Music, Movement and Marimba:
Solo Marimbists’ Bodily Gesture in the
Perception and Production of
Expressive Performance

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is acknowledged.

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Abstract

A combination of experimental and empirical studies investigate the assumption that musical expression is communicated in marimba performance through at least two channels – sound and action. A parallel is drawn between the bodily movements and gestures occurring with expressive musical sound, and gestures produced in concurrence with speech.

Experiment 1 investigated the assumption that bodily movements and gestures can enhance or diminish the perception of expression and interest in solo marimba performance when presented audio-visually compared to presentation in audio-only form. Body movement is of particular relevance here as the expressive capabilities of the marimba are relatively restricted, and the movements required to play it are visible. Twenty-four musically-trained and 24 musically-untrained observers rated auditory-only and auditory-visual presentations of 20th Century solo marimba excerpts for perceived expressiveness and interest. Performances were given by a male and a female professional musician in projected (public performance expression) and deadpan (minimised expressive features) performance manners. As hypothesised, significantly higher ratings were recorded in response to projected performances than to deadpan. The hypothesised interaction between modality and performance manner was observed. Higher expressiveness ratings were observed for projected performances, and lower ratings were observed for deadpan performances when the presentation was audio-visual compared to audio-only. Higher interest ratings were observed for projected performances when the presentation was audio-visual. Musically-trained participants recorded higher ratings than musically-untrained observers upholding the final hypothesis. The results suggest that expressive
functional bodily movements and bodily gestures play an important role in marimba performer-audience communication. Findings are relevant for both performers and educators.

The aim of Experiment 2 was to investigate whether the results of Experiment 1, conducted in laboratory conditions, would generalise to an ecologically valid setting – a real concert. Experiment 2 investigated audience continuous self-report engagement responses from 21 participants collected using the portable Audience Response Facility (pARF). The stimulus material was a solo marimba piece performed in a live concert. A female musician performed two musically similar sections within the piece in two different performance manners (deadpan and projected). The second-order standard deviation threshold method was used to analyse signal reliability. As hypothesised, mean engagement responses were greater in the projected sample than the deadpan sample. Reliable signal was only observed in the projected sample. Differences between deadpan and projected sample mean engagement responses may be due to expressive bodily movement from the performance manner manipulation; alternatively, serial order effect, necessitated by the concert setting, may be responsible. Such experimentation in ecologically valid settings enables understanding of audience perception of live music performance as it unfolds in time.

Expressive qualities of marimba players’ bodily gestures, witnessed in several projected and deadpan marimba performances in the stimulus material from Experiment 1 were analysed in Study 1. Laban Movement Analysis (LMA) observation techniques, involving embodied thinking and kinaesthetic mirroring, enabled analysis of force. Force is the third element of motion additional to temporal
and spatial aspects for which technology measuring only kinematics can not account. Effort-shape analysis and notation described and recorded expressive qualities of marimba players’ bodily gestures at specific locations on the musical score. With basic training, professional percussionist performers were able to understand and apply effort-shape analysis and notation. This inspired confidence that effort-shape analysis and notation has potential as an analytical tool for performers, teachers and students.

The results of Experiments 1 and 2 and Study 1 lead to the formation of a theory of bodily gestures in marimba performance. This theory accounted for functional bodily movements and bodily gestures in marimba performance based on an embodied interpretation of the musical score. Combined experimental and empirical results indicate that bodily movements and gestures can enhance perception of expressive marimba performance and therefore warrant focussed attention in pedagogy and practice.
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CHAPTER 1

Introduction
1.1 Background to the Project and Overview of Assumptions to be Investigated

The inspiration for this project grew from more than a decade of professional experience as a performer and teacher of classical percussion in the Western art music tradition. Playing percussion instruments requires highly coordinated fine and gross motor skills. Hence, from a purely functional perspective, bodily movement is a key factor in percussion practice. The concert marimba (see Figure 1.1) is a member of the Western classical percussion family of instruments. Playing the marimba requires especially finely coordinated movements. Additionally, highly attuned muscle memory is necessary as the marimba player is not in tactile contact with their instrument. Sound is produced using mallets. The marimba player must strike fairly thin bars, placed one next to the other, in an optimal position, and coordinate this while covering spatial distances of about a two and a half metre range. Visual identification of the bars to strike is not always possible as the extremities of the instrument often fall out of the direct range of sight. Therefore, muscle memory and refined coordination of bodily movements are focal areas of marimba practice. However, bodily movements rehearsed for reasons of pure technique are only one side of the coin in elite marimba playing. The body is importantly related to psychological and physiological aspects associated with every stages of practice through to presentation of performance (Davidson, 2002a).
An advanced-level percussionist is generally aware of the importance of engagement of the whole body in the act of producing an expressive performance. There is a general understanding among musicians that the parts of the body necessary to make expressive musical sound through an instrument do not operate in isolation. The tensions and relaxations of the muscles needing excitation for sound production are supported by adjoining muscles invoking complementary and supportive patterns of muscular tensions and relaxations, spreading throughout body and limbs and influencing postural contexts for expressive performance. A musician can influence the expressive quality of musical sound produced through setting up bodily patterns of muscular tensions and relaxations reflecting different expressive qualities in line with their musical intentions (Truslit, 1938, see Repp, 1993).

As technical movements for playing the marimba occur externally to the body, bodily movements enacted to create musical sound should be obvious to the observer. Pure technical movements created with expressive musical intentions will likely be
supported by other parts of the body in a coordinated manner. Since the marimba features limited sonic expressive capabilities in comparison to those of other instruments (Dahl, 2000; Dahl & Friberg, 2007; Fletcher & Rossing, 1998; Rossing, 1976; Rossing, Yoo, & Morrison, 2004), it is expected that the performer’s bodily gestures will be important for observers in discerning musical expressive intentions.

Music performance is concerned, for the most part, with generating auditory material. However, before inventions such as the radio and gramophone, music performance was an audio-visual phenomenon – the performer was seen and heard (Clarke 2002a; Thompson, Graham, & Russo, 2005). While technology allowed the dissemination of music through audio recordings to a wider audience, a side-effect was the separation of auditory and visual aspects of music performance. In contemporary Western culture, accessing music today is still predominantly via auditory means (Thompson et al., 2005). For the contemporary marimba player, presenting performances in an audio-visual, or multi-modal, manner wherever possible may be beneficial in reaching audiences and effectively communicating expressive intention, at the same time providing the richest musical experience possible to the audience. The concert setting of Western classical art music performance tradition provides a social context (Cross, 2005) supporting multi-modal music presentation. Though the focus is on the aural event, the traditional concert setting provides the audience with a wealth of visual, spatial and movement stimuli as well.

The goal of this project is to investigate the production and perception of bodily movements and gestures in expressive solo acoustic marimba performance in the Western classical art music tradition. Knowledge from diverse fields regarding how
human beings think, perceive, express and communicate provides the basis for investigating and understanding human action and perception in solo marimba performance. A long-term goal is to develop knowledge and skills that will enhance marimba pedagogy and performance practice.

1.2 Project Aims and Overview

A scientific method of enquiry is taken initially to investigate the role movements and gestures of the performer’s body play in the perception and production of expressive marimba performance. The foundation is laid by exploring gesture and speech, and bodily movement and gesture in instrumental music performance as two domains that exemplify coupled human sound and action (Chapter 2). Literature relating to the perception of artistic performance through one or more sensory modalities will be reviewed in Chapter 3, and lay the foundation for an experiment (Chapter 4). The first aim of this project is to investigate whether a marimba player’s bodily movements and gestures contribute to the perception of musically expressive marimba performance. Firstly, the assumption that marimba players’ bodily gestures are detectable and can influence the perception of musical sound will be tested. This assumption will be investigated in two experiments, in two experimental settings: 1) in a laboratory which will be reported in Chapter 4, and 2) in a live concert setting which will be reported in Chapter 5. The aim of the experiment conducted in a live concert setting is to study the contribution a performer’s bodily movements and gestures make to audience perception of solo marimba performance in a more naturalistic musical setting.
The experimental approach is balanced by a qualitative study exploring the expressive qualities of marimba players’ bodily movements and gestures. A theory of embodied cognition and kinaesthetic perception underpins the system for analysing, describing and recording the expressive qualities in marimba players’ bodily movements and gestures (Chapter 6). The aim of the study reported in Chapter 7 is to understand motivations for the production of expressive bodily movements and gestures by identifying links between observations of bodily expression and the musical score. An additional aim of the study is to develop a metalanguage for bodily expression. The metalanguage would operate in two ways: 1) as a tool for analysing and recording observations of performers’ bodily expression on the score, and 2) as an aid to performers in interpreting the musical score in an embodied, expressive manner. The study is based on the assumption that a musically expressive marimba performance is dependent on the performer’s interpretation of the musical score and his/her technical and expressive bodily skill.

Based on observations of marimba players in performance and relevant literature, it is anticipated that this combination of basic and applied research will contribute to knowledge about the creative and cognitive processes involved in communicative marimba performance. It is anticipated that through an understanding of audience perceptions of marimba performance and detailed analysis of performers’ bodily expression, connections between the musical score and the performer’s interpretation emerge. In addition, the features of bodily expression that contribute to more effective communication of the music with an audience in performance will be identified, analysed and recorded.
The outcomes of this project will contribute to theory and practice in music performance and education. Specifically, evidence will be provided in the form of empirical data that focuses on the role and importance of visual, spatial, and multimodal cues in performance and appreciation of art music. Additionally, methods training performing musicians, teachers and students to be more aware of bodily expression, and specific ways of incorporating this into performance preparation will be proposed.

Literature relevant to gesture and speech, and bodily movement and gesture in instrumental music performance as domains representing expressive, coupled sound and action will now be reviewed.
CHAPTER 2

*Bodily Movement and Gesture: Understanding Relationships between Expressive Sound and Action in Speech and Music Performance*
2.1 Overview of the Chapter

A major assumption of the investigation reported here is that musical expression is communicated in marimba performance through at least two channels – sound and action. In this investigation, action refers to bodily movement and gesture. Definitions for movement, but most importantly expressive movement or gesture, as found in speech and gesture, and music performance are discussed. A parallel will be drawn between music performance and speech production as domains where communication occurs through coupled sound and action. Theoretical proposals suggest that speech and gesture develop together and emerge as two channels with a common expressive goal. An analogous theoretical position drawn here considers a similar situation between expressive bodily movement, or gesture, and expressive sound in music performance. The elements of a gesture, and gestural construction relating to speech, are discussed. Parallels are drawn between the parts of gesture as they relate to speech, and possible similar relationships between expressive bodily movements and musical sound.

The variety of roles that the body plays in intentionally producing and expressing musical sound in solo instrumental performance are discussed. Musical expression is defined with a focus on components that the performer can deliberately manipulate through physical interaction with their musical instrument. Attention is directed towards timing and dynamics as the primary elements of sonic musical expression in percussion performance. A reductionist perspective is then expanded to consider performers’ bodily-instrument interactions as realising expressive intentions in sound and vision from a global perspective. This situates the chapter to follow.
2.2 Defining Movement and Gesture

According to the Oxford English Dictionary online (n.d.), a definition of movement includes, “I. A change of place or position…”, “I. a. The action or process of moving; change of position or posture; passage from place to place…”, and “a particular act or manner of moving.”. Generally speaking, in order to change place, position, or posture, the individual organises their body with its various appendages to systematically manoeuvre through space. Bodily movement in relation to instrumental music performance implies changes in place, position, or posture of the whole, or components of a performer’s body.

According to Zhao (2001), “Gesture, as a special sort of movement, links closely to the individual’s plans, emotions, imaginations, and desires, which are embodied in the whole body and manifested in the motion qualities during communicative acts” (p. 32). Definitions of gesture according to the Oxford English Dictionary online (n.d.) include, “1. a. Manner of carrying the body; bearing, carriage, deportment (more fully, gesture of the body)…”, “ 2. a. Manner of placing the body; position, posture, attitude…Also, a specified posture.” or “4. a. A movement of the body or any part of it. Now only in restricted sense: A movement expressive of thought or feeling.”. A summary of the term gesture as bodily movement, position or posture that appears expressive of thought, feeling or attitude, provides a starting point for investigating expressive bodily movement in marimba performance. The broad concept of gesture is largely identified as a facet of the nonverbal behaviours closely associated with speech and interpersonal communication.
2.2.1 Definitions of Gesture Occurring with Speech and Interpersonal Communication

Kendon (2004) proposes that gesture is, “a label for actions that have the features of manifest deliberate expressiveness...being done for the purposes of expression rather than in the service of some practical aim” (p. 15). Gestures, as visible bodily movements, have certain recognisable qualities distinguishing them from other action (Kendon, 2004). Interpretation of the intention communicated through an action is dependent on how the observer perceives the action, and the context (Kendon, 2004). According to McNeill (1992), gestures are the spontaneous, idiosyncratic movements of the hands and arms that occur with speech. The types of gestures related to speech and interpersonal communication are arranged along what McNeill (1992) refers to as Kendon’s continuum. At one end of the continuum, based on Kendon’s (1988) classification of gestures, are those gestures that always occur with speech (gesticulation) and at the other end are gestures independent of speech (sign languages). McNeill uses gesture and gesticulation synonymously – both refer to movement of the hands and arms occurring, or co-expressing, with speech (McNeill, 1992). McNeill (1992) argues that a person’s gesturing provides a window into their thoughts and inner world. According to Goldin-Meadow (2003), gestures are hand movements co-occurring with speech. They are created at the time of speaking as a component of intentional communication. Gestures differ from sign language in that they cannot replace speech. Gestures accompanying speech can express thought in a direct or abstractly referential manner (McNeill, 1992).

Studies of gesture from a psychological or linguistic perspective appear to focus primarily on hand and arm movements in speech and interpersonal communication (Goldin-Meadow, 2003; Kendon, 2004; McNeill, 1992). From a broader perspective
of nonverbal communication, gesture involves, “…voluntary bodily actions, by hands, head, or other parts of the body, which are intended to communicate.” (Argyle, 1988, p. 188). Along with gestural expressions accompanying speech, body postures play an important role in interpersonal communication (Argyle, 1988; Lamb & Watson, 1979). Body postures can illustrate personal attitudes, emotional states and intensity of emotion (Argyle, 1988; Lamb & Watson, 1979). Ekman and Friesen (1969) propose that body posture and movements are the *behavioural consequence* of affect shown through facial expression. Bodily expression can be confined to gestural movement of individual parts, or spread throughout the entire body.

Stillness can be just as expressive as movement. *A hold* - a pause in gesture - can occur extending the gesture before retraction, or changing to indicate the onset of the next gesture (McNeill, 1992). Brief cessations of movement can affect an extension of the communication of intended expression and thus still be considered as gestural. A similar state is common in music performance where a performer holds a gesture or position to indicate the continuance of the musical idea. The literature reviewed thus far in this chapter demonstrates that movements, positions and postures of the body are expressive of thought or feeling or attitude, thus fitting with general dictionary definitions of gesture. In a musical context, expressive movement, gesture or stillness of the body accompanying nonverbal sound may vivify communication of the performer’s inner thoughts or feelings.

While gesture has been most widely associated with speech and interpersonal communication, it has also been used to refer to features of artistic pursuits such as music and dance. Camurri, Mazzarino, Ricchetti, Timmers and Volpe (2004), for
example, suggested that expressive gesture in artistic performance contexts communicates expressive content. Importantly, expressive gesture and content in this context were considered as abstractly referential and different to gestures intended to denote meaning or support speech (Camurri et al., 2004). In a musical context, gesture has been a term associated with auditory, visual, physical and affective features interpreted from musical notation, or listening and/or watching musical performance.

2.2.2 Definitions of Gesture in the Context of Musicology and Musical Performance

Musical gestures have been recognisable in their, “significant energetic shaping through time” (Hatten, 2004, p. 95). Hatten (2004) proposed a theory of musical gestures based on general human perceptual and cognitive competencies, connecting and interpreting musical expression with human experience. The focus was on auditory gestures interpreted with regard to physical (motoric), or affective aspects of human experience, and gestures perceived through interpretation of visual aspects (referring to notation). Hatten’s embodied theoretical view posited musical gestures as expressions of significant biologically and culturally motivated movements. Physical gesture was only mentioned for its role in producing auditory musical gesture. The possibility of physical gesture as a visually expressive entity was not directly discussed. Since physical gestures are vital in realising musical gestures in sound, it seems appropriate that a complete study of gestures in a musical context should consider how they might also be perceived visually.

Musical gestures have been studied as visual, as well as auditory, phenomena. A general distinction has been made between physical gestures that are deemed
expressive and any other bodily movements witnessed in music performance. Gestures employed by performers have been categorised using a multitude of different terms. In a study of pianist Glenn Gould, Delelande (1988, cited in Cadoz & Wanderley, 2000) proposed three categories of gestures ranging from functional to symbolic: *effective, accompanist* and *figurative*. Effective gestures were those necessary for sound production. Accompanist gestures were those bodily movements not directly involved in sound production, but supporting effective gestures such as elbow movements. Therefore, these two categories had a functional and expressive physical basis. The final category, figurative gestures were those symbolic, rather than physical gestures, thought to be perceived by the audience. Musical gestures, according to Delelande (1988, cited in Cadoz & Wanderley, 2000), demonstrated the meeting of explicit movement and thought.

Cadoz (1988) proposed a classification of gestures involved in instrumental playing. As a subgroup of Delelande’s (1988, cited in Cadoz & Wanderley, 2000) effective gesture category, *instrumental* gestures were concerned with performer interaction with their instrument (Cadoz & Wanderley, 2000). Instrumental gesture consisted of three subdivisions. *Excitation gesture* provided the energy to coax sound from the instrument. The sound could immediately follow the gesture (*instantaneous*) as in striking or plucking. Or the sound and gesture could co-occur (*continuous*) as in bowing or blowing. *Modification gesture* adjusted the physical relationship between excitation gesture and resultant sound. Continuously varying an aspect of performance, such as vibrato, was considered a *parametric* or *continuous* modification gesture. *Structural* modification gestures were those involving a categorical alteration such as a technical change from bowing to plucking or tuning.
Finally, *selection gesture* involved choosing, either *sequentially* or in *parallel*, sonic possibilities inherent in the instrument, such as fingering and string selection. Cadoz and Wanderley (2000) examined cello, clarinet and bagpipe playing techniques as case studies illustrating the classification system.

The use of the word ‘gesture’ by Delelande (1988, cited in Cadoz & Wanderley, 2000), Cadoz (1988), and Cadoz and Wanderley (2000) in relation to sound producing, or functional movements seems somewhat at odds with the general definition of gesture referring to expressive qualities of movement, posture or stillness. Cadoz and Wanderley indicated that instrumental gesture was considered a *communication modality* of a three-tier *gestural channel*. The gestural channel was seen as a productive and perceptual pathway. *Ergotic* and *epistemic* functions both involved movements for manipulating and interacting with an instrument. The *semiotic* function related to movement or gesture with meaning or communicative intent (Cadoz & Wanderley, 2000). However, no term was given for such communicative movement or gesture.

Wanderley (1999) proposed the term *performer gestures*. However, performer gestures included functional, or sound producing movements (instrumental technique/effective gestures/instrumental gestures), as well as connected movements not directly involved in creating sound. Dahl and Friberg (2007) made a distinction between body movements directly employed in sound production, and natural, unconsciously produced expressive bodily movements that are present in music performance. These natural performer movements that co-occur with sound producing movements Dahl and Friberg (2007) termed *body language*.
Ruggieri and Katsnelson (1996) termed those movements not directly involved in the production of sound but associated with musical interpretation, *entourage movements*. They likened these to movements that occur in verbal language. The movements that were incorporated in performance but not directly involved in creating the sonic event (accompanist gestures), Wanderley (1999; 2002) termed *non-obvious* or *ancillary gestures*.

In a case study of expressive piano performance, Clarke and Davidson (1998) used the term *expressive gestures* in discussing bodily movements that were not directly tied to sound production. In studies involving instrumentalists, Davidson (1993, 2007) used the terms *movement* or *body/bodily movement* regarding performers’ bodily movements in relation to communication of different expressive intentions or expressive content. *Expressive performance movements*, *bodily expression in performance*, and *expressive movements* are also terms that have been used to denote expressive movements of a pianist’s body in performance (Davidson, 2002b). In a study involving sung music performance, Davidson (2001) made reference to a pop singer’s nonverbal communicative behaviours primarily involving the term *gesture*.

### 2.2.3 Summary and Conclusions

Definitions of gesture encompass natural bodily movements and postures with expressive qualities co-occurring with sound and reflective of thoughts, feelings or attitudes. Additionally, gesture does not necessarily involve movement. For example, a pause in movement can still be considered as part of gesture. Within the music literature there is myriad of different terms denoting expression revealed through bodily movement in music performance. However, there is a general
consensus that there is a difference between bodily movements that serve more functional roles, such as instrumental technique, and others supporting or accompanying bodily expression – gesture.

Therefore, in this study, embodied expressions of the whole, or part of, the body perceived as movement or stillness during marimba performance will be referred to as *bodily gesture(s)*. Other bodily movement judged as lacking in expressive content, but fundamental to instrumental technique to create (even) sound, will be referred to as *functional bodily movement(s)*. *Expressive functional bodily movement(s)* will refer to intentional variations on mere functional bodily movements necessary to interact with the instrument and create expressive variations in sound. It is possible that certain *expressive functional bodily movement(s)* may be perceived as *bodily gesture(s)*. Analysis of the individual bodily gesture should reveal whether the movement be involved in expressive sound production.

The term ‘gesture’, referring to bodily expression, has most often been associated with speech and interpersonal communication. Gesture accompanying speech provides a naturally occurring, human example of sound and action coupled in common expression. This provides an analogy for bodily gestures and expressive functional movements co-occurring with sound in music performance as another case of human action-sound coupling but in an artistically expressive domain. Exploration of the close connection between speech and gesture may provide insights for understanding bodily expression in music performance. A review of such research follows.
2.3 Sound and Action I: Coordinated Mechanisms in Speech and Interpersonal Communication

The co-occurrence of speech and gesture (Goldin-Meadow, 2003; McNeill, 1992; Kendon, 2004) provides a well known example of tightly coupled sound and action. Gesture accompanying speech is widely regarded as a universal phenomenon, though the exact relationship between the two channels appears to involve cultural, lexical and grammatical determinants (Kendon, 2004; McNeill & Duncan, 2000). According to Goldin-Meadow (1999):

…speech-accompanying gestures serve two, not mutually exclusive functions. Gesture provides speakers with another representational format in addition to speech, one that can reduce cognitive effort and serve as a tool for thinking. Gesture also provides listeners with a second representational format, one that allows access to the unspoken thoughts of the speaker and thus enriches communication. (p. 428)

Gesturing begins in early infancy and develops through childhood alongside speech (Acredolo & Goodwyn, 1988; Bates, Shore, Bretherton, & McNew, 1983; Goldin-Meadow, 1999; McNeill, 1992; Meltzoff & Moore, 1977; Trevarthen, 1977). At first, the two channels are not integrated, but become so before children start combining words (Goldin-Meadow, 2003). Gesture appears to be an integral component expressing thought with speech. Theoretical proposals for how speech and gesture develop in coordination may provide an informative analogy for a music context where sound and action are similarly coordinated.
2.3.1 Theoretical Proposals for the Development and Emergence of Gesture and Speech

McNeill, (1992) argues that speech and spontaneous, idiosyncratic hand and arm gestures coexist and are co-expressive, integrated components in utterance forming and communicative processes. He states that, “...gestures and speech should be viewed as two sides of a single system...” (McNeill, 1992, p. 4). McNeill (1992) proposes the concept of a growth point as, “...the speaker’s minimal idea...” (p. 220), or idea unit, from which an utterance and a gesture develop. McNeill’s theory suggests the development of the growth point involves linguistic and imagistic thought processes leading to observable, integrated speech and gesture. Growth point theory posits that a single process constructs integrated image and word.

Kita (2000) proposes that speech and gesture develop in tandem by way of the information packaging hypothesis. The key difference between McNeill’s and Kita’s theories is that Kita argues that gestures are based in spatio-motoric thinking, rather than imagery. Spatio-motoric thinking implies gestures have their inception as virtual actions operating in a virtual environment (Kita, 2000). Speech arises from analytic thinking, independently of gestures, though at the same time. Though speech and gesture are synchronised, Kita proposes that they develop from two independent, yet interactional, systems. This marks another key difference between growth point theory and the information packaging hypothesis.

While testing different theories of gesture-speech development is not the focus of the present investigation, the literature provides some consensus that speech and gesture emerge in common expression of thought. The following sections provide insights as to how obvious gestures coordinate with speech, and outline the elements that make
up a gesture. Bodily gesture may coordinate with expressive musical sound in a similar manner and this will be discussed throughout the following sections.

