'natural' playing behaviour and provided detailed descriptive statistics of session characteristics and player profiles, supplementing the data in Chapter 2. Both learning and cognitive explanations were utilised to explain the observed playing characteristics, providing a theoretical platform for explanations of structural effects.

Dickerson et al. (1991, 1992a, 1992b) espoused an operant conditioning explanation for the observed session characteristics in their studies. They reported that poker machine players exhibited stereotypical response patterns related to the reinforcement schedule and the players' level of involvement. Walker (1992a) offered an alternative, cognitive, explanation for Dickerson et al. (1991) findings. His
explanation for the behavioural observations centred on irrational thinking and the
principle of gambler’s fallacy. The findings of his study were reported as supportive
of these cognitive explanations. Delfabbro and Winefield (1999) attempted to resolve
the theoretical conflict and, although their results showed greater support for operant
conditioning explanations, there remained some within session characteristics that
did not meet operant predictions.

The critique of these studies highlighted numerous problems associated with
conducting research on gaming machine play. Not the least was Delfabbro and
Winefield’s (1999) speculation that differences between the findings of research may
be due to the differences in the structural characteristics of the poker machines across
studies. This further implicated the need for an understanding of the player-machine
characteristic relationship.

The final section in Chapter 4 provided a comprehensive review of the
literature on structural effects. The prime psychological sources utilised were
Cornish (1978) and Griffiths (1993a), however other articles related to marketing,
social policy, and venue operations were also discussed (e.g., Bayus et al., 1985;
Jellinek, 1997; Popkin, 1994). Although providing some insight into the possible
nature of structural effects, the common link between these articles was the absence
of empirical support for the claims made and lack of theoretical discussion.

Chapter 5 detailed the major theories implicated in poker machine research
with specific reference to structural effects. When conceptualising gambling as a
learned behaviour, several operant conditioning principles appear particularly
relevant to understanding the role of structural characteristics. Poker machine play was described as an elicited, contingency-shaped behaviour and, therefore, any machine characteristic with an established contingency between itself and the reinforcer should influence gaming behaviour. The results of studies conducted by Dickerson et al. (1991, 1992a, 1992b) and Delfabbro and Winefield (1999), however, indicated that poker machine playing behaviour did not unequivocally match operant theory predictions. Furthermore, it has been argued that studies examining learning theory predictions of gaming machine play have tended to ignore some fundamental behavioural and structural phenomenon of gaming machine play, such as choice between alternatives and the role of punishment (Cornish, 1978; Griffiths, 1990a; Walker, 1992b).

Ecological learning theory offered an alternative explanation that included decision-making (e.g., two-armed bandit theory, marginal value theorem), but still could not resolve the absence of any punishment effect in poker machine play. This theory also highlighted the unique and complex conditions of poker machine play, such as the player's prior knowledge of return rate and presence of other players.

Others have argued that cognitive theory can account for the deficiencies in the application of learning theory to structural effects (e.g., Griffiths, 1993a; Walker, 1992a). In general, cognitive explanations of gambling behaviour focus upon the rules governing behaviour rather than the contingency-shaped explanations associated with operant conditioning. When gaming machine behaviour is viewed within the cognitive paradigm, the task becomes one of identifying the structural characteristic of the game associated with these rules.
One cognitive approach utilised to predict rule-governed behaviour in
gambling is the normative decision theory (Wagenaar, 1988). A review of this theory
found it inadequate, when applied to gambling, for reasons similar to those of
ecological learning theory. Under rational decision-making, gambling should not
occur in the first place and normative decision theory does not readily lend itself to
scientific testing. Wagenaar (1988) suggested that gamblers do not base their
decisions on a rational evaluation of probabilities and utilities, but on a repertoire of
reasoning strategies or heuristics.

The heuristic and biases framework of human reasoning considers reasoning
as a special mental process, one for which people rely on special-purpose mental
rules to draw conclusions. Random situations, such as gambling, are situations where
inference rules can lead to errors in reasoning. Griffiths (1994) outlined six major
cognitive distortions that were believed to operate in gambling situations.

However, this cognitive argument also suffers from numerous problems, not
the least of which is the inability to predict outcomes, rather than merely offering
post hoc explanations for gambling behaviour. Wagenaar (1988) noted that the
heuristic approach does not indicate which heuristic would be applied in a given
situation. Even more problematic, was the suggestion that “…several heuristics
could be chosen in one and the same situation, and that these heuristics lead to
opposite behaviours.” (Wagenaar, 1988, p. 115). Wagenaar (1988) also reported that
experimental demonstrations of heuristics and biases have never yielded unanimity
among participants and explanations of individual differences have rarely been
attempted.
It was concluded in Chapter 5 that the major psychological theories of poker machine play do not readily lend themselves to explanations of structural effects. It was argued that an inherent part of this problem was the lack of research into structural effects, to the point where the effect had never been empirically observed. However, both learning and cognitive theorists recognised the role of money as an important motive driving gambling behaviour and this served to guide the first study investigating structural effects.

The first study examined aggregated player data from over 1000 poker machines. Two measures of expenditure, stake size and profit, were utilised and the observed variables were included based on the gambling literature, the findings displayed in Table 2.5, and communication with the gaming industry. The results suggested that both measures of expenditure were related to structural characteristics, with stake size showing a very strong relationship with the decline component of the multiplier potential. Subsequently, with the existence of structural effects now confirmed, the creation of theory driven hypotheses were possible.

An evaluation of the scientific merit of each theory suggested that traditional operant conditioning principles would best serve the task of predicting machine effects for individual players. The second study examined the expenditure patterns of 533 individual players in an ecologically valid setting. The results indicated that player stake size was related to certain structural characteristics, but only a very small relationship was found for net loss. These results failed to support the predictions of operant conditioning, as did a post hoc application of cognitive theory to the results.
Both studies demonstrated that structural effects play an important role in the understanding of gambling behaviour. The research process that led to the construction of the model was also emphasised. Initially, there were few speculations about the effects of machine characteristics on playing behaviour (primarily Cornish, 1978; Griffiths, 1993a). However, there now exists a substantial theoretical and empirical account of structural effects developed from a comprehensive understanding of game design. It was also demonstrated that ecologically valid research design and appropriate statistical analysis are not only possible in gambling research, but have the capacity to generate findings that assist with the direction of future research.

The use of the multilevel modelling technique identified both structural effects and the location of unexplained variance. For stake size, the greatest portion of unexplained variance was between players, rather than between occasions of play. For net loss, the partitioning of unexplained variance was more evenly divided. These findings formed the basis of the final model discussed in Chapter 8.

The final model considers a greater number of player level variables and also contains other machine variables not included in the two previous studies. The aim of this multilevel model is no longer the identification of structural effects, but the accounting of variance in expenditure across machines. The principles of operant conditioning form the theoretical basis for the machine level of this model. The inclusion of additional variables in the player level were based on a broad range of gambling studies, and, in particular was guided by Dickerson and Baron’s (2000) model of choice/control.
In conjunction with the ecologically valid research design and multilevel statistical procedure proposed, the final model represents a benchmark in gaming research. It is of significance to the understanding of both regular and excessive gambling, the operations of the gaming machine industry, and the regulation of game design for policy makers. It represents an integration of the many and varied sources of gaming information, and provides a testable model of psychological constructs related to structural effects. It extends the operant analysis of gaming machine play undertaken, and provides both a theoretical and empirical direction for future studies in this area.