### 2.3.2 Coordinating Gesture with Speech

As gestures emerge and become obvious to the observer, they typically appear semantically and temporally coordinated (Goldin-Meadow, 2003; Kendon, 2004; McNeill, 1992). Semantically synchronised gestures imply that the same idea is conveyed through both auditory and visual channels. The auditory and visual channels may refer to the same information leading to redundancies. However, most often, each channel provides different, yet related information about the same semantic content thereby enriching meaning (Goldin-Meadow, 2003; Kendon, 2004; McNeill, 1992). In music performance, it is more likely that a musical idea be communicated through matched auditory and visual channels. The reason being that the body and limbs are primarily involved in functional movement for sound production, therefore bodily gesture is constrained to those movements that do not impede functional movement. As an example, large and forceful movements may accompany a section of music performed with a loud dynamic. Observers’ impressions of heard musically expressive performance may be enhanced through the addition of the visual channel providing additional, coupled information.

On a more global scale from the broader field of nonverbal communication, bodily movement has been observed to co-occur with speech in a studying of emphasis in conversational pairs (Bull & Connelly, 1985). Arm and hand movements, and to a lesser degree, movements of the head and torso, were perceived as emphatic from viewing playbacks of the conversation without sound. A second analysis of body
movements associated with vocal stress demonstrated that emphatic movements were spread throughout the body. The hands and arms, head, torso, legs and feet displayed emphatic movements and most often in combination. Emphasis was clearly communicated through emphatic movements, not because of their appearance, but due to their close temporal relationship to vocal stress. Of the movements noted as emphatic from viewing alone, only a small amount corresponded to those observed with vocal stress in the second analysis. Bull and Connelly (1985) concluded that vocal stress was closely and importantly related to body movements, not just movements of the arms and hands. For accurate interpretation of visible gestures the accompanying sound should be considered. Therefore, in order to interpret musicians’ bodily gestures, it seems necessary that the expressive musical sound should be considered rather than the vision alone.

2.3.3 Gesture Construction and the Elements of Gesture

There are three phases from which a gesture can be constructed: a preparation phase; a stroke phase; and a retraction/recovery phase (Kendon, 2004; McNeill, 1992). The main part of a gesture - the stroke phase - is temporally synchronised with a segment of speech (Goldin-Meadow, 2003; Kendon, 2004; McNeill, 1992). In a music performance context, it is likely that bodily gesture is similarly synchronised with select parts of the performed music. Particularly in marimba performance (introduced in Chapter 1), the stroke phase of an expressive functional bodily movement would be temporally synchronised with the sound produced, and obvious to the observer. With certain limbs and other parts of the body coordinating to create sound through functional movement, the parts of the body remaining free to gesture would necessarily be coordinated with functional movement. Bodily gesture that interfered
with functional movement or the flow of performance would not likely remain part of a performer’s interpretation of the musical score.

While gestures usually occur in three phases, some bi-phasic gestures also exist (McNeill, 1992). Both tri-phasic and bi-phasic gestures involve a stroke phase. A gesture performed in three phases anticipates and synchronises with speech. The main part of the gesture, the stroke, is surrounded by a preparation phase and a retraction/recovery phase (Kendon, 2004; McNeill, 1992). In bi-phasic gestures, only the preparation and stroke phases occur. The preparation phase involves the excursion of body part(s) to a certain position whereby the stroke phase is performed. Retraction or recovery phases see body parts returning to a neutral, starting position. Sometimes a pause in movement can occur between phases of the gesture. This is called a hold.

Preparation of some kind is necessary to make musical sound. For example an inhalation of breath is necessary to sound a musical phrase through wind and brass instruments. As another example, every stroke played on percussion instruments involves a preparatory raising of a stick or mallet. These are examples of preparatory movements that are primarily functional in nature. From an expressive perspective, the style of preparatory phase of bodily gesture would likely normally predict the size, speed and force of the stroke phase that follow and the resultant sound. This idea fits with the accepted notion that gesture and speech are semantically and temporally coordinated. The retraction phase, occurring after the part of the body has performed its gesture and returns to a neutral resting position, would not appear until the performer had completed playing and returned to a rest position. However, a type of
retraction phase could be interpreted as occurring after the stroke phase of a bodily gesture had been completed, the performer returns to a neutral bodily position where purely functional movement could be performed. In a musical context, a hold could account for cessation of movement in performance where there appears to be a continuation of expression.

2.3.4 Summary and Conclusions

The co-occurrence of speech and gesture, illustrating coupled sound and action, appears to be a universal feature of speech and interpersonal communication. The notion of sound and gesture with a common expressive goal developing and emerging together provides a theoretical basis for developing a similar theory concerning musical sound and bodily gestures. Observations of how the parts of gestures coordinate temporally and semantically with speech provide an analogy for how bodily gesture may coordinate with the auditory stream in music performance. Music performance illustrates tightly coupled sound and action in an aesthetically expressive context for human communication. In instrumental music performance, the body serves functional as well as communicative roles. Both functional bodily movements and bodily gestures are important in realising expressive intentions in sound and vision, and communicating these to an audience through performance.

2.4 Sound and Action II: Functional Bodily Movement and Bodily Gesture in Instrumental Music Performance

The performance of music in the Western classical art music tradition exemplifies a cultural context for sharing and understanding human expression through intentional sound and action. According to Cross (2003), “…music embodies, entrains and
transposably intentionalises time in sound and action” (p. 79). Driven by the desire to communicate an interpretation of a musical score (sonically) to an audience, the performer intentionally links the auditory, movement and visual domains. The audience member attends with the intention of experiencing the performance. Holistically, the performance is a context for a shared intentional purpose that links the observer and performer (Cross, 2005). The performer’s functional bodily movement and bodily gestures are key to/in creating and communicating expressive musical intentions.

2.4.1 Functional Bodily Movement in Instrumental Music Performance

At a fundamental level, bodily movements, in the form of instrumental technique, are necessary to bring the notes of a musical score to sonic life (Davidson & Correia, 2002). Approximately 10,000 hours of deliberate practice is said to be required to attain a standard of performance equivalent to that of an international standard orchestral musician (Ericsson, Krampe, & Tesch-Römer, 1993). With a minimum of 10 years of deliberate practice on a particular skill, and quality instruction, expertise in that skill at an internationally competitive level can be achieved (Ericsson et al., 1993). Highly developed functional movement or technical skill is a necessary component of advanced music performance (Sloboda, 1996). Such technical facility is also observed outside the arts in activities such as touch-typing. Refined fine motor control may enable precision in factors such as timing, position, and force that the performer may then use deliberately for expressive purposes. To understand the factors that musical expression in the Western classical art music tradition encompasses, the following section offers some definitions.
2.4.2 Defining Musical Expression in the Western Classical Art Music Tradition

Juslin (2003) comments that, “…expression is largely what makes music performance worthwhile” (p. 274). In the Western art music tradition, performances are primarily constructed from notated music (Gabrielsson, 1988). A broad definition of musical expression applicable to this genre is “…expression as deviations in the performance data from a mechanical rendition of a score” (Timmers & Honing, 2002). Kendall & Carterette (1990) view expression as a perceptual phenomenon. Gabrielsson (1999) makes a distinction between musical expression as perceived by the listener, and expression as physical deviations from an exact rendition of the score.

Juslin (2003) elaborates his definition of expression as “…a set of perceptual qualities that reflect psychophysical relationships between ‘objective’ properties of the music, and ‘subjective’ (or rather, objective but partly person-dependent) impressions of the listener” (p. 276). Outlined as the GERMS model, expression comprises five components: Generative rules, Emotional expression, Random variability, Motion principles, and Stylistic unexpectedness (Juslin, 2003). Generative rules involve variations to acoustic components such as timing, dynamics and articulations, highlighting hierarchical musical structure. The achievement of emotional expression involves numerous acoustic variables. Performance expression involves random variability, implying that there is some random plasticity in motor programs. The category ‘motion principles’ involves intentional motion reflecting characteristic human movement, or unintentional motion demonstrating anatomically driven motoric constraints. Finally, stylistic unexpectedness, as the last category of the model, results from the violation of music expectancies. The GERMS model rests on
an assumption that for each expressive component of the model, the origins, characteristic patterns, neural processing and listener’s perception will be different. This model provides a view of musical expression from the perspective of both perceiver, and producer or musician. Perception of expression in music, from a global viewpoint, will be explored in the Chapter 3.

Musical expression is not just defined by a set of rules, but also encompasses experiential human movement characteristics. The temporal and dynamic qualities of human or physical motion have proved useful in explaining expressive deviations in timing related to phrasing. Friberg and Sundberg (1999) found a relationship between the deceleration timing pattern of a runner coming to a halt and the final ritardando pattern in Baroque music performance. Todd (1992) proposed a model of musical expression that encompassed timing and dynamic patterns based on earlier models inspired by kinematic and dynamic variations in simple physical actions. Timing patterns and dynamic patterns that follow the course of objects obeying gravitational forces seemed a useful model to explain expression in musical performance (Todd, 1995).

In order to simply perform the notes of a piece the musician employs functional bodily movements. However, to perform a piece with artistic expression above the level of mechanical interpretation, it logically follows that performers make alterations to their functional motor program to realize their expressive intentions in sound. As mentioned earlier, such movement here is termed expressive functional bodily movement.
2.4.3 Expressive Functional Movement in Instrumental Music Performance

Through sophisticated technical facility a performer can transform imagined sound concepts into a working motor program that communicates intended expression (Sloboda, 1996). Clarke (1993a) suggests that bodily movements are, “…a way of achieving precise control of acoustical aspects of expression and a dimension of expression in their own right” (p. 218). That bodily movements involved in creating expressive musical sound can become a source of visual expression is highly relevant to marimba performance. As mentioned in Chapter 1, all of the movements for playing the marimba are visible, therefore, it is plausible that expressive functional movements may be perceived as visually aesthetic by observers. The sensitivity of novice and more expert participants to visual (action) information in marimba performance will be investigated in a laboratory (Experiment 1) and live (Experiment 2) setting.

The focus of the next section is to detail the facets of musical expression resulting from performers’ physical interactions with their instrument. A reductionist perspective begins to identify the components of musically expressive sonic performance. This will be extrapolated in subsequent sections that explore relationships between the performer’s body and musical instrument in musically expressive performance from a more global perspective.

2.4.4 The Components of Sonically Expressive Instrumental Music Performance

As performed music in a Western art tradition is primarily viewed as acoustic phenomena, musical expression has largely been studied from an auditory
perspective. Differences in expression are ‘detectable’ and ‘interpretable’, and help to guide the listener through the performer’s interpretation of the musical structure (Sloboda, 1994). The elements of sonic expression the performer can manipulate through physical interaction with their instrument include timing (e.g. Clarke, 1985; Palmer, 1989; Repp, 1992, 1997; Shaffer, 1984; Timmers & Honing, 2002), and dynamics (e.g. Friberg & Battel, 2002; Kendall & Carterette, 1990; Todd, 1985; Todd, 1992). An expanded list is inclusive of articulations (e.g. Clarke, 2002b), intonation and tone quality (e.g. Clarke, 1988; Palmer, 1997). These elements constitute the microstructure of performance (Palmer, 1997).

The two fundamental elements that a performer deliberately manipulates for expressive purposes are timing and dynamics (Todd, 1985). Dahl (2000) noted that percussion instruments do not have the same range of expressive capabilities of other musical instruments, such as articulation, timbre and duration. Therefore, dynamic levels and increasing or decreasing timing/duration between notes and phrases play an important role in musically expressive percussion performance. It is these two elements – timing and dynamics - that will now be discussed as they relate to musical structure.

2.4.4.1 The Relation of Expressive Timing and Dynamics to Musical Structure

Deliberate variations in timing from a nominal performance (a deadpan or mechanical performance of the musical score) have been observed in relation to musical structure (Friberg & Battel, 2002). While variations can occur due to unintentional perceptual or motoric variability (Friberg & Battel, 2002; Penel & Drake, 1999), intended or deliberate variations are the focus here. Musical structure can be thought of as hierarchical organisations of grouping (phrasing) and metre. An entire piece can be
thought of as a single phrase. Within this phrase are contained smaller phrases and sub-phrases within those, down to the level of melodic groups. The metrical hierarchy is based on the *tactus*, or beat. Patterns of strong and weak beats usually in duple or triple, correspond to the bar. While grouping and metre are conceptualised as separate entities, their boundaries often fall together (Lerdahl & Jackendoff, 1983). A performer’s understanding of musical structure is thought to influence expressive timing patterns (Clarke, 1999).

Shaffer (1984) provided support for a generative theory of expression finding similarity in the timing patterns of performances of two pianists. One of the pianists gave a sight-read performance of a solo piano piece on only one occasion. The other pianist briefly rehearsed the piece before performing it. A year later, the same pianist gave two more performances again after a brief rehearsal of the piece. All performances of the solo piano piece showed similar expressive timing interpretations. Shaffer (1984) concluded that expressive interpretations were generated from analysis of the musical structure.

Tight coupling between timing patterns and musical structure was demonstrated in another study involving piano performance (Clarke, 1993b). Pianists were asked to imitate four heard melodies (that had previously been memorised), and transformations of these melodies. The results demonstrated that the more the relationship between structure and expression was violated the more the pianists’ performance became inaccurate and inconsistent. Performances of the violated structure-expression excerpts did show improvement on recurrent attempts.
Metre has been shown to influence timing patterns in piano performance (Sloboda, 1983). Pianists performed the same melodic material though in different metrical contexts. Strong and weak beats of the bar corresponding to the different metres were played with different articulations. Notes occurring in a strong location in the bar were performed louder and longer and with a legato articulation than beats in a weaker location. In addition to metrical accents, expressive accents were also observed in relation to rhythmic grouping and melody (pitch jumps and contour changes) (Drake & Palmer, 1993). Melodic accents and metrical accents were shown to be influenced by musical context. While the accenting of rhythmic groupings and metre remained consistent, the implementation of melodic accents was influenced by the presence of other accents.

Slowing towards the end of a phrase has been observed as common occurrence in musical performance (Friberg & Sundberg, 1999; Todd, 1985). Using a simple rule, phrasing hierarchy accounted for patterns of rubato observed in piano performances. The amount of slowing at phrase boundaries was relative to the hierarchical level of phrasing. The greatest amount of slowing was observed at the highest level, and lower levels displayed a lesser amount of slowing. Studying the timing patterns of well known pianists through CD recordings of performances, Repp (1992) observed commonality in expressive timing patterns. Though the surface may display idiosyncratic interpretations by performers, this surface level was based on an agreed core level of expressive timing patterns demonstrated across performers. At their expressive core, performances were organised around phrase structure. From a microstructure point of view, deliberative deviations in timing and dynamics help to communicate musical structure. Such timing and dynamic patterns are influenced by
performers’ expressive intentions. From a less reductionist perspective, intentions such as to disseminate musical character, involving motion or emotional qualities, result in expressive timing and dynamic patterning (Friberg & Battel, 2002).

2.4.4.2 Timing and Dynamic Patterns Reflecting Expressive Intentions

From a more global perspective, timing and dynamic patterns provide insight into connections between motivating factors, additional to musical structure, influencing performers’ intentional expressive functional bodily movements. A study investigated timing patterns in intended musical or unmusical piano performances (Palmer, 1989). Greatest deviations from notated timing patterns were found in musical piano performances in relation to important points in the musical structure: phrase or cadence endings. The tempo slowed the greatest at phrase boundaries. The melody was found to lead the other voices. Deviations were much less pronounced in intended unmusical performances, but increased in exaggerated performances.

Kendall and Carterette (1990) observed that intentionally musically expressive performances by a variety of instrumentalists were longer than performances intentionally lacking in expression. In general, as the level of intended expressiveness increased, so did the length of the note values. There was a tendency for notes of shorter value to be played shorter and louder in expressive performances. By comparison, longer notes were generally played softer. The ability to create performances of different expressive intent, revealed through different timing profiles, was related to the level of skill of the performer.
Dynamics were shown to play an important role in expressive violin, recorder and oboe performance (Nakamura, 1987). Comparing musicians’ notated interpretations of dynamics with their performance data revealed a close correspondence between intention and actual intensity level changes, especially for crescendos.

Shaffer (1995) noted that musical structure and expressive markings in the score, such as dynamics and tempo, did not solely account for musical expression. The timing and dynamic patterns of expert pianists were studied in relation to musical structure and expressive markings notated in the score. Two pianists’ performances of a piece of baroque repertoire were compared. Another two pianists’ performances of a piece of solo classical repertoire, and a further two pianists’ performances of a piece of romantic solo repertoire were also compared. Performers selectively used timing and dynamics to highlight their individual interpretation of musical structure. Patterns of timing and dynamics generally reflected the expressive markings in the score as well. Shaffer (1995) concluded that interpretive differences among performers led to the creation of individual musical characters.

Sloboda (1996) points out that expressive deviations from an exact rendition of the score are intentional, applied without conscious awareness, systematic, unique in some way to the performer, take account of the musical structure of the score and are detectable by listeners. It appears that it is the way each individual performer uses timing, dynamics and articulations in the formulation of their musical/artistic image that constitutes an expressive performance (Clarke, 2002b).
The literature reviewed demonstrates that in instrumental performance, expressive musical sound is the result of the performer’s intentional physical interaction with their instrument by way of expressive functional bodily movement. Links with the musical score will be addressed in Chapter 7. The performer’s intentional, expressive motor program creates expressive functional bodily movements affecting the resultant sound. Such a motor program designed to perform a piece of music incorporates stable and flexible elements.

2.5 Intentional, Expressive Motor Programs in Music Performance

An intentional, expressive motor program created for performance of a piece of music comprises both functional bodily movements and expressive functional bodily movements. Depending on the demand of performance, the musician may move between the two. Functional bodily movements demonstrate stability whereas expressive functional bodily movements reflect flexibility in the motor program. This assertion is supported by evidence from a case study of a professional pianist.

A case study of a professional pianist revealed stability and flexibility in timing and dynamics motor programs in performance of a solo piece of music (Chaffin, Lemieux, & Chen, 2007). More time was taken and less dynamic variability occurred at basic performance cues marking points of stability. This allowed greater focus on technical control and precision. Musical gestures were performed in a flexible manner providing variability within the performance. The researchers were provided with basic and expressive performance cues, phrasing and technically demanding aspects by the pianist from her interpretation of the music. Chaffin and colleagues concluded
that motor programs for the performance of the majority of basic and performance cues were intentional though may have been subconscious (Chaffin et al., 2007).

While highly-developed motor programs are a necessity for technical facility and the realisation of expressive intention in sonically expressive music performance, a skilled performer develops a motor program for performance of a piece that also communicates their expressive intention visually. In addition to the visually expressive material that expressive functional bodily movements may create, there is a level of involvement the body plays in expressive musical performance that goes beyond mere expressive instrumental technique. Bodily gesture refers to this additional level of bodily expression produced in expressive musical performance.

2.6 Bodily Gesture in Instrumental Music Performance

While bodily gesture can serve functional roles, such as communicating with co-performers (Davidson, 2001; Williamon & Davidson, 2002), the present investigation will focus on the bodily gestures of solo instrumentalists. In this context, bodily gestures in musical performance appear to be linked to the production of expressive sound. Studying the postural attitudes and movements of a solo violinist, Ruggieri & Katsnelson (1996) explored the relationship between performer, instrument and musical score from a psychophysiological standpoint. They postulated that the performer’s movements played both a ‘mechanical postural’ role as well as an ‘expressive aesthetic’ role. Their analytical framework was based on the assumption that the performer’s postural context is an integral component of the motor activities involved in producing the sound. The regulation of muscular tension and release by way of the performer’s motor activity seemed to be an important facet of expression.
In conclusion, Ruggieri and Katsnelson (1996) noted that while the information in the musical score remains the same, different musicians produce different interpretations through their individual movement styles.

It appears that performers embody their expressive intentions, in their own style, co-expressing visually with musically expressive sound. This notion is also supported by an analysis of auditory and visual performance data from a pianist’s performance of a solo 20th Century piece. The pianist would lean forward when performing passages of a quiet dynamic, and lean backward when playing passages of greater intensity illustrating the case that the performer’s intention to play quietly, or loudly, resulted in bodily gesture co-expressing that intention (Camurri et al., 2004).

2.7 Summary and Conclusions

Expressive functional movement, bodily gesture and musical sound are conjoined in expressive musical performance. Timing and dynamic performance data provide evidence that expressive functional bodily movement creates intentional deviations in these elements from a nominal performance resulting in expressive musical sound. It has been argued that bodily gesture and expressive musical sound may develop and emerge as two sensory channels expressing the same idea in a musical context. The ideas motivating the intentional, expressive motor program encompassing expressive functional movement and bodily gesture may be evidenced in the musical score. In order to investigate these assumptions, it is first necessary to confirm that musicians’ expressive intentions are in fact perceptible to audience members under controlled laboratory conditions. These assumptions will be investigated via the medium of recordings of solo marimba performance in a controlled laboratory setting.
As mentioned at the outset, a major assumption of the investigation reported here is that musical expression is communicated in marimba performance through at least two channels – sound and action. An experiment will investigate the contribution of expressive functional movement and bodily gesture (as the visually expressive channel) to the perception of expression in solo marimba performance.

The next chapter will explore perception of expression in auditory-only, visual-only, and combined audio-visual conditions in artistic domains. The focus will be on expression in the domain of music. Results of an experiment (Chapter 4) will then form the basis of an investigation and analysis of bodily gesture in marimba performance (Chapters 6 & 7).
CHAPTER 3

Perception, Attention, and Multimodal Phenomena: A Literature Review
3.1 Preamble

The aim of this chapter is to review experimental psychology research relevant to investigating the contribution of bodily gesture to audience perception of expression, attention, engagement, and interest in solo marimba performance. Literature pertaining to the perception of artistic expression through audio-only, visual-only, and combined audio-visual sensory modalities will be reviewed. Evidence of cross-modal integration and interactions provides support that visual information can influence the perception of auditory information in domains other than music. This is particularly relevant to marimba performance due to the limited expressive capabilities of the instrument for sonic expression. The two main current pedagogical approaches to marimba playing have opposing views regarding the influence of bodily movement and gesture on sound production. Neither approach considers the possible influence the performer’s bodily movement may exert on audience perception of performance. The view that multimodal presentation can enhance and enrich communication of expressive content is the core assumption driving Experiments 1 and 2. These experiments will be reported in Chapters 4 and 5.

3.2 Perception of Expressive Performance in Audio-Only or Visual-Only Conditions

Investigations in artistic performance domains have been conducted to discover whether observers are sensitive to musical performers’ expressive intentions in audio-only and visual-only modes. Relevant literature will be reviewed in Sections 3.2.1 and 3.2.2. Such investigations demonstrate that intended expression then produced by performers result in expressive sonic and expressive visual material which can be
perceived by listeners or observers. It will be argued that music performers’ body plays a fundamental role in creating expressive sound and vision. Literature reviewing unimodal perception of expressive intentions in artistic performance will now be presented. A review of literature regarding multimodal perception of expressive intentions in music will be presented in Section 3.4.

3.2.1 Perception of Sonically Expressive Performance

Differentiation between three levels of expression intended by violin, trumpet, clarinet, oboe and piano performers was made by listeners primarily using the acoustic properties of timing and dynamics (Kendall & Carterette, 1990). The levels of expression with which the musicians performed an excerpt of a vocal work were termed, “…without expression (senza espressione), with appropriate expression (con espressione), and with exaggerated expression (con troppo espressione)” (Kendall & Carterette, 1990, p. 137). In a categorization experiment, participants were asked to match the three different expressive versions of the same selection of the musical material performed by the violinist, trumpeter, clarinettist and oboist with the pianist’s models of the same selection of music performed in three different expressive intentions. Results suggested that performances with appropriate expression and with exaggerated expression were the most difficult for listeners to discriminate between, with listeners alternating category choice significantly. A rating task indicated that performances of real instruments, with appropriate expression and exaggerated expression were not significantly differentiated. The difference between mechanical and expressive performance seemed to be the easiest to perceive.
While interpreting perceived emotional content is not the focus of the present study, it is interesting to note that listeners in an audio-only condition could generally interpret performers’ intentions with regard to emotional expression/character in violin, flute, electric guitar and singing performances (Gabrielsson & Juslin, 1996). In another study, listeners could detect different emotional expressions in drummers’ performed swing, rock and waltz beats (Laukka & Gabrielsson, 2000). Laukka and Gabrielsson (2000) concluded that emotional expression in music performance may be manipulated through tempo, dynamics and timing variance.

3.2.2 Perception of Visually Expressive Performance

The artistic domain of dance offers the most obvious example of visually perceptible bodily expression. A study investigated spectators’ visual impressions of emotional expression/character and dancers’ intended emotional expression (Camurri, Lagerlöst, & Volpe, 2003). Camurri and colleagues (2003) showed that observers were able to detect dancers’ different intended emotional expressions from performances of the same choreography.

In a musical context, Dahl and Friberg (2007) found that observers were, for the most part, able to correctly identify a marimba player’s different emotional expressive intentions. Participants viewed visual recordings of the different emotionally intended performances showing different parts of the performer’s body. The emotions of happiness, sadness and anger were generally well communicated regardless of viewing condition. Fear was not well communicated. These studies indicate that audience members perceive the presence of, and variations in, artistic expression via both auditory and visual sensory modalities.
3.3 Multimodal Perception

In daily life, individuals receive information simultaneously from multiple sensory modalities. Research in many fields has demonstrated the occurrence of an interaction or integration between auditory and visual sensory modalities. Visual information has the potential to enhance, modify or diminish the perception of auditory information. Therefore, advantages can exist in experiencing the world through multiple sensory modalities. Relevant literature will now be reviewed.

3.3.1 Auditory-Visual Integration and Cross-Modal Interactions

In the field of speech perception, research has demonstrated that visual information provided by way of the speaker’s mouth movements influenced the auditory message heard. This phenomenon is known as the McGurk effect where participants reported hearing a /da/ or /tha/ sound when an auditory /ba/ was paired with the visual articulatory movements for /ga/ (MacDonald & McGurk, 1978). The McGurk effect has also been demonstrated with non-speech stimuli involving plucking or bowing a cello. Participants’ judgements of auditory plucked or bowed sounds was influenced by seeing the string either being plucked or bowed (Saldana & Rosenblum, 1993).

Synchronised auditory and visual channels have been shown to aid effective communication of a message. Intramodal synchrony, or synchrony between sensory modalities, was perceived when an auditory event preceded a visual event by as much as -75ms, or followed by up to 90ms (Levitin, MacLean, Mathews, & Chu, 2000). Redundancies occur when the same message is communicated through more than one mode resulting in more accurate communication, particularly when one mode is degraded (Wickens, Lee, Liu, & Becker, 2004). For example, in a noisy environment,
being able to see the face that was speaking helped in understanding what was being said because the visual signal was congruent with the auditory signal reinforcing or supporting the same message (Sumby & Pollack, 1954). Bahrick and Lickliter (2000) found that redundancy was an important facet of early perceptual learning, supporting the *intersensory redundancy hypothesis*. In their study, infants were only able to discriminate a novel rhythm from a habituated one when presented through synchronised audio and visual modes as compared to audio-only or visual-only presentations (Bahrick & Lickliter, 2000).

Human perception tends to be dominated by the visual sense (Wade & Swanston, 1991). However, research has shown that, while for spatial perception, vision tends to dominate, audition is more dominant in making temporal decisions - the *modality appropriateness hypothesis* (Welch, DuttonHurt, & Warren, 1986). However, it has been shown that in the temporal situation, vision, the weaker mode, could dominate when auditory information was ambiguous, and vision could also influence spatial location of a sound source - the *ventriloquist effect* (Shimojo & Shams, 2001). The ventriloquist effect has also been observed in dynamic situations with the direction of motion of visual stimuli affecting the perception of direction of motion in auditory stimuli, under certain conditions (Soto-Franco, Lyons, Gazzaniga, Spence, & Kingstone, 2002).

Possible interactions between auditory and visual modalities have also been investigated at a less reductionist level within the context of an artistic performance. A study investigated perception of structural and expressive relationships between music and dance in a single performance case study presented as music-only, dance-
only, or combined music and dance (Krumhansl & Schenck, 1997). In each condition, participants indicated their perception of section ends, new ideas, emotion and tension. For all four tasks, highly similar results were obtained. Krumhansl and Schenck (1997) concluded that results suggested an additive, rather than interactive, relationship between the two artistic domains. However, responses were made to only one performance, and the style of the music (Mozart) and choreography (Balanchine) may have influenced results because Balanchine deliberately choreographed movement that was analogous to the music. An interactive relationship between auditory and visual domains may be observed if an experiment, with a similar multimodal design, were to be conducted with the stimulus material drawn from an audio-visual recording of performer playing a piece of music. The performer’s bodily movements and gestures would necessarily be more closely related to the sound produced in expressive music performance than dance with music. Such an experiment will be discussed in the following section.

3.4 Multimodal Perception in Music

When observing a live music performance, an audience member is inundated with a wealth of aural, visual, spatial and movement stimuli. While the focal stimulus is aural (including pitch, timbre, rhythm, form, dynamics and articulation), both aural and visual modes are integrated, influencing the audience member’s aesthetic experience (McClaren, 1988).

Recent studies have demonstrated that sensory modalities interact and integrate in the perception of music performance. Schutz and Lipscomb (2007) found that long and short gestures accompanying the striking of a marimba note influenced musically-
trained non-percussionists and non-musician participants’ judgements of the duration of the note as being long or short, even though acoustically the duration was the same. Findings demonstrated a cross-modal interaction where vision dominated temporal judgements of auditory information using ecologically valid musical stimuli (Schutz & Lipscomb, 2007).

Vines and colleagues (Vines, Krumhansl, Wanderley, & Levitin, 2006) proposed the emergence of features from the interaction of auditory and visual sensory modalities in contemporary clarinet performance. A piece of 20th Century clarinet repertoire was executed by two performers in public performance manner. In a between-subjects multi-modal design, participants’ judgements of perceived tension (an affective index) and phrasing (an indicator of musical structure) were continuously recorded throughout the presentation of performances. Results demonstrated an interaction between auditory and visual sensory modalities that either enhanced or diminished communication of affective or structural content. Specifically, while sound dominated observers’ perceptual experience of tension, participants’ judgements of tension at significant points in the performances were either enhanced or diminished by the visual component in the audio-visual mode. While auditory and visual modes conveyed similar information with regard to phrasing, in the audio-visual condition the performers’ gesturing served to increase participants’ sense of phrasing. Visual information indicated the onset of phrases to the observer as well as extending the sense of phrase length into silence. Findings illustrated how the performer’s movements could highlight and guide the observer through their interpretation of affective and structural content.
Camurri and colleagues (2004) have used the domains of music and dance as test-beds for studying the affective influence of expressive gesture on spectators in the development of multimedia systems. They conducted a multimodal experiment investigating auditory and visual gestural cues responsible for communicating the intensity of a performer’s affective expressive intentions in music performances. Additionally, a model was developed for comparing performer’s intentions with spectator’s responses of performances of the same music. Auditory cues consisted of inter-onset-intervals and key-velocity measurements. Visual cues involved velocity and acceleration measurements of the performer’s head movements. A professional concert pianist performed a piece of 20th Century repertoire three times in two performance manners. The first performance was a normal, public manner with no audience. The second performance was given in an exaggerated manner, again with no audience. Finally, a performance was given in a public manner with an audience. These were presented to participants in an audio-visual format in random order. Over two presentations, participants were first asked to indicate phrase boundaries (by pressing a button), then on the second presentation indicate the level to which they were engaged with the music. A MIDI slider was used by participants to indicate the intensity of emotion they each perceived. Analysis of the MIDI files indicated highly similar acoustic timing and dynamic features across all three performances. Comparison of auditory and visual performance data, and response data showed that the auditory features of tempo indicated phrase boundaries, and dynamics indicated intensity of perceived emotion. The visual performance data consisted only of head movements. The velocity of these movements was correlated with dynamics so they were possibly contributing to perceived emotional intensity. The authors concluded
that participants made their assessments primarily on auditory information with visual information playing only a minor role (Camurri et al., 2004).

The focus of the present investigation is to discover whether bodily gestures accompanying expressive musical sound affects observers’ global judgements of perceived expressivity and their interest or attention to marimba performance in two conditions – auditory only and audio-visual. While the study of affective or structural communication is not the focus of this investigation, the findings of Vines and colleagues (2006) provide evidence that a multi-modal presentation has advantages for both the performer and observer. The findings of Camurri and colleagues (2004) are seemingly at odds. However, their study is constrained by the existence of no comparative audio-only condition.

McClaren (1988) examined the effects of performers’ visual attributes (body movements) on listeners’ perceived quality assessment of a performance of a 20th Century solo marimba piece. A panel of six experienced listeners rated the visual and aural attributes of performances on two seven-point bipolar scales. Three negatively and three positively rated performances were selected and presented in audio-visual and audio only conditions, in random order, to thirty-seven non-music college students. Participants rated these six performances on seven-point bipolar rating scales: sensitive-insensitive, effective-ineffective, good-bad, and positive-negative. Results revealed that, a ‘positive’ visual display coupled with a high quality aural component, enhanced judgements of the marimba performance as being of a better quality. ‘Negative’ performances did not receive significantly different ratings in audio-only and audio-visual conditions. McClaren (1988) concluded that the basis of
a good musical performance is the high quality of the aural performance, with positive visual attributes enhancing the audience perception of it as a better performance.

McClaren’s (1988) findings both fulfil, and contest the expectations with regard to multi-modal perception of marimba performance. Given the acoustic limitations of the marimba (to be discussed in Section 3.5.1), it is expected that ‘positive’ visual attributes would enhance the aural component of a performance. With these same acoustic limitations in mind it would also be expected that ‘negative’ visuals would likewise diminish perception of the aural component. The experiment reported in Chapter 4 investigates this hypothesis. There are several possible factors that could have influenced results which the present study aims to address by way of more stringent control of variables.

Only one piece of 20th Century marimba repertoire, as performed by university students, was used as the stimulus material in McClaren’s (1988) study. The manner in which the marimba players performed the piece was not directly manipulated. Experienced evaluators judged performances to be ‘positive’ or ‘negative’ after the recording process. The evaluators were not given specific definitions as to what a constituted a ‘positive’ or ‘negative’ performance. Raters viewed recordings showing the whole body of the performers, including faces and therefore, facial expression. Facial expression has been demonstrated to be an effective communicator of emotion (Buck, Savin, Miller, & Caul, 1972; Ekman, 1999). In Experiment 1 in the present study, a range of 20th Century repertoire were recorded that differed in style, tempi and level of difficulty. Performances were given by one male and one female professional musician. The manner in which the marimba players performed the
selected repertoire was directly manipulated for systematic investigation of responses. The performers’ faces were digitally masked to control for the possible influence that facial expression could exert on results.

In a study investigating the effect of performer attractiveness on performance assessments, higher ratings were given to performances by attractive male singers, in comparison to less-attractive male singers, when the presentation was audio-visual compared to audio-only (Wapnick, Darrow, Kovacs, & Dalrymple, 1997). Attractive female singers received higher ratings in both audio-visual and audio-only conditions as compared to less-attractive singers, though this result could be attributed to sampling error (Wapnick et al., 1997). The components of attractiveness - dress, behaviour and physical characteristics - were not explicitly differentiated in this study (Wapnick et al., 1997). In a subsequent study, violinists who received high ratings for dress and stage behaviour were given higher ratings for audio-visual performances, in comparison to their audio-only performances (Wapnick, Kovacs Mazza, & Darrow, 1998). There was no difference in ratings between audio-only and audio-visual presentations for violinists who received low ratings for dress and stage behaviour (Wapnick et al., 1998). Overall, more-attractive violinists received higher ratings than less-attractive violinists for musical performance expressive qualities (Wapnick et al., 1998). In Experiment 1 here, the digital masking of faces acted as a control measure for performer attractiveness as well as facial expression. As a further control measure, the performers in Experiment 1 both dressed in black pants and a black short-sleeved t-shirt, and were of a similar slim build.
The focus of Experiment 1 was to investigate the impact bodily gesture accompanying musically expressive sound had on perceived expressivity in audio-only and audio-visual conditions. In addition to perceived expressivity as a quality assessment, we investigated whether visual movement led to a peak in observers’ global interest in performances in audio-only and audio-visual conditions. Multimodal perception may play an important role in the perception of contemporary Western classical acoustic solo marimba performance due to the construction and resultant capabilities for acoustical expression.

3.5 Marimba Performance and Pedagogy

3.5.1 Expressive Capabilities of the Marimba

The contemporary Western concert marimba consists of wooden bars, set out and tuned similarly to that of a piano keyboard. Each bar is suspended over an individual aluminium resonator. This version of the marimba most often covers a five-octave range and is usually played with one-two mallets in each hand. (A history of the marimba, including a history of performance style and technique, can be found in Appendix A)

The marimba is an inherently staccato instrument where once a bar is struck the resultant sound decays at a rapid rate (Fletcher & Rossing, 1998; Rossing, Yoo, & Morrison, 2004) the decay rate is dependent on the register of the note being played. Lower notes resonate longer than higher notes. While the marimba player can not lengthen the duration of a note once it is struck, pressing the mallet head into the bar as it strikes the bar can shorten the duration of the sound (Dahl & Friberg, 2007). This is known as a deadstroke. Mallets made of different materials enable different
timbral qualities, as does striking the bars at different points (Fletcher & Rossing, 1998; Rossing, 1976). However, instigating such timbral changes is limited by technical constraints of performance. Whereas other instrumentalists are able to perform different articulations and perform notes of many differing durations, the percussionist is reliant on changes in dynamics and the timing between notes as a means of acoustically expressive performance (Dahl, 2000; Dahl & Friberg, 2007).

As the movements necessary for sound production in marimba playing are highly visible to the observer (Dahl & Friberg, 2007) marimba performance is a valuable vehicle for the study of bodily gesture in expressive musical performance.

3.5.2 Pedagogical Approaches to Marimba Performance

Currently, there are two main published pedagogical approaches to marimba performance. Stevens (1990/1993) advocates a maximum level of efficiency approach to movement around the instrument. This approach was developed from the belief that different gestures do not produce different sounds on the marimba. This notion was supported by Schutz and Lipscomb (2007) who found that longer gestures did not equate to longer sounding notes, however, perceptual judgements of differences in note duration was influenced by the presence of visual information.

Zeltsman (2003) takes the stance that differences in gesture do result in differences in sound on the marimba. For example, she advocates the performer paying attention to articulatory marking in the score and utilising different stroke types or gestures to realise these in sound. While acoustically this may not be the case, these gestures would probably have a perceptual impact on the observer. They may also be a means for the performer to organise movement to reflect the structure and character of the score.
3.6 Multimodal Perception of Expressive Intention and its Measurement in Music Performance

In contemporary Western classical art music, the performer is usually working from a notated compositional score. The score is the means by which composers record their musical thinking. The composer is reliant on the performer to convey the full meaning of the score (Hill, 2002). Using their skill and knowledge in interpreting the notation, the performer intentionally transforms the markings on the page into bodily movements resulting in expressive sound and vision that, in turn, are perceptible by the audience. Therefore, the body plays an important role, not only in the physicalities of playing the instrument, but also in communicating expressive intention to an audience (Clarke, 2002b).

Davidson (1993) showed the important role visual information played in conveying expressivity in music performance manner. In this study, Davidson conducted two experiments investigating the perceptual information contained in the body movements of violin and piano performers. Four final-year undergraduate violinists performed excerpts from four different pieces from the Baroque, Classical and Romantic violin repertoire. The student pianist performed a selection from a piece by Mussorgsky. Video recordings were made of performances by each musician in three differing performance manners: deadpan (with minimal expressive interpretation of the music), projected (consistent with public performance) and exaggerated (overstating all aspects of the expressive features) that were actually performable. She stated that the deadpan and exaggerated manners were typically used in teaching, while the projected manner was used in public performance. These recordings were made using point-light technique (Johansson, 1973). Fifty-five music students, who
served as observers, were presented with excerpts, between thirty and seventy seconds in duration, in three modes: sound only, sound and vision and vision only. Findings indicated that there was agreement between performer intention and audience detection of performance manner in all three conditions. Davidson concluded that vision alone seemed to provide more information as to expressive intention. It is unknown whether there was an effect of training on the results as only music students performed ratings. As the stimulus material consisted of different pieces of repertoire performed by different performers, it is not known whether this could have exerted an effect on results.

In an unpublished empirical follow-up study, Davidson (1995) used the stimuli and experimental design from her 1993 study to examine perceptual responses between musicians and non-musicians. Though sample size was small (ten musicians and non-musicians), previous results for the musicians group were confirmed. Non-musicians’ performance indicated that vision may be the most reliable means for discrimination between performance manners for this group.

Experiment 1, reported in the following chapter, made use of the definitions of performance manner stated by Davidson (1993): deadpan (with minimal expressive interpretation of the music), projected (consistent with public performance), and exaggerated (where all aspects of the expressive features are overstated). Deadpan and exaggerated performance manners are performable expressive states and are directions commonly given to students by teachers in order to focus the student’s attention on technical issues, or in achieving a greater range of expressive features respectively. To perform in a projected manner is to perform with a level of
expression midway between the extremes of deadpan and exaggerated. Therefore, due to their extensive training, professional musicians are aware of these levels of expression and are able to replicate them without expressed direction as to movements or gestures. In addition, without movements being dictated, performers are free to move in their individual style.

Although the performers were aware of the deadpan, projected, and exaggerated performance manners and their relative definitions for reference purposes, they were directed to perform the excerpts of marimba repertoire only in deadpan and projected performance manners. The exaggerated performance manner, where the performer would overstate all aspects of the expressive features, was omitted due to experimental time constraints, and the interference it caused the performers being able to perform with satisfactory comfort and accuracy with striking the bars. Playing the marimba requires finely tuned kinaesthetic memory. As the marimbist is not in tactile contact with their instrument, a certain level of stability is necessary in their movements in order to strike the correct notes. Since the movements necessary to play the instrument occur externally to the body and involve gross as well as fine motor coordination of the whole body, the marimbist is relatively constrained in the expressive movements they can make and exaggerated movements interfered with their ability to perform the repertoire satisfactorily. Practically speaking, it is a far easier task to inhibit expressive movement than it is to exaggerate it in marimba performance without compromising the integrity of the performance. In real terms, musical performances are attended to through only listening, or seeing and listening. For reasons of ecological validity, the vision only condition was omitted in the present study.
Experiment 1 set the work of Davidson (1993) as a foundation and extended the experimental paradigm to investigate whether different results would be yielded due to the unique characteristics of acoustic marimba performance than results obtained for the violinists and pianist study. Of particular interest would be results relating to deadpan performances between audio-only and audio-visual modes. Davidson (1993) observed a significant difference between audio-only and audio-visual deadpan performances for the study involving violinists. No such significant result was obtained for deadpan performances between audio-only and audio-visual performances for the pianist. Due to the limited sonic expressive capabilities of the marimba, audio-visual presentations of deadpan marimba performances would result in diminished judgments as compared to audio-only presentations. In Experiment 1, more control is exerted over possible extraneous or confounding variables. The stimulus material was comprised of a variety of repertoire selected by the experimenters, rather than left up to the personal choice of the performers, in order to control for possible confounding variables such as tempo, style and level of difficulty. The repertoire was performed by a male and a female professional marimba player with many years of performing experience rather than student musicians. The two-gendered approach to the creation of the stimulus was taken to control for possible gender bias (Davidson & Edgar, 2003; Elliot, 1995/1996) that was not addressed in Davidson’s (1993) study. A further development was to include an additional dependent variable, ‘interest’.
3.7 Attention and Interest

Attentional shifts toward stimuli can either occur voluntarily or involuntarily (Franconeri & Simons, 2003; Pashler, 1998; Scharf, 1998). A music performance is traditionally presented as an aural event where attendees will be actively listening rather than passively hearing. By actively listening, the observer is voluntarily attending to the aural stimuli (Scharf, 1998). Some studies have shown that musical or linguistic knowledge gives rise to expectancies on the part of the listener which could guide their attention (Scharf, 1998). “In listening to music, the listener seeks an equilibrium: There must be a proportion of novelty within a background of predictability” (Aiello, 1994, p. 57).

Selective attention is thought to be essential in perception (Wickens et al., 2004). Wickens and colleagues (2004) identify four important features of selective attention: 1) salience (eg. attentional capture - stimuli such as a car horn), 2) effort (selective attention must not be overly taxing), 3) expectancy (information is organised in a familiar manner) and, 4) value (modification of attention according to the value to the observer). It has also been suggested that emotionally charged stimuli can cause an involuntarily shift of attention (Pashler, 1998). The well-documented emotional Stroop effect is believed to illustrate this phenomenon. This is evident when participants are requested to say the colour of ink in which a word is written, as fast as possible and responses times are slower for emotional words (Pashler, 1998). Another observation that illustrates this effect is the involuntarily shift of attention people experience toward emotional stimuli in conversations that they think they are disregarding (Pashler, 1998).
Attention can be guided by a moving stimulus when predictive of a target location, whereas a moving stimulus that is unrelated to a target location does not capture attention (Hillstrom & Yantis, 1994). In a music performance context, bodily gesture integrated with expressive sound production may guide audience attention. Comparatively, bodily gesture created in a ‘showmanship’ style and not integrated with expressive musical sound production may not guide attention in the same manner. Attention is captured by dynamic events including novel or unexpected stimuli and motion that involves sudden or looming movement (Franconeri & Simons, 2003). Habituation occurs when a pleasant stimulus is repeated sufficiently for the response to diminish (Berlyne, 1970). In lay terms this translates as boredom. Novelty, attention and exploration of features have been found to contribute to instant enjoyment and situational interest in an activity (Chen, Darst, & Pangrazi, 2001). According to Hidi and Anderson’s definition, situational interest is, “…the appealing effect of an activity…on an individual, rather than the individual’s personal preference for the activity” (1992 cited Chen et al., 2001, p. 384).

Factors aside from the sound, such as the influence of visual stimuli provided by the musician’s bodily movement and gesture, may provide a means of performer connecting with audience, and maintaining the audience member’s attention and interest in the performance. These findings from the psychological literature provide useful information to performers regarding guiding and maintaining their audience’s attention throughout performance. By presenting multimodal information, performers have increased opportunities for engaging audience attention.
3.8 Audience Expertise

Typically, concert audience members are active listeners, engaged in the performance. Audience members bring their musical knowledge and experience to the task of listening, be it extensive or minimal. It has been suggested that experienced listeners may be more used to judging between levels of performance and particular musical styles than their non-experienced counterparts (Clarke, 2002a).

Gromko (1993) found novice listeners perceived performances of music from the Classical and Romantic periods differently in comparison to musically trained listeners. Whereas novice listeners were more reliant on aspects such as musical character and implicit sensation, musically trained listeners could draw on their knowledge of musical style and structure (Gromko, 1993). Musical training may therefore exert an effect on the perception of the performance of contemporary, classical art music due to explicit experience with and knowledge of the genre.

Reviewing the capacities for processing Western music by musicians and non-musicians, Bigand and Poulin-Charronnat (2006) claimed that findings highlighted a human capacity for perceiving and processing music that was not dependent on explicit musical training, but rather exposure to music. The reviewed studies made use of both tonal and atonal Western music idioms as stimulus materials and found that both groups performed similarly across cognitive and affective listening tasks (Bigand & Poulin-Charronnat, 2006). This set of studies largely focused on judgements relating to structural elements of music.
In the earlier studies reviewed, either musically trained (Davidson, 1993; Vines et al., 2006) or non-musically trained (McClaren, 1988) participants performed the final rating tasks, so the significance of a main effect of musical training is not known. According to Vines and colleagues (2006), pilot testing indicated that musicians and non-musicians performed similarly on their tasks so results could be generalised to both populations. Participant numbers in each condition were quite small: ten per condition. McClaren (1988) claimed that results obtained from presenting the same tapes to a panel of professional percussionists at the 1987 Percussive Arts Society International Convention were similar to non-musicians.

There are arguments both in support of, as well as refuting the concept that musical training bears an effect on humans’ judgements of musical performance. It would therefore be of interest to further investigate the issue of musical training to discover whether it has an effect on observers’ judgements pertaining to the perceived expressive quality of, or interest in marimba performance. Due to the aforementioned limited expressive capabilities of the marimba, it is anticipated that detection of variation in musical expression is largely reliant on participants being able to see and hear the marimba player as compared to listening-only for both musically trained and non-musically trained groups. In Experiment 1, musical training was considered as an independent variable. It was expected that musically trained observers would be more confident with the task due to experience in assessing musical performances and familiarity with the Western contemporary classical art music genre, and this would be reflected in their ratings. In Experiment 2, musical training was controlled rather than treated as an independent variable.
In a study assessing audio-only presentations of solo classical piano performance, rating consistency was shown to differ between piano specialists and other musically-trained participants (Wapnick, Ryan, Campbell, Deek, & Lemire, 2005). Whereas graduate piano majors and piano faculty rated performances higher than graduate and faculty non-piano majors, undergraduate piano majors rated performances lower than undergraduate non-piano majors (Wapnick et al., 2005). Instrument specific training can affect rating behaviour assessing performance on that instrument. Therefore, persons with specific training in percussion and marimba performance were excluded from participating in the following experiments.

3.9 Summary

It has been argued that expressive solo marimba performance communicates most effectively in a live presentation which offers a multimodal experience to the audience. Bodily gesture is a key way in which the performer can communicate expressive musical intentions to an audience. Audience attention and interest in marimba performance peak when bodily gesture co-occurs with expressive musical sound occur in a projected, expressive performance. Audience perception of music performance is influenced by musical knowledge and experience. An excerpt wherein these assumptions were investigated will now be reported.
CHAPTER 4

An Investigation of the Role of Bodily Movement and Gesture in Auditory-Visual Perception of Music

Experiment 1
4.1 Preamble

This chapter presents an experiment investigating the assumption that bodily movement and gesture have the power to enhance or diminish the perception of expression and interest in solo marimba performance. The hypothesis is investigated by comparing response to audio-visual amid audio-only presentation. This experiment is especially pertinent to marimba performance given the instrument’s inherently limited expressive capabilities. Additionally, it is proposed that a much richer and more interesting experience is afforded to the audience member who can see as well as hear the marimba player. With music in today’s society being accessed today primarily through auditory means (Thompson et al., 2005), it is anticipated that the results of this experiment will encourage advocacy of live music as a more meaningful experience.

The broad theoretical basis for this experiment is the notion that marimba players’ bodily gestures may accompany and co-express with musical sound in performance in a manner similar to gesture accompanying and co-expressing with speech. Though theories of speech and gesture integration or interaction are not directly tested, the proposal that sonic and visual channels work together in expressing thought provides inspiration for the possibility of a similar situation occurring in music performance. The perceptual effect of such a situation - that the visual channel enhances or enriches the experience of the auditory channel in expressive performance - is under scrutiny here. Literature demonstrating the influential effect that visual information can have on the perception of musical information in multimodal presentations drives the formation of specific hypotheses.
Expressive solo marimba performances featuring bodily gesture are assumed to be perceptible by observers and termed projected performances. Deadpan solo marimba performances, where all expressive features are minimised, are likewise assumed to be perceived by observers and affect judgments of interest and expressivity. The effect of musical expertise on judgements will also be investigated. The specific aim and hypotheses of this experiment, and the experiment itself will now be detailed.

4.2 Aim, Design and Hypotheses

The aim was to test the assumption that bodily movement and gesture play a role in communicating musical expression to an audience in Western contemporary classical acoustic solo marimba performance. The experimental design consisted of three independent variables: level of expertise of the observer (musically-trained or musically-untrained), modality (audio-only or audio-visual) and performance manner (projected or deadpan). The latter two variables were within-subject variables. The dependent variables were ratings of expressiveness and interest.

It was hypothesised that participants assign higher ratings to pieces performed in a projected manner than those performed in a deadpan manner; that an interaction occurs between modality and performance manner (specifically, that participants assign higher ratings to pieces performed in a projected manner, and lower ratings to pieces performed in a deadpan manner, when presented audio-visually in comparison to an audio-only condition); and that musically-trained participants, relative to participants without musical training, assign generally higher ratings to pieces.
4.3 Method

4.3.1 Participants
A total of 48 participants took part in the experiment (17 males, mean age 24.94 years, \(SD\) 7.09; 31 females, mean age 23.06 years, \(SD\) 9.38). The sample was divided into two equal groups of 24 (musically-trained and musically-untrained), based on information about each participant’s musical experience gathered via questionnaire. Musically-trained participants were those who had completed at least six years of formal training in music and were currently active as a performing, teaching or composing musician (17.29 mean years training, \(SD\) 11.2). Participants with training in percussion or marimba playing were precluded from participating in the experiment. Musically-untrained participants had undertaken less than two years of formal music training (0.7 mean years training, \(SD\) 0.83). Participants were recruited through a convenience strategy from universities in Sydney, the National Music Camp for students in Canberra, and music teachers from schools in Canberra. Psychology students from the University of Western Sydney received course credit for their participation. It was stipulated that participants must have normal or corrected-to-normal vision and normal hearing for inclusion in the study.

4.3.2 Stimuli
Two professional percussionists, dressed in black, performed a fast tempo and a slow tempo excerpt from four pieces of 20th Century marimba repertoire by four different composers. The repertoire that was selected for use ranged in level of difficulty from intermediate to advanced. A male and a female performer were used to record the stimulus material to distribute possible effects of gender preference that may exert an influence on participants’ judgements. Excerpts of compositions performed were
Movements II and III from *Marimba Dances* by Australian composer Ross Edwards (1990); Movements 1 and 3 from *Suite No.2 for Solo Marimba* by Japanese composer and marimbist Takayoshi Yoshioka (1995); *Nancy* by Emanuel Séjourné (1989) from France and *Merlin* by Andrew Thomas (1985) of the United States of America. The performers played these excerpts in two different performance manners – projected, as in public performance, and deadpan (without projection as in public performance). Excerpts were recorded in an audio-visual format. The microphone was situated next to the camera which was placed directly in front of the performer, taking into view the length of the marimba and the full height of the performer.

The audio-visual recordings were edited to make a total of 96, 20-25 second selections (clips) that included complete musical phrases. The length of excerpt was controlled as overall judgements of advanced level piano performances on technical and artistic measures have been found to be higher and more consistent for 60 second excerpts than assessments made of 20 second excerpts (Wapnick et al., 2005). However, the relationship between rating consistency and excerpt length requires further investigation (Wapnick et al., 2005). Additionally, the rating tasks reported by Wapnick and colleagues were only performed by trained musicians with varying degrees of experience. 20-25 second excerpts seemed an appropriate length in order to sufficiently control and manipulate variables as well as include intact musical phrases in the stimulus material and fit within the experimental time constraints. The audio-visual computer files (.avi) were converted into .wav files. Group normalisation was performed on the .wav files in order to equalise the volume between performers playing the same excerpt. This also ensured that there were comparable dynamics between projected and deadpan performances. Each normalised .wav file was then
relinked to its matching video file. In order to control possible confounds such as facial expression, an opaque, rectangular box was created using the plain off-white-coloured background and laid across the area where the head moved in each clip. This disguised the face of the performer without interfering with the observer’s ability to view the whole body of the performer, including the performer’s head.

The 96 audio-visual clips were divided into six sets of 16 clips, balanced in terms of gender of performer and performance manner. Each set contained selections from the fast and slow excerpts of all pieces performed. No set of clips contained performances of the same 20-25 second clip either by the same performer in both performance manners, or by both performers. Individual clips were only included once within each set.

Within the six audio-visual sets constructed, each of the 16 clips was presented twice. Title frames of two seconds in duration were inserted into the timeline to mark the first and second presentation of each clip. Following the second presentation of a clip, a title frame was inserted that contained the instructions to the participant that they had 15 seconds to record their response before the next clip would begin. An interval of one and a half seconds was left between clips and titles on the timeline.

Once completed, each of the six sets was individually imported into the Master Timeline window and the auto-colour correction effect was applied from the effects window, to eliminate noticeable changes in lighting that had occurred during the recording phase of the stimulus preparation. An audio-only version of each set of clips was created by removing the video footage of performances from the audio-
visual version, but leaving the sound and titles intact. Participants saw a black screen when the audio-only stimulus was presented. From the Master Timeline window, each of the six audio-only and audio-visual sets was exported as an .avi file. Each set of clips was 20 minutes in duration. The six sets of stimulus material used in Experiment 1 are included on DVD as Appendix B.

4.3.3 Equipment

Excerpts were performed on a Malletech Stiletto marimba using Encore Nancy Zeltsman series mallets and Mike Balter mallets. Recordings were made on a Panasonic digital video camera (NV-MX300EN/A) with an external RØDE NT4 stereo condenser microphone providing sound through a Behringer mixing desk. Video editing was performed using Adobe Premier Pro 1.5. The audio-visual computer files (.avi) were converted into .wav files using River Past Audio Converter 6.5. Group normalisation was performed on the .wav files using Adobe Audition 2.0. The stimuli were presented to participants via Windows Media Player on an LG LS70 Express laptop computer from a Maxtor One Touch II 200GB portable external hard-drive. Audio was provided through Koss (UR20) headphones.

4.3.4 Procedure

Participants were presented with an information sheet outlining the study and written consent was gained prior to testing. A copy of the information sheet and consent form is included in Appendix C. The testing procedure was conducted on an individual basis in a quiet room. Participants were presented with one of the six sets of audio-only clips and a different set of clips selected from the six audio-visual sets. No participant received the same set of excerpts in the audio-only and audio-visual
conditions. The order of presentation of audio-only and audio-visual sets was counterbalanced in both the musically-trained and musically-untrained groups. All order permutations of audio-only and audio-visual sets received ratings from two different participants in both the musically-trained and musically-untrained groups of participants. Every excerpt set in both the audio-only and audio-visual conditions was presented in the first and second position twice.

Each audio-only or audio-visual clip contained within a set of excerpts was presented twice. After the second viewing, participants were requested to record their responses of expressiveness (how expressive they deemed the clip to be), and interest (indicating their level of interest in the clip). Responses to expressiveness and interest were recorded by circling a number on two separate seven-point Likert scales (very inexpressive–very expressive; very uninterested–very interested) (see Figures 4.1 & 4.2) that best fitted their judgement. Participants were instructed that their ratings of expressiveness and interest may or may not be related to one another; similar or dissimilar responses to excerpts on the two scales were equally valid. In the audio-only condition, participants recorded their judgements based solely on the auditory information. In the audio-visual condition, participants recorded their responses based on the auditory and the visual presentation. Participants were given a one minute break between the presentation of audio-only and audio-visual sets. Each set was 20 minutes in duration. Upon completion of the testing procedure, information relating to each participant’s concert attendance habits and personal musical taste was gathered via questionnaire. The questionnaire also contained questions relating to personal taste for the sound of the marimba. The experiment took 50 minutes to complete.
Very             Quite          Somewhat      Neutral       Somewhat       Quite            Very
inexpressive inexpressive inexpressive (neither expressive expressive expressive
expressive
nor inexpressive)

Figure 4.1. An example of the ‘expressiveness’ dependent measure seven-point Likert scale.

uninterested uninterested uninterested (neither interested interested interested
interested
nor uninterested)

Figure 4.2. An example of the ‘interest’ dependent measure seven-point Likert scale.

4.4 Results

Data consisted of expressiveness and interest ratings and responses to questions regarding concert attendance habits and the marimba. Expressiveness and interest data were screened for outliers and to test whether data met the assumptions of normality. Two suspected outliers were observed: One in the expressiveness, deadpan performance manner, audio-visual condition, and the other in the interest, projected performance manner, audio-visual condition. The suspected outliers were dealt with by converting the raw scores to z-scores. The suspected expressiveness, deadpan performance manner, audio-visual outlier had a z-score of -2.63. The
suspected interest, projected performance manner, audio-visual outlier had a z-score of -2.20. Both of these z-scores were smaller than 3.29, which is the cut-off recommended by Tabachnick and Fidell (2001), therefore no further action was necessary. The data met the assumptions of normality with one exception. On the interest-dependent variable, responses from the musically-trained group to audio-visual projected performance manner presentations returned a significant result for the Kolmogorov-Smirnov test of normality \((p = 0.014)\). For this same group and data set the Shapiro-Wilk test of normality was not significant \((p = 0.089)\). It was assumed that this minor violation of the assumptions of normality would not affect a robust statistical procedure such as the Analysis of Variance, especially dealing with relatively large sample sizes as reported here (Hills, 2003).

Expressiveness and interest ratings were analysed separately using two, three-way analyses of variance followed by planned comparisons. Results of analyses of expressiveness and interest ratings are reported separately. Following these analyses questionnaire data from musically-trained and untrained groups are described.

### 4.4.1 Expressiveness Ratings

The first hypothesis stated that participants assign higher expressiveness ratings to pieces performed in a projected manner than those performed in a deadpan manner. A significant main effect was observed, \(F(1,46) = 60.734, p<0.001\), in support of the hypothesis with mean expressiveness ratings recorded for performances of 5.4 \((SD = 0.81)\) in the projected manner and 4.77 \((SD = 0.93)\) in the deadpan manner.
It was hypothesized that an interaction would occur between modality and performance manner. Specifically, it was anticipated that participants would assign higher expressiveness ratings to pieces performed in a projected manner, and lower ratings to pieces performed in a deadpan manner presented in the audio-visual condition in comparison to the audio-only condition. A significant interaction was observed between modality and performance manner (see Figure 4.3). Investigation by way of planned comparisons revealed a significant difference in mean expressiveness ratings as hypothesised between audio-visual ($M = 5.63$, $SD = 0.79$) and audio-only ($M = 5.16$, $SD = 0.78$) conditions for performances in a projected manner $F(1,46) = 20.486$, $p<0.001$, as well as between audio-visual ($M = 4.56$, $SD = 0.98$) and audio-only ($M = 4.98$, $SD = 0.83$) conditions for deadpan performances $F(1,46) = 14.295$, $p<0.001$.

The final hypothesis stated that participants with musical training would assign higher expressiveness ratings to pieces relative to participants without musical training. This effect was observed $F(1,46) = 7.203$, $p<0.05$, with mean expressiveness ratings recorded by trained participants of 5.34 ($SD = 0.89$) compared with 4.82 ($SD = 0.89$) recorded by untrained participants.
4.4.2 Interest Ratings

The first hypothesis stated that participants would assign higher interest ratings to pieces performed in a projected manner than those performed in a deadpan manner. The anticipated main effect was observed, $F(1,46) = 25.102, p<0.001$, in support of the hypothesis with mean interest ratings recorded for performances being 5.09 ($SD = 0.87$) in the projected manner and 4.76 ($SD = 0.86$) in the deadpan manner.

It was hypothesized that an interaction would occur between modality and performance manner. It was anticipated that participants would assign higher interest ratings to pieces performed in a projected performance manner, and lower ratings to pieces performed in a deadpan manner presented in the audio-visual condition in comparison to the audio-only condition. A significant interaction was observed between modality and performance manner (see Figure 4.4). A significant difference in mean interest ratings was observed between audio-visual ($M = 5.29, SD = 0.89$) and

![Figure 4.3. Mean expressiveness ratings: Modality by performance manner interaction. Error bars refer to standard error of the mean.](image-url)
audio-only ($M = 4.88$, $SD = 0.81$) conditions for projected performances $F(1,46) = 24.183, p<0.001$, but no significant difference in mean interest ratings between audio-only and audio-visual conditions was observed in the deadpan performance manner condition $F(1,46) = 1.2, p=0.28$.

The final hypothesis predicted that participants with musical training assign higher interest ratings to pieces relative to participants without musical training. This effect was observed $F(1,46) = 7.442, p<0.01$, with the mean interest ratings recorded by trained participants being 5.21 ($SD = 0.85$) compared with a mean of 4.64 ($SD = 0.81$) recorded by untrained participants.

![Figure 4.4. Mean interest ratings: Modality by performance manner interaction. Error bars refer to standard error of the mean.](image-url)
4.4.3 Musically-Trained and Untrained Participants’ Concert Attendance Habits and Responses to Questions Regarding the Marimba

Questionnaire data gathered from participants revealed that musically-trained participants attended more concerts than musically-untrained participants (musically-trained 100%, musically-untrained 58%). On average, musically-trained participants \( (M = 9.96, SD = 13.03) \) attended more concerts in a six month period than their musically-untrained counterparts \( (M = 0.79, SD = 1.32) \). Whereas musically-trained participants had heard of the marimba (95.83%) and had prior exposure to the sound of the instrument (100%), only a small number of musically-untrained participants had heard of the marimba (16.67%) or had heard the sound of the marimba (20.83%) prior to taking part in the study. All of the musically-trained participants (100%) and most of the musically-untrained participants (91.67%) expressed a liking for the sound of the marimba.

4.5 Discussion

Higher ratings of both expressiveness and interest were recorded by observers for pieces performed in a projected manner compared with those pieces performed in a deadpan manner in support of the first hypothesis. It was demonstrated empirically that observers of Western contemporary classical acoustic solo marimba performance are sensitive to changes in expressive intention across audio-only and audio-visual conditions (Davidson, 1993). Also highlighted was body movement functioning not only as instrumental technique, but also as means to communicate expressivity through sound and vision (Clarke, 2002ab; Davidson & Correia, 2002). When performing in a deadpan manner, the prevailing remaining body movements were those necessary to play the required notes. The results suggest that observers could
differentiate between this baseline of functional movement and performances that involved expressive movement.

The predicted interaction between modality and performance manner was supported by significant results for both dependent variables. A significant difference was observed between audio-only and audio-visual modes for projected and deadpan performances on the expressiveness dependent variable. This interaction was only observed for the projected performances on the interest dependent variable. These findings support the assumption that there are perceptual advantages to experiencing a marimba performance through complementary multiple sensory modalities. For a performer, presenting marimba performance in a projected manner through auditory and visual channels offers enhanced opportunities to engage and communicate with an audience.

The observed interaction between modality and performance manner demonstrated that observers could most effectively detect differences in musical expression in marimba performance when the presentation was audio-visual. Significantly different judgements between audio-only and audio-visual presentations of both projected and deadpan performances indicated that visual information, provided by way of expressive body movement, influenced perception of the aural component of marimba performances (Schutz & Lipscomb, 2007; Vines, Krumhansl, Wanderley, & Levitin, 2006). In particular, expressive movement provided cues to an audience as to a musically expressive marimba performance (Davidson, 1993; McLaren, 1988). Results both support but also challenge findings from earlier studies. The significant difference between audio-only and audio-visual modes observed for deadpan violin
performances reported by Davidson (1993) is supported by results from the present study. However, Davidson observed no significant difference between audio-only and audio-visual conditions for the pianist’s deadpan performance. Similarly, and contrary to the results of the present study, McClaren (1988) observed no significant difference between audio-only and audio-visual conditions for ‘negative’ performances. McClaren’s results could be a result of the individual skills of the performers involved in the study. The present findings highlight the capacity for the marimba player to manipulate observers’ aesthetic experience through their use of expressive body movement and multi-modal perception.

Regarding the interest dependent variable, a significant difference between audio-only and audio-visual conditions was only observed for the projected performances. It appears that a richer, more interesting experience is offered to the observer by being able to both see and hear a marimba player perform than simply to hear only. However, this effect is dependent on the performance being in a projected, expressive manner. Bodily gesture integrated with expressive sound production appears to guide audience attention (Hillstrom & Yantis, 1994). An audio-visual presentation of marimba performance is no more interesting for the observer than an audio-only presentation if the visuals are somewhat static. This provides support for the concept that novelty and variety in dynamic visual information command audience attention (Franconeri & Simons, 2003), and contributes to observers’ interest in marimba performance (Chen, Darst, & Pangrazi, 2001).

As visual perception of movement can arouse and maintain attention and interest on the part of the audience, it would be to the performers’ advantage to consider how
they move when preparing for public performance. In particular, performers may bear in mind the importance of movement that is congruent with the inherent expressiveness in the musical score, as seemed to occur in the projected manner in this study.

Musically-trained participants assigned higher ratings, regardless of modality of presentation to pieces relative to participants without musical training, supporting the final hypothesis. The significant effect of musical training observed in the present study that was not found in the literature reviewed (McClaren, 1988; Schutz & Lipscomb, 2007; Vines et al., 2006) could reflect the demands of the task. Results may suggest that musically-trained participants are more experienced with the task of appraising classical music performances and more familiar with, or sensitive to, the 20th Century contemporary classical music genre than their musically-untrained counterparts (Clarke, 2002a; Gromko, 1993). With explicit training in the task of judging musical expression in performance, and with exposure to the 20th Century classical art music genre, musically-untrained participants may perform similarly to participants with extensive, formal musical training (Bigand & Poulin-Charronnat, 2006; Clarke, 2002a; Gromko, 1993). Higher ratings assigned by musically-trained participants could also be related to personal taste for the music, prior exposure to the marimba, and familiarity with the classical music performance setting. While it was presumed that people in today’s Western society would be equally experienced with music in audio-only and audio-visual formats (Thompson et al., 2005), higher ratings assigned by musically-trained participants may be related to the frequency of their interaction with classical music as concert audience members. It would be interesting to replicate the experiment with a repertoire from other periods or genres of music, as
well as with improvised music. Replication of the study with additional male and female performers would further validate results.

While previous research provided a starting point for the present experiment (e.g., Davidson, 1993; McClaren, 1988), the design of the current study extended the research with more stringent control of variables through counterbalancing performer gender and selection of repertoire with varied tempi, musical styles and levels of difficulty, and inclusion of a new dependent measure: interest. In addition, the present experiment investigated the contribution of visual information in deliberately minimally-expressive marimba performances to observer judgments in audio-only and audio-visual conditions. This was particularly pertinent given the limited sonic expressive capabilities of the marimba, and mixed, sometimes contradictory findings, in the literature.

Although this study was conducted under laboratory conditions for reasons of experimental control, efforts were made to present stimulus material that was as ecologically valid as possible. While this experiment approximated a concert setting, it allowed the researchers to investigate and confirm current theorising with regard to the contribution that body movements and gestures make to the perception of marimba performance. The confirmation of perceptual assumptions now permits the exploration of the role of body movement in marimba playing in more ecologically valid settings.
4.6 Implications and Conclusions

There are implications for instrumental music pedagogy and performance from these results. Findings demonstrated, by way of musically rich and valid stimuli, the positive (or negative) impact a performer’s movements (or lack of movement) can exert on an audiences’ global judgments of musically expressive marimba performance. Also demonstrated was the influence expressive body movement can have on observers’ interest in marimba performance. It was assumed that the meaningful coordination of a performer’s movements and sound in particular, rather than mere variety in visual movement, guides an audience member through a music performance maintaining their attention and interest. It may be the case that the congruency of the performers’ movements with the sound reinforces communication of the musical message, as opposed to simple variety in movement. A visually and sonically expressive and congruent music performance may be the result of a performer embodying their musical interpretation in functional and expressive movement. A future experiment could explore whether movement stimuli unrelated to the performance will yield similar results to the findings of this experiment.

Future research will draw on Rudolph Laban’s theories of movement and method of movement analysis to study selected performances from this investigation (Chapters 6 & 7). The movements of the performers in items that scored most and least favourably will be analysed to identify what a performer was or was not doing that led to more positive or more negative ratings. This will ultimately lead to the development of methods for training advanced music students to enhance their expressive and communicative performance skills (Chapter 7). Future research will
build on the findings from this experiment and attempt to address the ecological limitations imposed by laboratory experimental conditions by situating a future experiment in a live concert setting (Chapter 5).

For performers of instruments whose sonic expressive capabilities are relatively restricted, such as the marimba, expressive body movement can provide an important channel of communication in effectively disseminating musical expressive intention to an audience. In marimba performance, the visual mode can serve to augment communication of aural content. In addition to enhancing communication of expressive intention, a congruent and expressive audio-visual presentation of marimba performance can lead to increased interest in the performance on the part of the audience. These findings are of relevance to those involved in the performance of music that like to play to an audience, and would like the audience to want to come back again.
CHAPTER 5

Continuous Self-Report of Engagement to Live Solo Marimba Performance

Experiment 2
5.1 Preamble

The experiment reported in this chapter builds on the results of Experiment 1 where, under controlled laboratory conditions, performance manner - projected or deadpan – was manipulated systematically. The associated bodily gesture occurring in projected performances was shown to enhance judgements of expressiveness and interest of excerpts of contemporary solo marimba performance. Likewise, the absence of bodily gesture resulted in lower ratings of expressiveness and interest in excerpts of contemporary solo marimba performance. In Experiment 1 and as hypothesised, higher ratings of expressiveness and interest were assigned to projected performances, and lower ratings were assigned to deadpan performances, when the presentation was audio-visual in comparison to audio-only. Given these findings obtained in laboratory conditions, an investigation was mounted to discover whether they would generalise to an ecologically valid setting. Additionally, it has been suggested that listening to a series of excerpts from performances may differ from the experience of listening to complete works of longer duration (Wapnick et al., 2005). Therefore, investigating generalisation of observed effects from ratings of excerpts of marimba performance presented in a laboratory controlled experiment to assessments of a piece performed in its entirety was warranted.

The majority of research that has investigated bodily movement in the perception of music performance has been conducted under laboratory conditions using pre-recorded performances (e.g. Dahl & Friberg, 2007; Davidson, 1993, 1994, 1995, 2002b; McClaren, 1988; Schutz & Lipscomb, 2007; Thompson et al., 2005; Vines et al., 2006; Wanderley, Vines, Middleton, McKay, & Hatch, 2005). Research that has been conducted in a naturalistic setting has tended to be qualitative, focussing on
affective and evaluative responses to live concert attendance (Thompson, 2006, 2007). Such research has invited audience members to answer questionnaires before a concert, or during an interval. There is a need to understand how audience members respond to a concert as the music unfolds in time presented in a more naturalistic performance environment.

5.2 Overview of Experiment 2

Experiment 2 investigated whether manipulating performance manner, or the level of expression used in performance, would impact upon auditory-visual assessments gauged throughout the performance of an entire piece of solo marimba repertoire. Performance manner was manipulated in two identical sections of the music for comparison. The first presentation of musical material was performed in a deadpan manner and the return of the same musical material later in the piece was performed in a projected manner.

In Experiment 2, musical expression was not chosen as the dimension for assessment as it was assumed the professional musician performing the stimulus material would possess a high level of skill and produce an expressive, or inexpressive, performance as required. This manipulation was demonstrated as effective in Experiment 1. Of particular interest to Experiment 2 was whether bodily gesture, resulting from the performance of musical material in a projected, manner would provide a means of connecting with and engaging audience members’ attention.
5.3 Audience Engagement

Engagement was selected as the dependent variable for Experiment 2 to reflect audience members’ attention, interest, and cognitive and behavioural responses throughout the marimba performance. As affective responses were not the focus of this experiment, a term such as preference would not be suitable as it would likely draw on participants’ sensory or emotive response (Finnäs, 2001). Emotional engagement has been used as a measurement of spectators’ emotional response to the perception of emotional intensity in expressive gesture (Camurri et al., 2004). Engagement has been used widely in educational studies as a term involving cognitive, behavioural and affective elements, and is closely related to motivation (e.g. Reeve, Jang, Carrell, Jeon, & Barch, 2004; Russell, Ainley, & Frydenberg, 2005). According to Furrer and Skinner (2003), “Engagement refers to active, goal-directed, flexible, constructive, persistent, focused interactions with the social and physical environments.” (p. 149). Thompson (2007) asserts that engagement, involving the audience member’s connection with the music and the musicians through the performers’ ability to hold their attention, is the most important component that contributes to audience enjoyment of a performance. Performer engagement in the activity of performing, possibly displayed through bodily gesture, may lead to audience engagement.

5.3.1 Measuring Audience Engagement during Live Marimba Performance

Perceptual responses to performed music are often in the form of global judgments, collected at the conclusion of a performance excerpt (e.g. Dahl & Friberg, 2007; Davidson, 1993, 1994, 1995, 2002b; McClaren, 1988; Schutz & Lipscomb, 2007).
Few investigations have sought to understand how audience members’ perceptual judgements evolve over time within the context of significant portions of musical works (Schubert, 2001; Vines et al., 2006; Wanderley et al., 2005). Though these published studies have been conducted using recordings of music performance, they pave the way for exploration of audience perceptual responses to music performed in a live concert environment. While experimentation in a concert setting introduces factors such as social interaction and ambience that can be controlled in the laboratory, it is such factors that are an integral part of the concert experience. The experience of music performed live has been shown to elicit more positive reactions, relative to recorded music presentations in educational and other such contexts (Finnäs, 2001). This suggests that music performed live provides a richer experience to the observer than recorded music in audio-only or audio-visual formats. In Experiment 2, an attempt was made to conduct a partially-controlled perceptual experiment measuring audience engagement ratings within the context of a live, music performance. Audience members self-reported engagement ratings were gathered continuously throughout performance of a solo marimba piece. This approach was taken to gain understanding of how perceptual responses unfold with the performed music over time.

**5.4 Analysing Continuous Response Data**

Using continuous measurement techniques to investigate music performance in ecologically valid settings introduces the problem of serial correlation (Schubert, 2001). Serial correlation refers to responses to music performance, at any point in the time-series, being related to what has preceded in the music, as well as participants’ preceding responses and participants’ memory. This relationship of one moment to
the next is an important facet and goes to the heart of what makes music performance time-series data special. Serially correlated data introduces problems if intending to use inferential parametric statistical procedures to analyse the data (Schubert, 2002). The analysis of continuous response data for statistical significance poses several problems (Schubert, 2007). The use of commonly used parametric analysis methods such as t-test, F-test or ANOVA is difficult as the time-series data usually violates the assumptions of normal and independent distribution. Additionally, the distributional properties of the time-series are not likely not to be known a priori. Any significant result between two random points would have to be viewed with suspicion in light of the fact that what might be assumed to be reliable signal could just as easily be noise.

One question is how do we know that there is anything of significance in continuous response data? Or how can two sections of continuous data be assessed as significantly different? The main approaches for comparing samples of continuous response data for statistical significance come from Functional Data Analysis (FDA) or Time-Series Analysis (TSA). TSA operates on an assumption of stationarity, where the mean and variance are expected to remain fairly stable, diagnosing stochastic properties in a time series (Vines, Nuzzo, & Levitin, 2005). FDA on the other hand diagnoses changing patterns, including mean and variance, both within and between curves occurring over time (Vines et al., 2005). FDA models and smooths discrete data points creating what is called a functional object, or curve representative of the original data, eliminating noise from the raw data and identifying the smooth underlying signal in the data (Levitin, Nuzzo, Vines, & Ramsay, 2007). Functional Data Analysis (FDA) has been implemented as a technique for modelling and smoothing continuous ratings of tension from music performance observations (Vines...
et al., 2005). Traditional inferential statistical methods, such as ANOVA, are being adapted so that they can be used to compare functional objects, or curves from transformed samples of continuous data (Cuevas, Febrero, & Fraiman, 2004; Levitin et al., 2007). However, these adapted methods are in their infancy and still under development (Levitin et al., 2007). FDA requires, at the very least, basic knowledge of calculus and statistics, and experience with more advanced concepts and methods to conduct more intensive investigations (Levitin et al., 2007). Specialised software is also required to carry out FDA, and programming experience is necessary at present to utilise more advanced techniques (Levitin et al., 2007). Perhaps most importantly, the questions requiring voicing before applying complex statistical procedures are: How do we know that the original signal is reliable, and are complex statistical procedures really necessary to diagnose differences between two samples?

Firstly, the question regarding signal reliability in the two samples of time-series data will be addressed. Techniques from Time-Series Analysis (TSA) will be employed to analyse observer responses in two samples of similar musical material from a single performance of a piece of solo marimba repertoire. To identify significant or reliable points of signal, the second-order standard deviation threshold method of analysis will be implemented (Schubert, 2007). Schubert (2007) summarised the disadvantages and advantages in using this method for analysing time-series data. Using post-hoc criterion as the basis for decisions of significance, a percentage of responses will be assessed as significant, and a percentage of responses will be judged as insignificant, regardless of reliability of samples. Therefore, this analytical system may be considered as a ranking of significance. The second-order standard deviation threshold is not set using any particular criteria at this point in time. Further work is
required to discover the value of different second-order standard deviation thresholds for identifying relative significance. An advantage in using this method is that assumptions required about the distribution of the data are few. In addition, the analysis requires only simple statistical calculations which can be conducted using readily available software with basic statistical operations such as Microsoft Excel meaning no need to purchase or learn to use new software. Finally, results are graphically presented and easy to visualise.

### 5.5 Aim, Design and Hypotheses

The aim of the experiment was to investigate variations in audience engagement throughout the performance of a solo marimba piece in a live concert setting. It was expected that the level of audience engagement would be related to the intended presence, or absence, of bodily gesture manipulated during performance of the piece. Projected performance manner (with a level of expression consistent with public performance) referred to the use of bodily gesture accompanying expressive musical sound. Conversely, deadpan (where all expressive features were minimised) indicated an absence of bodily gesture and comparatively inexpressive musical sound. As the dependent variable, responses measuring engagement in the performance of the solo marimba piece were gathered continuously from participants throughout performance.

It was hypothesised that higher mean ratings of engagement are recorded by observers responding to a section of music performed in a projected manner than a similar section of music performed in a deadpan manner. Significant, or reliable, signal in the projected and deadpan samples of the time-series data allow confident comparison between projected and deadpan mean engagement ratings. A large difference
between projected and deadpan sample mean engagement ratings allows us to deduce higher ratings in the projected performance section attributable to the performer’s bodily gesture.

5.6 Method

5.6.1 Participants

From a total audience numbering approximately 100, twenty-three participants took part in the experiment. The data from two participants were omitted from the experiment. One had extensive training as a percussionist. Rating consistency has been shown to differ between piano specialists and other musically-trained participants in assessing piano performances (Wapnick et al., 2005). The other participant did not perform the rating task as requested. Of the twenty-one remaining participants (12 males, mean age 32.17, SD 7.86; 9 females, mean age 31.89, SD 10.60), thirteen were musically-trained and eight were considered musically-untrained. Musically-trained participants were those who had completed at least six years of formal training in music and were currently active as a performing, teaching or composing musician (14 mean years training, SD 7.29). Musically-untrained participants had undertaken less than two years of formal music training (0 mean years training, SD 0). Participants were recruited through a convenience strategy from universities in Sydney, and replies accepting the invitation to attend the concert. It was a requirement for inclusion in the experiment that participants had self-reported normal hearing and normal or corrected vision.
5.6.2 Stimuli

The stimulus material was a contemporary, tonal, piece from the solo marimba repertoire, *Two Mexican Dances for Marimba, 2* by Gordon Stout (1977). This piece was unfamiliar to all participants. The work was performed by the researcher dressed in appropriate concert clothing consisting of black pants and a black top overlayed with black and silver lace. This piece was performed at the beginning of a 50 minute recital, *Marimba Plus…Perception and Action in Music Performance*, at the HCSNet SummerFest ’06, Sancta Sofia College, University of Sydney. The performance of the piece of stimulus material can be viewed on the DVD of the full recital included as Appendix J. Program notes about the recital and performer biographies are included as Appendix D. The concert venue was a large room used for chamber music recitals and set with rows of chairs facing the performance area providing seating for the audience and participants. There were no visual or auditory distractions for the duration of the recital.

The researcher’s performance of the second of the *Two Mexican Dances for Marimba, 2* (1977) had duration of three minutes and five seconds. Within this piece, a section of music performed at the beginning (11.5 sec) recurs towards the end in an almost identical form (12.5 sec). Figure 5.1 represents the first occurrence of the musical material and Figure 5.2 illustrates the repeat of the musical material towards the conclusion of the piece. The researcher performed the first presentation of this musical material in a deadpan manner and the recurrence of the section of music in a projected manner. Counterbalancing performance manner was not possible in this ecologically valid setting. Therefore, results would have to be viewed with the possibility of presentation order exerting some effect.
It was anticipated that the section of music to be performed in a projected manner may result in it being of a louder volume than the section of music performed in a deadpan manner. The possibility of changes in volume between projected and deadpan performances was controlled in Experiment 1 by normalising the wave files. Obviously, such a control measure would not be possible in a live concert. As such, intensity levels associated with the projected and deadpan response samples will be reported.

Figure 5.1. Two Mexican Dances for Marimba, 2 by Gordon Stout (1977), bars 1 (repeat)-7. This is the first section of musical material in which performance manner was manipulated by the performer. It was performed in a deadpan manner.
Figure 5.2. Two Mexican Dances for Marimba, 2 by Gordon Stout (1977), bars 53 (repeat)-60. The red brackets indicate the second section of musical material in which performance manner was manipulated by the performer. This section was performed in a projected manner.

5.6.3 Equipment

The second of the Two Mexican Dances for Marimba, 2 (1977) was performed on a Malletech Stiletto five-octave marimba using Malletech Stevens mallets. The mallet held in the left hand and playing the lowest notes was a Malletech Stevens LS10. The remaining three mallets making up the set of four were Malletech Stevens LS15H mallets. Participants’ continuous responses to the stimuli were collected using the portable Audience Response Facility (pARF) (Stevens et al., 2007) (See Figure 5.3). An Acer TravelMate 8000 laptop computer with a 1.8 GHz Pentium ® M processor and 1GB of memory, and running Microsoft Windows Server 2003 acted as the
server. Experiment information and participants’ responses were stored on the server. Participants responded individually via an HP iPAQ Pocket PC h5500 featuring an Intel PXA255 processor and 128MB of memory running Microsoft Pocket PC version 4.20.0. Engagement ratings were made by participants on one dimension (x-axis) by drawing on the device’s screen using a stylus. The screen measured sized 240 by 330 pixels. The bottom portion of the screen contained status information, therefore, the size of screen participants were able to draw on measured 240 by 240 pixels. Responses were sampled at a rate of two per second. The devices were connected to the server via a 802.11 WiFi network. A digital video recording of 25 frames per second was made of the live performance and the server clock using a Sony HandyCam HCR-30E.

![Image of client devices](image_url)

*Figure 5.3. The client devices of the pARF.*

A 24-bit/48kHz recording was made using a pair of matched Neumann KM140 condenser microphones using the ORTF (17cm apart and at a 110degree angel) stereo
recording technique. A Digidesign Digi 002 interface connected to a PowerBook Mac computer via FireWire, was used to record the performance with ProTools Ver. 6.9 software. The recording was done in 48kHz 24-bit file AIFF file format which was then converted to 44.1kHz.16-bit format in QuickTime 7.1.

The digital video recording (.avi file) and the audio recording (.wav file) were synchronised and edited in Adobe Premier Pro 1.5. The matching .wav file was analysed in PRAAT 4.6.01 using a script for overall intensity in the sections of the piece under investigation. Analysis of the continuous data collected via the pARF was performed in Microsoft ® Office Excel 2003.

5.6.4 Procedure

Participants arrived at the concert venue 30 minutes prior to the commencement of the concert. Upon arrival, they were presented with an information sheet outlining the study and written consent was gained prior to testing. A copy of the information sheet and consent form is included in Appendix E. Then participants partook in a fifteen minute training session in an adjacent room where they were introduced to the pARF client device. The pARF client device consisted of a palm-sized, rectangular, flat, hand-held computer. The touch-sensitive screen accounted for the majority of one of the large, flat faces. Participants received instruction on how to draw on the pARF client device screen to make their response of engagement using a pen-like object called a stylus. The engagement scale was two-dimensional, ranging from 0 to 10, on the x-axis of the hand-held device (not engaged-neutral-engaged) (See Figure 5.4). The actual scores for each recorded sample corresponded to the pixel number of the x-axis where a participant’s stylus made contact. The limit of non-engagement was
pixel position -120. Neutral was pixel position 0, and the maximum level of engagement was pixel position +120. Participants were requested to keep the point of their stylus in contact with the screen throughout the performance and move it across the screen in accordance with their assessment of engagement. Following the training session, participants took seats in the front rows of the concert venue with the rest of the audience for the commencement of the recital. The testing procedure involved participants responding continuously as to how engaged they were by the audio-visual experience of a performance of a solo marimba piece as witnessed live in the concert situation.

![Figure 5.4. An example of the pARF client device showing a one-dimensional engagement scale.](image)

Prior to the commencement of the first piece in the concert, the pARF server (a laptop computer) sent synchronisation packets to the pARF client devices to synchronise each device with the server clock. A video recording of the live performance displaying the server clock (h:mm:ss:ms) was made using the digital video camera. This enabled timecode matching of the pARF and video.
After a verbal introduction, the concert began. At the commencement of the first piece on the program, *Two Mexican Dances for Marimba*, 2 (1977), participants began their engagement ratings. Participants’ responses were sampled continuously throughout the performance via the pARF at a rate of 2Hz (two samples per second). This sampling rate has been shown to be satisfactorily high in continuous tension judgements (Madsen & Fredrickson, 1993) and continuous loudness judgements of dynamics in music (Geringer, 1995). The test session lasted just over three minutes - the duration of the piece. Every participant accepted the offer to continue responding via the pARF for the duration of the recital if they wished, although these data are not reported here.

### 5.7 Results

**5.7.1 Preparing the Continuous Data for Analysis**

Before analysis could be conducted on the continuous response data, the video recording had to be time-locked with the response data. This was necessary to identify the data corresponding with the sections of musical material where performance manner was manipulated. The video was sampled at a rate of 25 frames per second whereas the continuous response data was sampled at a rate of two samples per second. It was assumed that participants could not respond to an event that had not yet happened. Therefore, where a beginning or an end of a section of interest (SOI) in the video occurred between a whole second and 0.5 second mark (up to twelve frames), responses were attributed to the 0.5 second response sample immediately following the 12 frames. Responses to SOIs evidenced in the video
beginning or ending between 13 and 25 frames were credited to the following whole second sample.

Signal variability in the continuous response data was analysed using the second-order standard deviation threshold method. Firstly a forward moving average was calculated across participants’ engagement responses. A 1.5 second forward moving average was calculated to account for lag in response times and smooth the signal. The 1.5 second time frame is in line with research observing lags of between 0.5 seconds and 1.5 seconds (Geringer, 1995), 1 second (Kuwano & Namba, 1985), and 3.25 seconds (Krumhansl, 1996). The average of all participants’ responses at each sample was replaced by an average of all participants’ responses over 1.5 seconds beginning with, and following, the sample to be replaced. The standard deviation of the forward moving average at each sample was then calculated. The second-order standard deviation of the forward moving average standard deviations was calculated. The mean of the standard deviations of the forward moving averages was also calculated. The mean of the standard deviations of the forward moving averages, minus the whole second-order standard deviation value provided an initial level of significance threshold – significance level A. This can be thought of as a conservative alpha significance level such as 0.025. A second threshold level – significance level B - was calculated by subtracting half of the second-order standard deviation value from the mean of the forward moving averages’ standard deviations. This can be thought of as a less conservative alpha level of significance such as 0.05. Standard deviation scores for the forward moving average at each sample that were below the level set for significance were taken to indicate reliable signal or response.
Following this analysis, visual inspection allowed judgements to be made of
difference or similarity between compared samples.

Initial graphing of the mean and standard deviation of the 1.5 second forward moving
average transformation of the continuous data revealed great variation in engagement
responses in the first 12 seconds after which the data appeared to settle (See Figure
5.5). The deadpan performance of the first presentation of the musical material began
6 seconds into the piece and lasted until 17.5 seconds of the piece had elapsed. Due
to the high variability in responses in the first 12 seconds of the performance, these 12
seconds of data were omitted. This resulted in a deadpan performance section with
duration of 6 seconds instead of 11.5 seconds. The projected performance of
recurrence of the section of music commenced 2 minutes and 16.5 seconds into the
piece and finished at 2 minutes and 29 seconds. Omitting responses to the same
section of music as had to be omitted from the deadpan performance resulted in the
projected performance section duration of 6 seconds instead of 12.5 seconds.
Figure 5.5. Mean and standard deviation for engagement ratings throughout performance of the second of the *Two Mexican Dances for Marimba, 2* (1977) by Gordon Stout. The black dots on the lines represent the mean and standard deviation firstly mark the beginning and end of the deadpan performance section. The beginning and end of the projected performance section are marked by the subsequent black dots. The deadpan performance section analysed ran from 12-18 seconds. The projected performance section analysed ran from 2 minutes and 23 seconds to 2 minutes and 29 seconds.

5.8 Results

The continuous response data corresponding with the two, 6 second sections of musical material in which performance manner was manipulated were analysed using the second-order standard deviation method of identifying significant points in a time-series. Significance level A (*SD* 23.68, *SE* 0.29) was set as the conservative threshold. This threshold was calculated as a whole second-order standard deviation value below the mean of the standard deviations of the 1.5 second forward moving averages. A less conservative threshold level - significance level B (*SD* 28.14, *SE* 0.51) was also set. This threshold was calculated as the mean of the standard deviations of the 1.5 second forward moving averages, minus half the second-order standard deviation value. Standard deviation scores for the 1.5 second forward
moving average at each sample that were below the level(s) set for significance were taken as a second criterion indicating reliable agreement of response.

Firstly, significance level A (SD 23.68, SE 0.29) was set as the conservative threshold or level of significance. Little reliability was observed between participants’ engagement responses in the first section performed in a deadpan manner. Little reliability in engagement responses to the repeated section of music performed in a projected manner was similarly observed. With the less conservative significance level B (SD 28.14, SE 0.51) set as the threshold, little reliability in engagement responses to the first section of music performance in a deadpan manner was also observed. However, reliable engagement responses were observed in the repeated section performed in a projected manner.

It was hypothesised that higher mean engagement ratings are recorded by observers in response to a section of music performed in a projected manner than a similar section of music performed in a deadpan manner. It appears from visual inspection mean engagement ratings are higher in response to the section of music performed in a projected manner than a similar section performed in a deadpan manner (See Figure 5.6). Unreliable agreement between participants as to engagement was observed in deadpan, and the majority of projected, samples. At the points in the projected sample where significant, reliable response was observed, the higher mean engagement ratings are interpreted as due to bodily gesture. Low reliability in response signal precludes firm attribution of higher engagement ratings responding to the projected performance section to bodily gesture.
Figure 5.6. Mean performance manner engagement ratings and standard deviations with a 1.5 second forward moving average. The black dots on the lines relating to the projected sample mean engagement responses and standard deviation indicate points of significance at significance level B ($SD\ 28.14, \ SE\ 0.51$).

The .wav files of the deadpan and projected performance samples were similar in intensity (dB) levels on the whole with some divergence towards the end of the section (See Figure 5.7). The mean intensity level for the deadpan sample was 54.21dB ($SD\ 7.25$), and 56.66dB ($SD\ 4.67$) for the projected sample. 2 minutes and 4 seconds elapsed between the deadpan and projected performance sections. During this time, participants experienced intensity levels ranging from 21.24dB to 70.01dB.
Figure 5.7. Mean performance manner engagement ratings and intensity (dB) levels with a 1.5 second forward moving average. The black dots on the line relating to the projected sample analysed indicate points of significance at significance level B (28.14, SE 0.51).

5.9 Discussion

Mean engagement ratings were higher in response to the section of music performed in a projected manner than a similar section performed in a deadpan manner. Visual inspection of ratings for the sections of interest appears to support the possibility that the manipulation of performance manner was the dominant contributing factor. However, it is necessary to view the results cautiously for a number of reasons.

Low reliable agreement between participants as to engagement in deadpan, and the majority of projected, performance sections limit confidence drawing firm conclusions from the comparison of these two samples of time-series data. No points of significance were observed in the engagement data with the threshold for significance set at a conservative level (significance level A), or a less conservative level (significance level B) during the deadpan performance of the section of the
piece. This suggests that there was little agreement as to the level of engagement in this section of music. Such a result may have been due to the fact that only 12 seconds of the piece had elapsed and participants could have still been orienting themselves with the task and pARF client device. This adjustment period may have lasted between 30 and 60 seconds (Schubert, 2007). Another factor for consideration is the difference between a task rating a series of excerpts and rating an entire piece of music of longer duration (Wapnick et al., 2005). The lower mean engagement ratings for the deadpan performance section may have been due to the fact it appeared first and early on in the piece, whereas the projected section began more than halfway through performance of the piece.

No significantly reliable points of engagement response were observed for the projected performance section with a conservative significance threshold set (significance level A). Significant, or reliable, engagement responses were observed in the projected performance section data when the threshold for significance was set at a less conservative level (significance level B). These higher and reliable points of engagement responses may be due to the projected performance demonstrating a greater level of engagement on the part of the performer (Thompson, 2007). Bodily gesture may have been the element of performance participants were responding to indicated by these high and significant points in the data.

While cautiously proposing that the performer’s bodily gesture played a part in eliciting increased engagement in the performance from the audience, other factors may have also contributed. When the section of music was repeated, participants may have become accustomed to the task and grown in confidence using the pARF client
device. As this experiment took place during a live concert, it was not possible to control for order effects. Counterbalancing the order of presentation of performance manner was, of course, not possible in this experiment. Therefore, responses to the second presentation of musical material may be influenced by preference (an affective response), or recognition memory (a cognitive response) due to mere exposure (Zajonc, 2001). An exposure effect has been demonstrated with an increase in liking and recognition of unfamiliar melodies after just one repetition (Peretz, Gaudreau, & Bonnel, 1998). Similarly, cognitive responses of familiarity and liking for a previously unheard piece of music have been shown to increase with repetition during a testing session (Hargreaves, 1984) and this may have affected results. Only one female performer (the researcher) performed the stimulus material introducing the possibility of gender bias (Davidson & Edgar, 2003; Elliot, 1995/1996). It is not possible to generalise observed effects to the population of male marimba players without further investigation. In addition, the performer’s face could not be masked to eliminate the possible influence of facial expression on results (Buck et al., 1972; Ekman, 1999). Results are viewed with these caveats in mind.

In Experiment 2, sound intensity, as measured in decibel level, was considered as a factor possibly contributing to higher engagement responses being recorded in response to the projected performance. As previously noted, it was not possible to normalise deadpan and projected performance intensity levels in the concert context. The intensity levels (dB) in deadpan and projected performances were similar on the whole, diverging towards the end of the section. Humans are able to detect a noticeable difference in loudness for wideband noise between 0.5dB and 1dB (Moore, 1997). It is not known if the slight variation in loudness affected results. It is worth
noting that between the deadpan and projected performance sections, 2 minutes and 4 seconds elapsed. During this time, participants were exposed to intensity levels ranging from 21.24dB to 70.01dB.

A future experiment could compare repeated phrases of music in the performance of an entire work where performance manner is not manipulated to see the amount of natural variability in response. Of interest would be to examine the video recording and analyse the performer’s bodily movements in the deadpan and projected performance sections for comparison of movement quality. Future work might examine the continuous engagement responses for the duration of the piece and investigate links between responses and musical structure. An area for further investigation would be to correlate patterns of response with overarching compositional structural and mathematical theories of proportion such as the golden mean.

5.10 Implications for Music Perception and Cognition

While it would be premature to draw firm conclusions as to the relationship between bodily gesture and reliably higher ratings in the section of music performed in a projected manner, it is encouraging to have been able to perform a quasi-experiment with manipulation of some variables in a real, live concert setting. This kind of validation or generalisation experiment is essential for music performance research. In order to be confident in generalising results, it is vital to conduct experiments with laboratory controls and then test results in an ecologically valid setting. The application of experimental techniques to the study of music performance in its own environment builds new pathways for performing musicians, teachers, researchers and
those involved in the presentation of music performance to better understand the
behaviour and development of audience members. Such research in the future will be
of great interest to the aforementioned groups and impact upon the creation,
presentation and programming of live concert music.
CHAPTER 6

A Theory of Embodied Cognition in Music Performance, and Development and Implementation of a Movement Analysis and Notation System
6.1 Overview of the Chapter

In the two previous experimental chapters, qualitative and cognitive responses confirmed the assumption that bodily gesture is an important component in perceiving expressive marimba performance. This chapter approaches bodily gesture in marimba performance from the performers’ perspective. The goal is to develop frameworks for analysing and interpreting the expressive qualities observed in marimba players’ bodily gestures. The theoretical assumption underpinning the approach centres on the body as an entity incorporated in intentional cognitive and expressive activity. An embodied approach to musical thinking, expression and communication is taken. A review of pertinent literature will inform the development and implementation of a systematic framework for identifying, analysing and describing bodily gestures produced by marimba players.

The aim is to build concrete relationships between perceived bodily gestures of marimba performers’ and the musical score. Expressive functional bodily movement and bodily gesture created in the realisation of a piece of music in expressive sound is founded on the musical score. Therefore, it is expected that the musical score will be important in differentiating and interpreting observed expressive functional bodily movements and bodily gestures. Another aim is to complete the circle and tie perceived bodily gestures back to the musical score through development of a qualitative recording tool. The proposed tool would link observations directly to specific locations in the musical score. Finally, an aim in developing such a tool is that it would also operate as a means for performers and teachers to record on the score itself their interpretations of expressive functional bodily movements and bodily
gestures derived from interpretation of the musical score. This would deliberately target a relatively untapped facet of performance preparation.

6.2 A Theory of Embodied Cognition and Communication

The idea of a bodily basis for thought is as old as the field of experimental psychology. 19th Century physiological studies, relating bodily sensations and mental conceptions, were the foundation for modern experimental and cognitive psychology (Dogantan-Dack, 2006). A Cartesian, or disembodied, view of psychological processes followed as the prevailing philosophy in ensuing years (Rohrer, 2007). Embodied cognition is currently a topic attracting attention in experimental, cognitive, and social science – “Human beings have bodies, and those bodies shape and constrain how we think.” (Rohrer, 2007, p. 368). As the body explores its environment, sensorimotor feedback capabilities lead to the development of cognitive structures (Iyer, 2002). Intentional motor activity is influenced by cognitive and biological processes arising within the human body, and modified by external factors (Seitz, 2000). The close relationship between bodily and mental perception and action implies that bodily action displays a person’s cognitive processes. Mathematical thinking has been reported as a visual, kinetic and in some cases auditory imagistic process, rather than thoughts only in terms of words or mathematical symbols (Hadamard, 1945). Musical thinking, as another creative non-linguistic domain, may similarly occur in images and physical metaphor. As noted in the literature reviewed in Chapter 2, human gestures and nonverbal behaviours demonstrate bodily action illustrating thought.
Witnessing another’s activity may induce similar bodily and cognitive states. A theory of social embodiment is based on the notion that modal simulations of perception, action, and introspection represent knowledge of social situations, similar to mental imagery (Barsalou, Niedenthal, Barbey, & Ruppert, 2003). This theory connects social psychology with cognition and demonstrates four ways in which cognitive and bodily states are flexible and influenced by social factors: Perceived social stimuli generate bodily states as well as cognitive states; perceivers mirror bodily states of others; affective states result from performed bodily states; and cognitive and motor processes are optimised when cognitive and bodily states are attuned (Barsalou et al., 2003). This theoretical position supports the notion that the intention initiating performers’ embodied cognitive processes, will result in bodily action that observers perceive, among other ways, through elicitation of mirrored bodily states.

As early as the preparatory phase for action, thought and intention are revealed through the body. Runeson and Frykholm (1983) found that observers could detect differences between weights of a box from the lifter’s preparatory movements displaying their expectation of its weight. Observers could also detect attempts to act deceitfully in revealing the weight of the box when preparing to lift it (Runeson & Frykholm, 1983). Where the intention and action are incongruous (i.e. trying to express a weight of the box in movement that is untrue), observers can detect this deceit. This finding supports the notion that bodily gesture that is not integrated and matched with musical intention, for example showmanship antics, will be detected as deceitful action. In the 18th Century, instrumentalists mimed and rehearsed affective gestures to furnish their performances with expression (Gellrich, 1991). Gellrich
(1991) cautioned if attempting to apply a layer of expressive gestures to a performance, possible adverse muscular tensions that may impede ability to play the instrument should be considered. Therefore showmanship antics may not only be perceived as deceitful action, but may also impact negatively on the performers’ motor program.

In sum, embodied experience appears to shape cognitive processes. Intentional action seems similarly to be shaped by cognitive and bodily processes. Perceiving the activities of others may be lead to an understanding of their intentions through mirrored cognitive and bodily states. This perception may involve the kinaesthetic sense in addition to the visual sense.

6.2.1 Kinaesthesis, Kinaesthetic Memory and Kinaesthetic Thinking

In Chapter 2, the notion of multimodal perception as a combination of auditory and visual sensory modalities was explored. In the present chapter, multimodal perception is extended to include kinaesthesis highlighting embodied knowledge arising from the sensory experience within the individual’s body. Kinaesthesis, or the ‘muscle sense’, is additional to the five commonly known senses: vision, hearing, taste, touch and smell. Moore and Yamamoto (1988) define kinaesthesis as, “…the sensual discrimination of the positions and movement of body parts based on information other than visual, auditory, or verbal.” (p. 48). Fitt (1996) concurs that kinaesthesis is, “…a perception of both motion and position…dependent on the proprioceptors and the sensory organs involved in the righting reflexes.” (p. 276). Sensory information regarding muscular relaxation and tension, joint position and velocity of motion is sent to the central nervous system (Fitt, 1996). The sensory end-
organs of special muscle fibres called muscle spindles, tendons, nerve endings in joints, and the vestibular apparatus in the inner ear play roles of varying degrees in sensing movement of the body (Moore & Yamamoto, 1988). A related term, *proprioception*, “…refers to our sensation and perception of limb, trunk, and head position and movement.” (Magill, 2004, p. 91). Kinaesthesia and proprioception have both been used as terms referring to movement and position sensation. A broad interpretation based on the history of the use of the terms suggests kinaesthesia as a conscious state, and proprioception as sub-conscious sensation (Hopkins, 1972). For the purposes of this study the term kinaesthesia, referring to conscious awareness of bodily movement and position, and the qualitative perception of bodily states arising from this bodily sensation, shall be used.

*Kinaesthetic empathy* – proposed as the ability to physically identify and subtly imitate observed movements of others – may play a role in perceiving and understanding the intentional actions of others (Moore & Yamamoto, 1988). More obvious entrained bodily actions arising from social, interactive situations between two people have been termed *bodily mimicry* (Barsalou et al., 2003). Cox (2001) presents the *mimetic hypothesis* which states that overt and covert imitation of auditory and visual performer information, enabled through bodily experience and knowledge, leads to understanding of human movement and human made sounds. Godøy (2001) argues that motor imagery of sound-producing action can elicit a musical image of the sound. Leman and Camurri (2005-2006) propose that *corporeal imitation*, through a mirroring system relating perceived spatial and temporal elements to imagined movement sensation, enables the understanding of others’ actions and expressiveness including musical expressiveness. When motor activity is
observed, mirror neurons are activated in the observer creating a motor image of the observed motor activity (Gallese & Goldman, 1998). It appears that kinaesthetic empathy, covert imitation, or mirroring, of human movement, involving motor imagery and kinaesthesia is important in understanding the movements of others – particularly in expressive situations.

Kinaesthesia is key to endeavours that involve refined motor skill such as sport, music and dance. Stout (2001) advocates using the body’s kinaesthetic sense to train movement around the marimba to locate notes that are out of the performer’s direct sight range. Kinaesthetic imagery has been shown to benefit the learning of motor tasks that require a high degree of coordination (Féry, 2003). The use of kinaesthetic perception and imagery would appear to be important facets of training kinaesthetic memory. Kinaesthetic memory can be thought of as resembling procedural knowledge (i.e., knowing how to do something such as ride a bike) in the field of cognitive psychology (Seitz, 2000). The ability to think in spatial and movement terms, invoking muscular effort, characterises kinaesthetic memory (Seitz, 2000). Kinaesthetic memory may play a key role in recalling the movements to play an instrument. But more important to artistic endeavours, kinaesthetic memory may enable the artist to perform movements with different qualities of human expression. Kinaesthetic thinking comprises, “…orchestrating a sequence of activities; intellective, emotional, and multisensory experience; and selecting and executing appropriate movement, action or activity.” (Seitz, 2000, p.35). Skilled ability in using the body in goal-directed and expressive manners was identified by Gardner (1983) as one of the multiple intelligences – Bodily-kinaesthetic intelligence. Kinaesthetic
memory and kinaesthetic thinking may be key components of embodied thinking and expression in artistic performance.

The kinaesthetic sense is recognised as key in the field of dance, where the goal is expressive action (Fitt, 1996). The kinaesthetic sense may also play an important role in music performance where expressive functional bodily movement is required to create expressive musical sound. It has been suggested that kinaesthesia may be crucial in the ability to act gracefully, leading to expressive movement (Galvao & Kemp, 1999).

In artistic endeavours such as music and dance, the body is recognized as being of central importance to the artist for experiencing, expressing and communicating thoughts and feelings. Music and dance both involve high-level motor performance, but with an added dimension of heightened nonverbal communication. In dance especially, the body acts as the primary vehicle for expression (Hanna, 1987). Embodied processes reveal themselves in dance as expressive action for aesthetic purposes (Stevens & McKechnie, 2005). Music presents another artistic context where an embodied approach has long been proposed as beneficial to musical cognition and expression.

### 6.3 An Embodied Approach to Musical Cognition and Expression

Late 19\textsuperscript{th} Century theories of human perception and cognition included physiological and muscular sensation components (Dogantan-Dack, 2006). Around this time, such theories underpinned experimental investigations in music which noted links between the dynamics of rhythm, phrasing, and bodily movements – both internal and spatial
movements (Dogantan-Dack, 2006). Rhythmic aspects of music were seen as involving distinct phases of bodily movement incorporating an active and a resting quality, such as respiration (Dogantan-Dack, 2006). Phrasing was seen as similar to sustained movements in space, or the inhalation and exhalation of breath (Dogantan-Dack, 2006). Early philosophies about musical expression were founded on bodily concepts. Bodily-based experience shaped musical thinking and idealised musical concepts. An embodied view of the process of musical cognition and expression was adopted in the late 19th to early 20th Century by well-known Swiss music educator Emile Jacques-Dalcroze.

6.3.1 Embodied Cognition in Music Pedagogy - Emile Jacques-Dalcroze

Dalcroze proposed that both the body and brain should be involved in musical activity (Galvao & Kemp, 1999). A recent review of literature involving music, the body and brain supported Dalcroze’s stance that the body and bodily movement are central to musical expression (Seitz, 2005). The Dalcroze approach developed bodily sensitivity towards the qualities of music and movement with bodily action providing a physical metaphor for comprehending and expressing musical concepts (Juntunen & Hyvönen, 2004).

Dalcroze developed a pedagogical method, Eurhythmics, based on fundamental, rhythmic, human behaviours such as breathing and walking that utilised the whole body kinaesthetically integrating and strengthening the communication between the brain and body (Farber & Parker, 1987). Dalcroze connected rhythm in music to human muscular movement (Galvao & Kemp, 1999). Dalcroze training has been
implemented worldwide to help music students become more musically sensitive and responsive to the elements of musical performance (Mead, 1996).

Embodied approaches to musical cognition and expression, in a similar vein to Dalcroze, have been discovered and implemented independently by musicians all over the world throughout the 20th Century. Some of these examples (Davidson & Correia, 2001; Gellrich, 1991; Pierce, 1997; Sudnow, 2001; Truslit 1938, see Repp, 1993) will be reviewed in the following section. It appears that among the music community, there is general understanding that expressive concepts experienced in an embodied manner in rehearsal contribute to the development of musically expressive performance. This notion is supported by Sloboda (1996, p. 124), for example, who comments “unlike technique, expression has characteristics that are similar to extramusical activities (bodily and emotional gestures)”.

6.3.2 Embodied Cognition in Music Rehearsal and Performance

Truslit (1938, see Repp, 1993) proposed that there were three basic, natural and dynamic motion curves that could shape musical sound: open movement, closed movement and winding movement. Applying different motion curves to the performance of musical material resulted in markedly different acoustic performances. This result was attributed to performers experiencing the motion curves as inner motion, as opposed to applying expressive effects, such as crescendo and diminuendo from the outside (Truslit, 1938, see Repp, 1993). Without direct reference to the work of Dalcroze, Pierce (1997) proposed experiencing kinetic qualities associated with the musical features of beat, melody, cadential tonic, phrase and climax as a tool for improving performance.
This notion of bodily-based knowledge shaping rehearsal and performance has been explored explicitly in a case study of a solo flute player (Davidson & Correia, 2001). The flute player reported exploring movement and gesture qualities in building his interpretation of two solo flute pieces. In preparing a piece of Baroque music, movement and gesture qualities associated with interpretations of phrasing were explored and classified into three metaphorically-named movement categories. Drawing on these, a movement narrative was built helping to create a cohesive interpretation of the piece. The second piece, a piece of 20th Century solo flute music, inspired the creation of a quality of movement to unify separate motivic ideas. In rehearsal, bodily movement qualities expressing his musical interpretations were explored and created deliberately. In performance however, the flutist reported only a distant awareness of movement and sound as a single entity. This is supported by the reports of some clarinettists that while a general awareness of bodily movement existed in performance, they could not generally explain the details of these movements (Wanderley et al., 2005).

Sudnow (2001) recounted the development of his embodied way of thinking in improvised jazz piano playing. He described how his finger and hand movements and configurations became a way of thinking, for example, shaping melody and keeping time. These ways of his hands spilled into involvement throughout his body. Sudnow aptly summarised his embodied account of improvised music making, “…I had the most vivid impression that my fingers seemed to be making the music by themselves.” (Sudnow, 2001, p. 2). As reported by the flutist in Davidson and
Correia (2001), conscious awareness of bodily movements and movement qualities produced in rehearsal appeared to be automated and subconscious in performance.

Expressive functional bodily movements and bodily gestures involve certain bodily patterns of muscular tensions and relaxations. Certain tensions are necessary and contribute positively to music performance, for example, to perform loud passages of music. Gellrich (1991) proposed that muscular tensions also occur as physical manifestations of psychological states (such as emotional or concentrated), from unpractised movements, or in reaction to tension in another part of the body. Performers’ voluntary muscular tensions support the notion that expressive states in musical thinking are indeed embodied. Some of these voluntary muscular tensions may manifest in visually and kinaesthetically perceptible bodily gestures accompanying expressive musical sound. Logically then, learning to control tensions and relaxations throughout the body by acting out affective states would probably be a beneficial practice in which musicians might engage. Such practice would focus attention on developing a bodily awareness and increasing the range of expression able to be displayed for expressive communication.

6.4 Summary and Conclusions

It appears that human thought can be embodied and expressed or shared through intentional action. In a musical context, performers’ bodily gestures may provide evidence of embodied musical cognition. Observers may be able to interpret performers’ expressive intentions most effectively through sonic, visual and kinaesthetic perception. Kinaesthetic perception draws on embodied experience of
muscular patterns of tension and relaxation through mirroring the performer’s bodily patterns of tension and relaxation.

The literature reviewed in Chapter 3, and the results of Experiments 1 and 2, demonstrated the positive effect performers’ bodily gestures could exert over affective and cognitive perceptual responses to solo performance. In recent times, studies have sought to analyse and interpret the bodily gestures that musicians produce, and understand how they contribute to the perception of expressive musical performance. Investigations have been undertaken using quantitative and qualitative approaches. The literature reviewed in the next sections highlight analytical approaches, key findings and develop a new system for identifying, describing and recording the expressive qualities of bodily gestures.

6.5 Quantitative Approaches to Recording, Analysing and Interpreting Bodily Gesture in Music Performance

Studies have attempted to examine bodily gesture using movement tracking technology measuring the temporal and spatial aspects of musicians’ bodily movements in performance. As such technology only captures kinematics, studies relying on motion capture data have only been able to account for bodily gesture in terms of amount and velocity of movement. While increased quantity of movement has been shown to lead to judgments of more expressive performance (Davidson, 1993, 1994), it is important to consider the quality of movement as an important indicator of expression as moments of little movement, or stillness, can be deemed to be expressive (Davidson, 1994, 2002b).
The elusive expressive qualities in movement or stillness that motion tracking technology is unable to account for are most likely related to ‘force’. Motion is constituted of three basic elements: time, space and force (Fitt, 1996). Force may be an element of performers’ bodily patterns of tension and relaxation perceptible through kinaesthetic empathy or mirroring. While movement tracking technology can well record the temporal and spatial elements of movement, it does not offer information regarding the qualitative aspect of movement – ‘force’. The limitation of this means of measuring expressive movement were foreseen, “…performing a function which has concrete effect in space and time through the use of muscular energy or force…such actions are never devoid of expressive elements, which means that they cannot be determined by logical reasoning, nor grasped by measurable factors only. They are pervaded by elements which bring out the quality and the attributes of particular species.” (Laban, 1988, p. 75).

This difference between kinematic measurements and perception of movement quality was illustrated in a study of a pianist (Davidson, 2002b). A discrepancy was observed between motion tracking data and observer perception of expressive movement. The fairly persistent body sway found in intentionally expressive (projected and exaggerated performance manner) piano performance data was detected by observers. However, body sway evident in the motion tracking data in intentionally less expressive performance (deadpan) was not perceived by observers (Davidson, 2002b). This difference highlights an inherent problem in motion tracking technology as it stands today.
6.5.1 Interpreting the Temporal and Spatial Aspects of Bodily Gesture

Studies employing motion tracking technology have, however, contributed to interpretation and understanding of the temporal and spatial elements of bodily gesture in expressive musical performance. Davidson (1994, 2002b) found that certain areas of a pianist’s body, such as the upper body, seemed to communicate more expressive information than other bodily locations. This result is likely to generalise to most instrumental music performers, whether performing seated or standing, as gesturing primarily involves hand, arm and head movements, and postural adjustments. This was demonstrated in literature reviewed in Chapter 2. Aside from a context such as dance, natural human gesture is not widely recorded as primarily focusing expressive movements of the feet and legs. For instrumentalists, the feet and legs are either primarily the support system for standing, or occupied with functional movements such as using the pedals on the piano or harp.

Evidence from motion tracking data supports the notion that bodily gestures are an essential component of musical performance. Clarinettists’ gestures were observed to be fairly consistent across multiple performances of the same piece (Wanderley et al., 2005). It proved very difficult for performers to inhibit a learned motor program for an expressive performance on request and perform in a completely immobilised manner (Wanderley et al., 2005).

Similarly, Davidson (2002b) identified a few expressive moments in an intentionally inexpressive (deadpan performance manner) piano performance. In comparison, intentionally expressive (projected and exaggerated performance manner) performances of the piece given by the pianist featured individual incorporated
moments punctuating an overall, expressive body sway (Davidson, 2002b). Davidson (2002b) speculated that some body parts may indicate expression in a global manner where others would be more local indicators. Davidson’s (2002b) results from two vision-only condition experiments suggested that expressive information was not available continuously and that links between musical structure and expressive movements did exist. However, as mentioned in Chapter 2, interpretations of bodily gestures from a vision-only perspective may yield different results compared with interpretations of bodily gestures when sound is present.

6.5.2 Interpreting Factors Influencing the Production of Bodily Gesture

In deciphering how bodily gestures are employed in expressive musical performance, technical or anatomical constraints (Davidson, 1994, 2002b, 2007; Wanderley, 2002), issues of musical structure (Clarke & Davidson, 1998; Davidson, 2002, 2007; Wanderley, 2002), as well as interpretive concerns (Wanderley, 2002) have been proposed as modifying factors. In an attempt to explain the ancillary, or expressive, gestures made by a clarinettist in performance, Wanderley (2002) termed the three possible origins of bodily gestures: material/physiological (instrumental technique/physical constraints), structural (musical structure) or interpretive (performer interpretation). These three possible origins proposed for interpreting non-obvious or ancillary gestures may be important in deciphering motivations for instrumentalists’ bodily gestures.
6.5.2.1 Technical Constraints

Illustrating the case that technical constraints modify performance, Wanderley and colleagues (2005) found that performers’ expressive movements decreased or were virtually non-existent during technically demanding passages. An increase in movement was noted during passages that were easier to play. In contrast to the relative bodily freedom of speakers and singers, instrumentalists are constrained in the movements they can make during performance by the technical demands of creating their desired sound from an instrument. For instance, in marimba playing, the arms and hands are involved in manipulating the mallets across a keyboard of wooden notes approximately two and a half metres in length. The size of the standard concert five-octave marimba necessitates that functional bodily movements of the arms and hands are manoeuvred into the required playing position through the supportive functional bodily movements of the feet, legs and torso. It seems appropriate that the technical, or functional bodily movements required in producing music via an instrument be considered in studying bodily gesture.

6.5.2.2 Musical Structure

Bodily gestures have been linked to elements of musical structure. Motion tracking data revealed clarinettists moving more at the start and finish of a musical phrase signifying this important facet of musical structure (Wanderley et al., 2005). Bodily movement was also noted and linked to rhythmic elements in the music. It was proposed that types of continual movement may have been influenced by the rhythmic structure of phrases. Clarke and Davidson (1998) found a similar type of continual movement, which they referred to as body sway, produced by a pianist. They concluded that body sway appeared to perform time-keeping and phrase-linking
functions. Clarke and Davidson (1998) proposed that body movement and musical structure were co-determining features of performance, rather than separate issues, one causing the other. This supports the notion of musical thinking and expression as embodied processes.

6.5.2.3 Interpretive Issues

As noted in the literature reviewed in Chapter 2, sonic musical expression is closely related to performers’ interpretation of musical structure, affected through expressive functional bodily movement interacting with the instrument. The bodily gestures a performer produces may too be generated from analysis and interpretation of musical structure. Additionally, expressive functional bodily movements and bodily gestures may result from performing elements notated in the musical score, such as expressive markings. Finally, expressive functional bodily movements and bodily gestures may be produced reflecting individual interpretation of un-notated elements in the musical score. Wanderley and colleagues’ (2005) found that individual differences in movement styles existed between clarinettists’. They concluded that musical considerations, being mainly phrase structure and metrical considerations, caused differences in performers’ movements. The combination of expressive functional bodily movements and bodily gestures produced in performance may evidence embodied expression of embodied musical thought.

6.5.3 Summary and Conclusions

Motion tracking technology has provided data which has assisted in interpreting the temporal and spatial elements of bodily gesture. In examining and interpreting bodily gestures, the upper body was shown to be most expressive in terms of amount of
movement. Comparing motion tracking data of differently intentioned performances identified points of commonality and difference leading to explanations as to their causes. It appears that bodily gesture is integral to instrumental music performance evidenced by the difficulty performers experience in trying to inhibit expressive bodily movement additional to performance. However, while useful for interpretation purposes, motion tracking data does not account for, or explain, the expressive qualities in bodily gestures in music performance. Few studies have attempted to address the apparent expressive qualities in bodily gestures and develop an effective and efficient system of describing and recording them.

6.6 Qualitative Approaches to Analysing, Interpreting, Describing and Recording Bodily Gesture in Music Performance

It appears that a purely quantitative approach to investigating bodily gestures in music performance is insufficient. This was noted by Clarke and Davidson (1998) who employed both quantitative and qualitative means to study the bodily gestures of a pianist. The appearance of bodily gestures observed were described in words in terms of their appearance, and given a category name such as ‘body sway’ or ‘wiggle’. Bodily gestures were interpreted according to information in the musical score at the locations where they were observed. Bodily gestures observed as local indicators of expression were marked with arrow heads on the motion tracking data at the locations where they were observed (Clarke & Davidson, 1998). No systematic and generalised approach was developed for analysing, describing and recording the observed expressive qualities in bodily gestures.
It is important to develop methods of analysing, describing and recording bodily gestures evident in music performance in order to understand how they are produced in relation to the music performed, and how they specifically impact on audiences’ perception. Davidson (2001) used a method for categorising non-verbal behaviour (Ekman & Friesen, 1969) to describe and analyse the nonverbal behaviours of a singer producing a written, verbal, descriptive transcript. In terms of analysing the body movements of solo marimbists this method of categorisation does not fit well. Singers usually have lyrics, or a verbal narrative to communicate to the audience, whereas instrumentalists do not. The arms and hands play a particularly important role in verbal communication through gesturing (e.g. Kendon, 2004; McNeill, 1992). Instrumentalists’ limbs, in particular the arms and hands, are usually constrained by the functional requirements of producing sound through the instrument. In addition, Ekman and Friesen’s (1969) method of categorisation creates another descriptive transcript that is cumbersome if trying to correlate it efficiently with a musical score. However, Davidson’s (2001) approach was an important step towards interpreting the expressive qualities in observed movements of a performer using a meta-language, rather than merely describing them.

Most recently, Davidson (2007) conducted a case study that aimed to link observed movement qualities of a pianist with the musical score. Based on a previous study of a solo pianist showing body movement to reveal a general level of expression overall, and indicate specific locations of expression (Davidson, 2002b), Davidson (2007) developed a symbolic notation system to record her observations of the performer’s movements and relate them to the musical score. The symbolic notation system Davidson (2007) developed was based on Labanotation – a system for recording
human movement and used widely to record the movements of dance. Labanotation will be reviewed in section 6.6.2 of this chapter. Descriptions of the pianist’s vocabulary of expressive movements was compiled, symbols were devised to represent the movements, then expressive movements were recorded on a graph in locations corresponding to the bar numbers at which they were observed with her symbolic notation system.

Davidson’s (2007) study is important in the evolution of studying the bodily gestures in music performance. The study addresses connecting a repertoire of movements observed to be expressive to the musical score. However, Davidson’s (2007) study is based on Labanotation - a system for recording primarily temporal and spatial aspects of human movement with limited ability to record dynamic qualitative aspects of movement. Additionally, the symbols are limited in their ability to generalise to other instrumental performance contexts due to different technical demands. The creation of further symbols would be necessary leading to the problem of easy and efficient implementation of the system. However, the notion that the bodily gestures a performer produces are tightly coupled with the musical score is valid. In the Western art music tradition, the musical score, which represents the composer’s creative ideas and intentions, is the primary source for performance preparation.

6.6.1 The Musical Score as the Source of a Functional and Expressive Bodily Movement, and Bodily Gesture Plan

The score provides the performer with guidelines as to what note to play and when, and expressive markings including dynamics, tempo, articulations (such as accents) and phrasing. The performer’s musicality enables the transformation of the score into imagined sound that is then realised, through their instrument, in audible sound (Hill,
2002). With the written musical score providing the map, the performer then transforms the notation into expressive sound reflecting their individual interpretation in their individual movement style.

In analysing a performer’s bodily gesture accompanying expressive musical sound, it would follow logically that the musical score, as the foundation of the performance, could provide the link between observed gesture, and interpreting possible motivations for gesture. Analysed and interpreted bodily gestures could be mapped on to the musical score either descriptively or through symbolic notation. Methods of recording human movements, through descriptive and symbolic means as they relate to a musical score, have been explored in greatest detail in the field of dance.

6.6.2 Dance Notation – A Brief History

The earliest records of symbols substituted for movement date from the mid 15\textsuperscript{th} Century and are held in Cervera, Catalonia (Royce, 2002). Thoinot Arbeau published \textit{l’Orchésographie} in France in 1588 (Ashley, 2002). Descriptive lists of steps and positions were made, and these reduced to a single letter (e.g. “R” – \textit{reverence}, “d” – \textit{double}, “s” – \textit{single}) for notation under musical notes in the score where the movement was to take place (Royce, 2002). This was the first attempt at connecting dance movement and the musical score.

Dating from the early 18\textsuperscript{th} Century track drawing, based on a system of dance notation by Pierre Beauchamps, was published in 1701 by Raoul Feuillet in \textit{Choréographie ou l’Art de d’écrire la Danse} (Hutchinson Guest, 2005). Basic steps, body and limb movements were described and drawn symbolically in \textit{Feuillet
notation. Movements and steps were arranged to the left and right of a vertical line which charted the directions of movements much like a floor plan. The musical score and steps were linked by numbering the bars in the score and numbering the steps that corresponded (Royce, 2002). Another attempt to record dance movements in relation to the musical score was made in the 19th Century with the publication of *Stenochorégraphie* by Charles Arthur Saint-Léon. This system made use of stick figures drawn on a musical staff with steps on the ground notated on lines and movements in the air recorded in spaces. Symbols were placed above the music notes indicating timing (Royce, 2002). A modified version of *Stenochorégraphie* emerged in 1887 by Friedrich Zorn in *Grammatik du Tanzkunst* and was used in Europe and the USA. In 1892 Russian dancer and teacher Vladimir Stepanov published *Alphabet des Mouvements du Corps Humaine* as an attempt to record movements of the whole body in *anatomical* language. Stepanov is partly credited with the survival of *Swan Lake* and *Sleeping Beauty* (Ashley, 2002).

In the 20th Century, two systems for recording human movement emerged, and are still in wide use today, that are capable of relating human movement to a musical score. *Benesh notation* was developed in England by mathematician Rudolph Benesh and his dancer wife, Joan in 1956. Although created specifically for recording dance, *Benesh notation* has been applied to recording movement in a variety of settings including physiotherapy and physical education, industry and medicine (Royce, 2002). *Benesh notation* records static positions and movements that precede them on a five-line staff or matrix which runs above, and parallel to, the musical score (Royce, 2002). Placement of symbols on the matrix relates movements to specific locations the musical score (Ashley, 2002). *Benesh notation* indicates rhythm and phrasing.
above the staff, the floor plan below the staff, and dynamic qualities through use of musical terms such as *adagio* (Ashley, 2002). An example of Benesh notation is shown in Figure 6.1.

![Figure 6.1. An example of Benesh notation. The figures drawn about the stave and the printed words would not normally appear. These are included to explain the notation written on the five-line stave. (Ashley, 2002, p.215).](image)

In 1928 Rudolph Laban published a system for recording human movement based on general movement principles rather than dance specific principles that could be applied to any human movement context (Hutchinson Guest, 2005). *Labanotation* is based on Laban’s theories of forms of movement in space, *Choreutics*, and qualities of movement, *Eukinetcs* (Royce, 2002). In his 1928 publication, Laban focussed on the structural content of movement after an attempt to address both the quantitative and qualitative aspects of movement in a 1927 publication (Royce, 2002). In Labanotation, symbols indicating steps and movements are arranged along either side of a vertical staff running parallel to the musical score. The length of symbols reflects the duration of movements and specific locations relate movements to the score. A key to Labanotation is shown in Figure 6.2. Through its longevity, Labanotation has demonstrated its usefulness as an effective means of recording quantifiable observable
steps and movements of the body. Of the current systems for recording classical ballet movements, Labanotation is unique in its usability in any human movement context, not just classical ballet. An example of Labanotation is shown in Figure 6.3.

Figure 6.2. Labanotation symbolic glossary (Hutchinson, 1966, p.263).
Figure 6.3. An example of a ‘skip’ featuring natural arm movements in Labanotation (Royce, 2002, p. 47).

Dance notation presents systems whereby symbols represent movements or steps. Such a symbolic system seems fitting in linking performer’s bodily movements with the musical score. Yet dance notation primarily addresses recording dance steps or movements and less attention is directed towards recording the expressive qualities of bodily gestures. As noted earlier, bodily gestures do not always involve movement. Therefore a meta-language system that enables description and symbolic recording of the expressive qualities of performers’ bodily gestures in both movement and stillness is required.
6.7 Developing a New Movement Meta-Language for the Musical Score

The development of an effective and efficient lexis for identifying and describing bodily gestures, and a system for dissemination, would be of benefit to performers, students and teachers (McClaren, 1988). An appropriate approach would consider the temporal, spatial and forceful aspects of bodily gestures. It is the premise of this study that a method of analysis and recording bodily gestures accompanying expressive musical sound be based not only on objective visual observation, but also on subjective observation, or kinaesthetic empathy. Mimicking the performer’s bodily patterns of tension and relaxation should lead to understanding of the element of force involved in bodily gestures through kinaesthesia and embodied knowledge. It is anticipated the implementation of such observational and analytical techniques will reveal essential qualities in bodily gestures not previously addressed in the field.

The creator of the dance notation system Labanotation, Rudolph Laban, developed a system of symbolic notation to record the expressive qualities of bodily gestures. This system of symbolic notation captured the expressive qualities of bodily gestures through the analytical system, Laban Movement Analysis. Laban Movement Analysis (LMA) differs from Labanotation in that where LMA addresses the qualitative aspect of bodily expression, Labanotation primarily records the quantitative aspect of bodily movement. Part of the foundation of LMA is Laban’s theory of effort in bodily motion which addresses the concept of ‘force’ as an expressive element. Study 1, reported in the following chapter, focuses on analysing, describing and recording the expressive qualities of marimba players’ bodily gestures.
through LMA. Rudolph Laban’s life and work is described in further detail in Appendix F.

6.8 Laban Movement Analysis

LMA is a system based on 20th Century choreographer and movement analyst Rudolph Laban’s research and theories of human movement. It has been developed by subsequent generations of practitioners (Groff, 1995). LMA is based on the assumption that inner motivation for movement manifests in observable movement. Therefore, movement involves integration of mind and body. It has proven to be a useful means of analysing movement in a variety of settings including dance, sport, work actions, and non-verbal communication in conversation (Hamburg, 1995). Concepts involved in LMA have been applied to business settings to improve communication through studying movement patterns and their relationships to personality (Lamb & Watson, 1979). LMA has received conservative support as a framework for investigating links between individual movement styles and personality in clinical psychology (Levy & Duke, 2003). The authors concluded that they were able to establish that the assumed relationship between psychological/emotional states and particular movement patterns did exist (Levy & Duke, 2003).

The principal assumption of LMA - that inner motivation for movement becomes apparent through observable movement - presents a case for investigating the system as a means to study bodily movement in music performance. The system may enable analysis and understanding of the qualities evident in musician’s bodily movements in performance, and the drawing of conclusions as to the motivations for such movements. The case for investigating the system further is strengthened by the fact
that LMA has been implemented to analyse human movement in many differing contexts.

LMA identifies four components involved in movement: body, shape, space, and effort (Levy & Duke, 2003). The body, as the vehicle for movement, can be observed in segments and shape refers to the way the body takes form in space (Levy & Duke, 2003). Space is made up of the horizontal, vertical and sagittal axes of spatial movement (Bartenieff & Lewis, 1980) and effort reflects, “…a person’s attitude towards movement, or the dynamic, qualitative variables of movement.” (Levy & Duke, 2003, p.44). The effort component of LMA is based on Laban’s theory of effort in bodily motion which involves the expressive concept of ‘force’.

6.8.1 Theory of Effort

Laban’s theory of effort is concerned with expression in human movement stemming from the observable dynamic rhythms of physical exertion – tension, release and phrasing of body movement (Maletic, 1987). Originally called eukinetics derived from the Greek eu (good) and kinesis (movement), Laban’s theory became known in the English language as effort (Maletic, 1987). Eukinetics was a theory concerned with expression in dance whereas the theory of effort encompassed expression in human movement in general (Maletic, 1987). As such, the theory of effort should be supported through the study of bodily movement in a music performance context.

Effort in bodily actions can be observed and understood from two perspectives: 1) the objective function of the movement (measurable aspect), and 2) subjective movement sensation important in expressive settings (classifiable aspect) (Laban, 1988).
Therefore, perceiving effort in movement involves not only objective visual observation, but also embodied knowledge through kinaesthetic experience of movement. The analysis of effort in movement requires analysis of the four motion factors: weight, time, space and flow. Each motion factor includes a bipolar continuum of effort elements ranging from a fighting to an indulging quality: weight (strong-light), time (sudden-sustained), space (direct-indirect) and flow (bound-free). Effort elements reveal a person’s inner attitude towards each of the motion factors and different qualities of movement (Bartenieff & Lewis, 1980). Laban (1988) suggested that the effort of inner preparation through attention, intention and decision for bodily action manifests in discernible effort expressed in movement. Effort and shape are two key components of LMA for discerning qualities in bodily action. These two concepts are most relevant to Study 1 investigating bodily gesture accompanying expressive musical sound in marimba performance.

6.8.2 Effort-Shape Analysis and Notation

The concepts of effort and shape are core to understanding the qualities exhibited by the body in human movement. Effort-shape analysis describes the qualitative aspects of movement – how the movement is done rather than what is done (Davis, 1970). The components of effort and shape, which will be discussed in the following section, are viewed as ‘irreducible’ qualities, or the smallest elements in observable movement (Davis, 1970). A system of symbolic notation using select parts of the effort graph enables qualitative descriptions of movement to be recorded. The effort graph will be explained in subsequent sections. Effort and shape terminology has the potential to be employed as the movement metalanguage for describing the qualities observed in marimba players’ bodily movements in performance. Additionally, the
accompanying notation system should be able to be implemented as a means of recording qualitative observations on the musical score. The system for describing and notating effort and shape will now be outlined.

6.8.3 The Effort Drives

Through his observations Laban identified different combinations of motion factors and effort elements to reveal essential qualities in human movement. Three-motion factor combinations that result in effort drives are the most obvious of expression (Bartenieff & Lewis, 1980). These are taken as core components in the analytical system presented here. Incomplete efforts or inner states, where only two motion factors are observed, most often appear fleetingly as upbeats to action or between drives. Four-motion factor combinations do not usually occur as they display extreme, wild and unfocussed action.

The action drive is comprised of three motion factors: space, weight and time (Bartenieff & Lewis, 1980). The combination of the bipolar effort elements of these three motion factors results in eight possible basic effort actions. Each of these basic effort actions displays two rhythmic phrases of exertion and relaxation. They are goal directed actions. The eight basic effort actions were noted by Laban and his colleague F.C. Lawrence working in England during the Second World War streamlining processes in industry for greater productivity (Laban & Lawrence, 1974).

Representing the range of contrasting working actions performed in human movement, the eight basic effort actions are also essentially expressive movements of emotional and mental states (Laban, 1988). These basic effort actions are
metaphorically named *slashing, gliding, pressing, flicking, wringing, dabbing, punching* and *floating* (Laban & Lawrence, 1974, p. 21-22). The metaphoric name refers to the action itself and the kinaesthetic feeling of the action. The basic effort actions and their composition of motion factors and effort elements are shown in Table 6.1. As basic effort actions are representative of human working actions, it is conceivable that these actions could exist in a musical context where playing an instrument and producing sound constitutes working movements.

Table 6.1

<table>
<thead>
<tr>
<th>Metaphoric name</th>
<th>Space (effort elements)</th>
<th>Weight (effort elements)</th>
<th>Time (effort elements)</th>
<th>Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Float</td>
<td>Indirect</td>
<td>Light</td>
<td>Sustained</td>
<td>N/A</td>
</tr>
<tr>
<td>Glide</td>
<td>Direct</td>
<td>Light</td>
<td>Sustained</td>
<td>N/A</td>
</tr>
<tr>
<td>Wring</td>
<td>Indirect</td>
<td>Strong</td>
<td>Sustained</td>
<td>N/A</td>
</tr>
<tr>
<td>Press</td>
<td>Direct</td>
<td>Strong</td>
<td>Sustained</td>
<td>N/A</td>
</tr>
<tr>
<td>Flick</td>
<td>Indirect</td>
<td>Light</td>
<td>Sudden</td>
<td>N/A</td>
</tr>
<tr>
<td>Dab</td>
<td>Direct</td>
<td>Light</td>
<td>Sudden</td>
<td>N/A</td>
</tr>
<tr>
<td>Slash</td>
<td>Indirect</td>
<td>Strong</td>
<td>Sudden</td>
<td>N/A</td>
</tr>
<tr>
<td>Punch</td>
<td>Direct</td>
<td>Strong</td>
<td>Sudden</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Note.* Metaphoric name for each basic effort action reflects the kinaesthetic feeling of performing the action.

The *transformation drive* occurs when one of the motion factors space, weight or time is replaced by flow (Bartenieff & Lewis, 1980). There are three possible combinations: *passion* (weight, flow, time), *spell* (weight, flow, space), and *vision* (flow, time, space) (Bartenieff & Lewis, 1980). The transformation drive differs from
the action drive in that it is more expressive of mood, quality, or attitude rather than
goal oriented (Bartenieff & Lewis, 1980). Whereas the basic effort actions of the
action drive have distinct rhythmic phases of exertion and relaxation and are
performed over a relatively short duration, a transformation drive can last for longer
periods of time. As the transformation drive reveals qualitative states in general
human activity, it is probable that it also occurs in the activity of performing music.
A transformation drive and a basic effort action can not occur at the same time; they
follow one another in qualitative phrases. Each of the transformation drives and their
composition of motion factors and effort elements are shown in Table 6.2.

Table 6.2

<table>
<thead>
<tr>
<th>Metaphoric name</th>
<th>Motion factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Space (effort elements)</td>
</tr>
<tr>
<td>Passion</td>
<td>N/A</td>
</tr>
<tr>
<td>Spell</td>
<td>Indirect or Direct</td>
</tr>
<tr>
<td>Vision</td>
<td>Indirect or Direct</td>
</tr>
</tbody>
</table>

Note. "Has a feeling or emotive focus – either wildly passionate or gentle and sensitive. The elements of weight and time are highlighted whereas flow pulsates. "Has a focus of fascination or hypnotic quality as if time is standing still. The elements of space and weight are highlighted. Movement has a stabilised quality. "Has a mentally alert focus and a feeling of precision in time and place. A disembodied state as if one is drawn out of oneself. It can seem as if the individual is concerned with thought rather than the here and now. Or the individual is concentrating. The elements of space and time are highlighted.
6.8.4 The Effort Graph

The effort graph represents Laban’s system for notating effort consistent with the movement analysis system (Bartenieff & Lewis, 1980). Each of the four motion factors with their bipolar effort elements are represented in the effort graph (see Figures 6.4 & 6.5). The motion factors are depicted in a linear fashion. The lines representing weight (vertical) and flow (horizontal) motion factors intersect in the middle. The horizontal line representing the motion factor of time is broken by the vertical weight motion factor line. The space motion factor line is bent at a 90 degree angle between “twelve o’clock” and “three o’clock”. It is joined to the intersection between weight and flow by a diagonal line signifying the presence of movement (Bartenieff & Lewis, 1980). The end of each motion factor line represents the indulging or fighting quality of the continuum of effort. For example, the motion factor, weight, is represented by the vertical line. The top of the vertical line depicts light weight and the bottom end shows strong weight. To write in effort notation, each of the relevant motion factor lines is firstly identified. The end of each motion factor line that is relevant to the observed element of effort is recorded. This creates a unique symbol for each of the basic effort actions of the action drive, and each of the transformation drives – passion, spell, and vision. As an example, the basic effort action ‘punch’ comprising strong weight, direct space, and sudden time, is notated in Figure 6.6.
Figure 6.4. Effort notation graph showing the motion factors (Bartenieff & Lewis, 1980, p. 224).

Figure 6.5. Effort notation graph illustrating the effort elements (Bartenieff & Lewis, 1980, p. 225).
Figure 6.6. The basic effort action ‘punch’, comprising strong weight, direct space, and sudden time, notated symbolically in effort notation.

6.8.5 Shape

Shape requires analysis of movement with reference to the axes of space: vertical (rising or sinking), horizontal (widening or narrowing), and sagittal (advancing or retreating). Shaping reveals to what degree the whole body or person is involved in the activity. Postural effort shows that the person’s whole body is involved in the activity they are performing, rather than just the body part required to perform the job (gestural effort) (Bartenieff & Lewis, 1980; Lamb & Watson, 1979). Shaping features can be recorded symbolically using an extension of the effort graph (see Figure 6.7). These would be notated separately to the effort drive symbols. This is to avoid confusion as to the shaping feature observed. For example, a punch basic effort action accompanied by a sinking shaping feature would be notated as shown in Figure 6.8. However, this could also be interpreted as a punching action accompanied by a narrowing shaping feature because the parallel diagonal lines meet with the lines for strong weight and direct space.
6.9 Summary

Embodied cognition, as outlined here, provides a theoretical framework for investigating the production of, and motivation for bodily gestures accompanying expressive musical sound in solo marimba performance. It has been noted that performers can be acutely aware of their bodily movements and gestures in musical thinking during rehearsal. Intentional action resulting from expressive musical interpretation of a musical score may communicate and share performers’ expressive intention with observers. Visual and auditory sensory modalities may communicate expressive intent to observers. Kinaesthesia and motor imagery may provide means of understanding expressive behaviour through mirroring, or covert imitation of observed performer expressive functional movements and bodily gestures. The patterns of tensions and relaxations involved in an intentional motor program for
performance of an expressive interpretation of a piece of music may be subtly experienced by the observer. While movement tracking technology can account for temporal and spatial features of movement, it is as yet unable to account for force which is an important component of motion in expressive situations. Studies addressing the qualities of bodily gesture co-expressing musical sound in performance have been undertaken by few researchers.

Laban’s theory of effort asserts that expression in human movement stems from the dynamic rhythms of movement – tension, release and phrasing – and is revealed through observable movement. The principle assumption that LMA operates under, that inner motivations for movement manifest in observable movement, reflects the embodied basis of the analytical system. LMA provides a framework for analysing qualities in bodily gesture, and interpreting motivations for the creation of such gesture. It relies on kinaesthesis, drawing on embodied knowledge from the experience of performing or imagining performing the observed actions oneself, as well as visual observation. The effort and shape components of LMA are key to understanding expression in bodily movement and gesture. It has been argued that Effort-shape analysis and notation could form an effective movement meta-language enabling observed qualities of bodily gestures to be described and recorded on the musical score – the foundation of the performance. This approach of symbolically connecting movement and music has a long history in the field of dance.

Effort-shape analysis has been able to be applied to studying human movement in a variety of different contexts, from business settings to sport. This inspires confidence that it will easily apply without adaptation to studying the bodily gestures of marimba.
players. It is probable that the notation system will be an effective means of symbolically linking observations of bodily gesture with the musical score. Whether effort-shape concepts and analysis can be understood and implemented by other professional percussionists after some basic instruction will be investigated in the following chapter.

6.10 General Aims

The broad aim of this study is to understand motivations for the production of bodily gestures co-expressing with musical sound by solo marimba performers. Through LMA observation techniques, employing visual observation and kinaesthesis, the qualities observed in solo marimba performers’ bodily gestures will be identified and analysed. Effort-shape terminology will be used to describe the expressive qualities of bodily gestures. Interpretation of the gestural qualities will be made in conjunction with evidence in the musical score. This will reveal sources of motivation for performers’ production of bodily gestures. Finally, effort-shape notation will be implemented as a tool to connect observed and sensed movements with the musical score.
CHAPTER 7

A Qualitative Analysis of Bodily Gesture Accompanying Musical Sound in Solo Marimba Performance

Study 1
7.1 Preamble

Body movement is a necessary component in the process of bringing a musical score to sonic life. While performers move their bodies in order to produce sound from their instruments, they tend to move expressively as well. It has been demonstrated that performers’ bodily gestures can provide visual information that enhances the perception of musically expressive performances (Davidson, 1993; 1994; 1995; 2001, 2002b; McClaren, 1988; Wanderley et al., 2005; Vines et al., 2006). There is a need for further research in this area to develop effective methods to identify, analyse and understand the production of bodily gestures that enhance audience experience. The advent of technology has afforded researchers new methods to capture and measure movement quantity. However, effective methods are needed to document and analyse the qualities of bodily gestures in musically expressive performance (Davidson, 1994, 2002b, 2007).

The following study evolved from the results of Experiment 1. Projected excerpts presented in audio-visual form received higher expressiveness ratings than projected excerpts presented through sound only. Additionally, deadpan excerpts presented audio-visually received lower expressiveness ratings than deadpan audio-only presentations. A selection of eight projected and eight deadpan marimba performance excerpts were selected from the stimulus set of Experiment 1 for analysis to identify critical visual cues in projected performances. The procedure for selecting the specific excerpts is outlined in Section 7.4.2. The 16 excerpts of projected and deadpan solo marimba performance can be viewed on DVD (Appendix G). The aim of the study was to investigate the qualities in marimba performers’ bodily gestures. Initially, a preliminary study was conducted to begin to develop a framework for
movement analysis (See Appendix H). From the preliminary study, LMA observation techniques and effort analysis provided a framework that could be applied to the study of bodily movement qualities in marimba performance. Additionally, the analysis of shaping features displayed by the performer’s body identified shape as an important component of expressive qualities in bodily gestures. Effort-shape notation is developed as an effective and efficient means for recording observations symbolically.

7.2 Preparing Effort-Shape Analyses of Excerpts of Solo Marimba Performance

In preparation for the analysis of an excerpt, the researcher marked two parallel vertical lines above the stave in the musical score indicating the locations that were the beginning and the end of the action sequence for observation. Between these two markers, a horizontal line was drawn parallel to, and above the musical score (the *action stroke*) (see Musical Examples 7.1 - 7.16 later in this chapter). The action stroke indicated the presence of movement and marked out the section of music for analysis. The researcher analysed the qualities of the performers’ bodily gestures evident in each of the sixteen excerpts of marimba performance of two performers. This was conducted following the existing analytical framework of LMA involving visual observation and kinaesthesia. Attention was paid to identifying and describing effort and shape features. These observations were notated by hand in words and using effort and shape symbolic notation on the musical score at the locations where they were observed.
The researcher followed the same procedure in analysing each of the sixteen excerpts of marimba performance. Each excerpt was viewed many times over a period of a few days: 1) with sound, so as to focus attention on how the performer’s movements related to the musical score provided; and 2) without sound, to focus attention on bodily movement and gesture alone. Freedom was granted to stop and start playing the excerpt at will, especially when needed to observe a section in greater detail. Switching between watching the deadpan and projected performance of the same excerpt was also permitted and helped to distinguish movements that were necessary to play the notes of the piece, and movements that involved more effort.

With each viewing of the excerpt, attention was concentrated on one element of the analysis. Firstly, the absence of movement, or stillness, was identified and recorded by inserting a break in the action stroke line at the location where it was observed. Any basic effort actions of the action drive, or any transformation drives (passion, spell, vision) if present, were identified and recorded at the observed locations on the musical score. As mentioned in the previous chapter, a basic effort action and a transformation drive could not occur at the same time. However, they could follow one another in qualitative phrases. Observed basic effort actions and passion, spell and vision transformation drives were recorded above the action stroke. Basic effort actions and transformation drives were recorded in words using their metaphoric names (e.g. punch or passion). The relevant motion factors and related effort elements involved were recorded symbolically in effort notation illustrated by the effort graph.
Observed shaping features were recorded in metaphoric words with reference to the axis of space: rising or sinking (vertical), widening or narrowing (horizontal), or advancing or retreating (sagittal). Shaping features were also recorded symbolically below the action stroke. Where shaping features were observed in combination, for example rising and retreating at the same time, both symbols were notated, one on top of the other. This created a unique symbol featuring one set of parallel diagonal lines, signifying the presence of movement, with multiple single lines radiating identifying each type of shaping feature observed. As an example, a sinking and a widening shaping feature observed occurring together would be notated as in Figure 7.1. The symbolic notations made to record the drives and shaping features were positioned along the action stroke to match observed movements to points in the musical score.

Figure 7.1. Shape notation for a sinking and a widening shaping feature observed occurring together.

7.3 Aim and Research Questions

The aim of Study 1 was to identify and describe the expressive qualities of bodily gestures of two marimba players as witnessed in several projected and deadpan marimba performances through effort and shape analysis. Effort and shape notation was expected to be an effective tool for recording the observed expressive qualities of marimba players’ bodily gestures at the locations on the musical score where observed. The ultimate goal of this study was that effort-shape analysis and notation
may be used as an analytical tool for performers, teachers and students. Awareness of the concepts of effort and shape could provide a means to interpreting the different expressive qualities perceived through analysis of a musical score in an embodied manner. Additionally, effort-shape notation may provide a means of recording an individual performer’s embodied interpretation on the musical score.

If the system was intuitive and logical, it was predicted that independent professional percussionists would be able to understand and implement effort-shape analysis and notation. Through this understanding, good agreement would be reached with the suggested effort-shape analyses of two marimba players’ bodily gestures observed in audio-visual excerpts of marimba performance. It was expected that performers’ bodily gestures would reveal a greater amount of effort and shaping features in projected performances in comparison with the same excerpt performed in a deadpan manner. Effort-shape notation would be implemented as a means of linking observations to the related locations in musical score. Interpreting the information given in the musical score at these locations would shed light on the motivations for the bodily gestures observed.

7.4 Method

7.4.1 Participants
Two professional percussionists who were experienced marimba players (1 male, 1 female) independently analysed a marimba performer’s bodily gestures in sixteen selected audio-visual excerpts of projected and deadpan marimba performances.
7.4.2 Stimuli

Sixteen audio-visual recordings of 20 to 25 second excerpts of solo marimba performance were selected from the stimulus material used in Experiment 1. In Experiment 1, 24 musically trained and 24 non-musically trained participants were presented with sixteen audio only, and sixteen audio-visual excerpts of performances of marimba repertoire. Each condition contained excerpts performed by a male and a female professional percussionist and marimba player in an intention with minimal expression (deadpan), and in an expressive public performance intention (projected). Participants were asked to rate each excerpt from both conditions on two, separate, seven-point Likert scales for interest (very uninterested-very interested) and expressiveness (very inexpressive-very expressive). The present study used the ratings from the expressiveness dependent variable attributed to the male and female performers in the audio-visual condition.

An initial eight excerpts were selected. Of the eight selected excerpts, four excerpts that were selected received ratings in the top 17.71% for expressiveness, and the other four excerpts received ratings in the bottom 11.46% for the same dependent measure. The four highly-rated excerpts were performed in a projected manner (that consistent with public performance) and the four poorly-rated excerpts were performed in a deadpan manner (with minimal expressive interpretation of the music). Of the four projected performances, half were performed by a male and the other half by a female marimba player. Two of the four deadpan performances were performed by the male, and the other two by the female performer. In addition, a fast and a slow tempo excerpt performed by both the male and female performer was represented in the four projected and four deadpan audio-visual excerpts. Finally, the matching excerpts
performed in the opposite manner to each of the eight selected were chosen for comparative analyses. This made up the total of sixteen excerpts. The excerpts were drawn from *Suite No.2 for Solo Marimba, III* by Japanese composer and marimba player Takayoshi Yoshioka (1995), *Marimba Dances, II & III* by Australian composer Ross Edwards (1990), *Nancy* by French composer Emanuel Séjourné (1989), and *Merlin, I* by Andrew Thomas (1985) from the United States of America.

All of the selected 20 to 25 second audio-visual (.avi) excerpt files were individually imported into a new sequence window in the video editing program Adobe Premier Pro 1.5. An opaque box was included on the screen masking the head in each excerpt and thus, any facial expressions. Aside from the face, the head of the performer and any head movements were visible. Each excerpt was preceded by a title screen introducing each excerpt. Chapter markers were set at the beginning of each title and excerpt. Table 7.1 represents the order of excerpts. The sequence was then imported into the Master Timeline window and the auto-colour correction effect was applied from the effects window to balance noticeable lighting changes across all excerpts. The sequence was then exported from the Master Timeline window to DVD for playback on commercially available DVD players and televisions.

The final component of the stimulus material was the section of musical score related to each audio-visual excerpt of marimba performance. Each excerpt of musical score featured the researcher’s effort-shape analyses of the performers’ bodily gestures recorded in words and symbolic notation.
Musical Examples 7.1 and 7.2 are notated in effort and shape symbolic notation with the names for the symbols provided to assist in understanding. Musical Examples 7.3 to 7.16 are notated in effort and shape notation only.

Table 7.1

*Presentation Order of the 16 Excerpts Analysed in terms of Effort and Shape*

<table>
<thead>
<tr>
<th>Excerpt No.</th>
<th>Performance Manner</th>
<th>Performer Gender</th>
<th>Tempo</th>
<th>Selected or Comparison excerpt</th>
<th>Mean Expressiveness Rating (min. = 1, max. = 7)</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Deadpan</td>
<td>Male</td>
<td>Slow</td>
<td>Selected</td>
<td>2.75</td>
<td>1.58</td>
</tr>
<tr>
<td>2</td>
<td>Projected</td>
<td>Male</td>
<td>Slow</td>
<td>Comparison</td>
<td>4.75</td>
<td>2.25</td>
</tr>
<tr>
<td>3</td>
<td>Deadpan</td>
<td>Female</td>
<td>Slow</td>
<td>Selected</td>
<td>3.13</td>
<td>1.46</td>
</tr>
<tr>
<td>4</td>
<td>Projected</td>
<td>Female</td>
<td>Slow</td>
<td>Comparison</td>
<td>5.00</td>
<td>1.41</td>
</tr>
<tr>
<td>5</td>
<td>Deadpan</td>
<td>Male</td>
<td>Fast</td>
<td>Selected</td>
<td>3.63</td>
<td>1.41</td>
</tr>
<tr>
<td>6</td>
<td>Projected</td>
<td>Male</td>
<td>Fast</td>
<td>Comparison</td>
<td>5.75</td>
<td>0.89</td>
</tr>
<tr>
<td>7</td>
<td>Deadpan</td>
<td>Female</td>
<td>Fast</td>
<td>Selected</td>
<td>4.00</td>
<td>1.85</td>
</tr>
<tr>
<td>8</td>
<td>Projected</td>
<td>Female</td>
<td>Fast</td>
<td>Comparison</td>
<td>6.63</td>
<td>0.52</td>
</tr>
<tr>
<td>9</td>
<td>Deadpan</td>
<td>Male</td>
<td>Slow</td>
<td>Comparison</td>
<td>5.50</td>
<td>1.31</td>
</tr>
<tr>
<td>10</td>
<td>Projected</td>
<td>Male</td>
<td>Slow</td>
<td>Selected</td>
<td>6.25</td>
<td>0.89</td>
</tr>
<tr>
<td>11</td>
<td>Deadpan</td>
<td>Female</td>
<td>Slow</td>
<td>Comparison</td>
<td>5.00</td>
<td>2.14</td>
</tr>
<tr>
<td>12</td>
<td>Projected</td>
<td>Female</td>
<td>Slow</td>
<td>Selected</td>
<td>6.00</td>
<td>0.93</td>
</tr>
<tr>
<td>13</td>
<td>Deadpan</td>
<td>Male</td>
<td>Fast</td>
<td>Comparison</td>
<td>4.13</td>
<td>1.89</td>
</tr>
<tr>
<td>14</td>
<td>Projected</td>
<td>Male</td>
<td>Fast</td>
<td>Selected</td>
<td>6.38</td>
<td>0.74</td>
</tr>
<tr>
<td>15</td>
<td>Deadpan</td>
<td>Female</td>
<td>Fast</td>
<td>Comparison</td>
<td>5.63</td>
<td>0.74</td>
</tr>
<tr>
<td>16</td>
<td>Projected</td>
<td>Female</td>
<td>Fast</td>
<td>Selected</td>
<td>6.88</td>
<td>0.35</td>
</tr>
</tbody>
</table>

*Note.* Mean expressiveness ratings and standard deviations collapsed across musically-trained and musical-untrained participants.

### 7.4.3 Equipment

The .avi files were edited, sequences created and exported to DVD using Adobe Premier Pro 1.5. The excerpts were viewed by two expert auditors via commercially available televisions and DVD players.
7.4.4 Procedure

After the researcher had completed effort-shape analyses of the bodily gestures observed in the sixteen excerpts of marimba performance and notated each analysis on the accompanying musical scores, the DVD of the annotated musical scores were distributed to two expert auditors. The expert auditors were asked to view each audio-visual excerpt on the DVD and indicate their agreement with a tick (✓) or disagreement with the analyses with a cross (✗) on the musical score. They were also invited to offer alternate analyses, though only the forced-choice agreement would be reported. A copy of the information and instructions distributed to the expert auditors can be found in Appendix I.

7.5 Results and Discussion of Effort-Shape Analyses

The first aim of the present study was to identify and describe the expressive qualities of marimba players’ bodily gestures witnessed in several projected and deadpan marimba performances through effort and shape analysis. It was predicted that professional percussionists would be able to understand the concepts of effort-shape analysis and notation. In turn, this would enable decisions as to agreement with the researcher’s effort-shape analyses of marimba players’ bodily gestures observed in video excerpts of marimba performance notated on the musical scores. Success of the system of analysing the expressive qualities of marimba players’ bodily gestures is evident in 97.5 and 96.11% agreement between the researcher’s analyses and those of the two expert auditors. The percentages reflect only positive agreement with action drive, transformations drive, and shaping observations suggested by the researcher.
Effort and shape notation was expected to be an effective tool for recording observations of effort and shape on the musical score at the locations where observed. From the point of view of the researcher, while effort and shape notation was a little tricky to grasp immediately, after some practice, it provided a quick and effective means of recording observations of the expressive qualities of performers’ bodily gestures at precise locations on the musical score. The expert auditors reported using shape notation as a means of noting their own analyses as they gained more experience with the concepts of shape analysis. This enabled faster comparison with the analyses recorded by the researcher. Effort analyses were compared primarily through metaphoric names for basic effort actions and transformation drives.

Effort notation was most effective in the recording of basic effort actions more than transformation drives. However, effort notation lacked a capacity to indicate duration (the motion factor time refers to the performer’s attitude towards time – whether they appear hurried or at leisure). As such, it worked best linking basic effort actions, being rhythmic in nature, to rhythmic elements (notes or rests), or structural elements (phrasing) where the natural duration of a basic effort action matched the length of note or phrase. In an attempt to indicate duration for transformation drives occurring over longer periods and not necessarily coincide with rhythmic or structural elements, the researcher drew a horizontal line after the effort notation. The length of this line indicated the duration of the effort (see Musical Example\(^1\) 7.6, first symbol notated above the action stroke). Shape notation was an effective tool for recording observed shaping features. Similar to effort notation, shaping notation lacked the capacity to

\(^1\) Musical Examples are grouped together at the end of this chapter for ease of comparison and to avoid disrupting the text significantly.
indicate duration. Therefore, where a shaping feature evolved over a longer duration than indicated than inherent in the action, the researcher drew a horizontal line after the shape notation (see Musical Example 7.8, bars 3 and four of effort-shape analysis). The length of the line indicated the duration of the action. Another innovation was to symbolically notate shaping features that were observed in combination, for example rising and retreating at the same time, one on top of the other. This created a unique symbol featuring one set of parallel diagonal lines, signifying the presence of movement, with multiple single lines radiating identifying each type of shaping feature observed (see Musical Example 7.2, last symbol notated below the action stroke at the end of the first line). An additional development implemented by the researcher was the use of brackets around effort or shape notations. Brackets indicated that the basic effort action(s), transformation drive(s), or shaping feature(s) observed, was of a smaller scale than usual. As an example, see Music Example 7.1, second symbol notated.

It was expected that the performers’ bodily gestures would reveal a greater amount of effort and shaping features in projected performances in comparison with matching deadpan performances. This was observed with projected performances showing more use of different effort qualities and shaping features than deadpan performances. Comparatively, in deadpan performances, only occasional basic effort actions were observed and no transformation drive or shaping feature was displayed. Table 7.2 tallies the basic effort actions, transformation drives and shaping features observed across projected and deadpan performances.
Table 7.2

*Number of Observations of Basic Effort Actions, Transformation Drives and Shaping Features (by Metaphoric Name) in Eight Deadpan Performance Manner, and Eight Projected Performance Manner Audio-Visual Excerpts of Solo Marimba Performance*

<table>
<thead>
<tr>
<th>Effort or shape metaphoric name</th>
<th>Number of observations in projected performances</th>
<th>Number of observations in deadpan performances</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic effort action</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dab</td>
<td>28</td>
<td>1</td>
</tr>
<tr>
<td>(Dab)</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Punch</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>(Punch)</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Float</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>(Float)</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Press</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>(Press)</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Glide</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>(Flick)</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Transformation drive</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vision</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Spell</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Passion</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td><strong>Shaping feature</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rising</td>
<td>58</td>
<td>0</td>
</tr>
<tr>
<td>(Rising)</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Sinking</td>
<td>69</td>
<td>0</td>
</tr>
<tr>
<td>(Sinking)</td>
<td>13</td>
<td>0</td>
</tr>
<tr>
<td>Widening</td>
<td>31</td>
<td>0</td>
</tr>
<tr>
<td>Advancing</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Retreating</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

*Note. Smaller versions of each basic effort action or shape feature are listed in brackets.*

Comparison of projected and deadpan performance versions of an excerpt performed by the same musician highlighted differences between functional bodily movements, necessary to play the notes of the piece, and bodily gestures used for expressive purposes. This enabled focussing attention on bodily gestures in the projected
performances for analysis. Bodily gestures observed will be discussed in effort and shape terms. Possible explanations and motivations for the bodily gestures observed, from an interpretation of evidence in the musical score, will also be discussed. However, firstly observations of movement and stillness will be presented.

### 7.5.1 Movement and Stillness

A total of five breaks in the action stroke (the horizontal line drawn above and parallel to each system of the musical score indicating the presence of bodily movement), indicating moments of stillness were noted in the projected performances. Six moments of stillness were observed with breaks in the action stroke in the deadpan performances. The majority of still moments in the deadpan performances did not match with those in the projected performances. Predominantly, in both the projected and deadpan performances, the observed breaks in the action stroke occurred where there were rests printed in the musical score (see Musical Example 7.1, deadpan performance effort-shape analysis, and Musical Example 7.4, projected performance effort-shape analysis). There were only three occasions where stillness was observed in the absence of printed rests. Two of these occurred in deadpan performances. One occurrence was between a chord and its repetition (See Musical Example 7.13, bar 3) meaning no movement was required to reposition for different notes. The other occurrence was between a single note and then a chord incorporating that same note. In this case, the tempo was sufficiently slow that there was time to wait before the chord was due to be struck (See Musical Example 7.11, bar 1 of effort-shape analysis). On one occasion a break in the action stroke was observed in a projected performance in the absence of printed rests. This moment of stillness occurred where a single note was being sustained at a quiet dynamic (pp) and the tempo was slow
(See Musical Example 7.4, line 2, third break in the action stroke). This stillness may have reflected the performer’s intention to reflect the still, peaceful, quiet mood of the piece with minimal movement – hence an interpretive decision (Wanderley, 2002).

It was noted that stillness in the projected and deadpan performances appeared to have different expressive qualities. In the deadpan performances the performers looked disinterested, or disengaged, in their performance and the stillness seemed to imply mere conservation of energy. Conversely in the projected performances, stillness appeared to be expressively charged and integral to the performer’s expressive interpretation of the piece. For example, in an excerpt performed in a projected manner, the same passage of music involving three points of silence between notated phrases (with notated rests) occurred twice. On the repeat passage, no stillness was observed where there were notated rests between the phrases in contrast to the first time the section of music was performed (see Musical Example 7.16, compare 9-11 with bars 13-15). A possible reason may relate to the performer intending to provide a different musical interpretation during the repeated passage.

### 7.5.2 Effort Analysis

Of the eight basic effort actions across the 16 excerpts, six were observed namely, punch, press, dab, glide, float and flick. Slash and wring were not observed in any of the sixteen excerpts of marimba performance analysed. This is not surprising as slashing and wringing are actions that would not be conducive to playing the marimba in the traditional, classical manner. Smaller versions of punch, press, dab, float and flick were also observed (notated in brackets). Table 7.3 lists the metaphoric names of the basic effort action, with smaller versions listed in brackets, and sorted by the
number of times each was observed. The excerpts of marimba repertoire analysed were representative of normal performance techniques and musical styles in the genre. The specific number of each type of basic action observed likely reflects expressive features of the excerpts of musical composition analysed.

Table 7.3

<table>
<thead>
<tr>
<th>Basic effort action metaphoric name</th>
<th>Number of observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dab</td>
<td>29</td>
</tr>
<tr>
<td>(Punch)</td>
<td>22</td>
</tr>
<tr>
<td>Punch</td>
<td>20</td>
</tr>
<tr>
<td>Float</td>
<td>15</td>
</tr>
<tr>
<td>(Dab)</td>
<td>14</td>
</tr>
<tr>
<td>Glide</td>
<td>7</td>
</tr>
<tr>
<td>(Float)</td>
<td>4</td>
</tr>
<tr>
<td>Press</td>
<td>3</td>
</tr>
<tr>
<td>(Press)</td>
<td>3</td>
</tr>
<tr>
<td>(Flick)</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note.* Smaller versions of each basic effort action are listed in brackets.

While the majority of basic effort actions were observed in projected performance excerpts, a few were witnessed in deadpan performances. The basic effort actions and their smaller versions observed in both projected and deadpan performance excerpts were: dab (dab), float, (float) and (punch). The basic effort actions that appeared in the deadpan performances were usually of the same, or similar, type to that witnessed at the same location in the matching projected performance excerpt, though to a lesser degree. The unexpected occurrence of these effort actions in deadpan performances may be the result of the performers’ engrained motor programs for the projected performance of the same excerpt being difficult to inhibit (Wanderley et al., 2005).
Alternatively, their existence may be due to exertions of effort required to reach the notes stipulated by the musical score – hence instrumental technique (Davidson, 1994, 2002b, 2007; Wanderley, 2002).

The dab, and smaller version (dab) basic effort actions were observed in projected and deadpan performances where the dynamic range was quiet \((ppp)\) to a medium \((mf)\) level. In the excerpts analysed, dabbing actions were observed connected to notes that highlighted points of climax within phrases. These were phrases implied by the musical structure and performer interpretation (see Musical Example 7.4, third effort drive notation from the beginning of the effort-shape analysis). The excerpts analysed contained few notated phrase markings. In those excerpts that did contain notated phrases, a dabbing action was not musically warranted (see Musical Example 7.9). Dabbing actions were only observed in relation to single notes, and not those marked for a sustaining roll technique. To perform a roll and create the illusion of a sustained sound, the performer rapidly alternates between hands or individual mallets. Within the dynamic range noted, dabbing actions were observed at notes marked with tenuto and accent signs in the musical scores (see Musical Example 7.7, bars 9-10, 16 and 22 of the effort-shape analysis, and Musical Example 7.8, bars 2-12 and 17-22 of the effort-shape analysis). Dabbing actions were also observed where agogic\(^2\) accents, interpreted from the musical notation, highlighted rhythmic groupings and punctuated the metrical structure (see Musical Example 7.16, bars 1-7 of the effort-shape analysis). Performer interpretation appeared to play a role in the use of dabbing

\(^2\) Agogic: “An Adjective indicating a variety of accentuation-not that which is bound up with the regular pulsation of the music (the 2 beats in a measure, or whatever it may be), but that which is called for by the nature of any particular phrase of the music.” (The Concise Oxford Dictionary of Music: Scholes, 1964, p.11).
actions witnessed linked to rhythmic groupings, punctuating the metrical structure with agogic accents (Wanderley, 2002; Wanderley et al., 2005).

Punch basic effort actions were primarily observed linked to accent markings, in sections of music marked at a loud dynamic (f or ff) in the musical scores (e.g. see Musical Example 7.16, bars 2, 4, 6, 8 of the effort-shape analysis). However, an accent marking coupled with a loud dynamic marking in the score was not always predictive of a punching action. A few locations were observed where accents were recorded in the score, but no punching actions were observed in the video (see Musical Example 7.16, bars 12 and 16 of the effort-shape analysis). A possible explanation for this relates to a physiological cause. A punching action at these points would disrupt the flow of the performance and interfere with performer comfort and ability to play the specified notes. An example would be a series of accented notes of a short duration requiring performance one after another at a fast tempo. Punch basic effort actions were also observed at some locations in the score where no accents were marked (see Musical Example 7.16, bars 17 and 19 of the effort-shape analysis). A possible reason for the punch basic effort action on these occasions could be the assistance provided the performer in a technical matter such as ‘grounding’ or ‘planting their body’ giving a reference point for tempo control (Davidson, 2001). Other explanations may relate to personal interpretation of the music (Wanderley, 2002) or highlighting structural issues such as harmonic change (Clarke & Davidson, 1998; Davidson, 2002b, 2007).

The smaller version of punch, (punch), was observed at some points of climax within implied phrases of a quite dynamic range (ppp-p) (see Musical Example 7.2, fourth
symbol of the effort notation). One such case involved a note marked with an indication for a roll on the note (see Musical Example 7.4, line 2, sixth symbol of the effort notation). Small punching actions were also observed highlighting rhythmic groupings in an uneven metrical structure at a loud dynamic level (f) (see Musical Example 7.8, bars 9-12 of the effort notation). Small punching actions were observed in projected performances where accent markings at a medium level dynamic (mp-mf) were notated in the score (see Musical Example 7.14, bars 2 and 10 of the effort notation). Whereas in projected performances a pronounced punching action would usually correlate to notes marked with an accent at a loud dynamic level (f-ff), in the deadpan performances, a small punching action was observed in relation to such locations (see Musical Example 7.15, bars 2, 4, 6, 8, 12). As mentioned earlier, this may be the result of difficulty in inhibiting an engrained expressive motor program, or due to an issue of instrumental technique (Wanderley et al., 2005). (Punch) was also observed in relation to a staccato marking in the score where the performer used a deadstroke (pressing the mallet heads into the bar as the bar is struck to shorten the duration of sound) (see Musical Examples 7.11 and 7.12, bar 4 of the effort notation). Finally, (punch) was observed at a tenuto marking in a deadpan performance (see Musical Examples 7.11, bar 4 of the effort notation). Press basic effort actions were observed at the staccato marking and the tenuto marking in the projected version of the same performance excerpt Musical Example 7.12, bar 4 of the effort notation). Press and punch have two effort elements of the possible three, in common: direct space and strong weight. Press, and the smaller version (press), actions were also observed at locations where there were no tenuto markings in the score, but the performer seemed to be implying a tenuto, or lengthened, feel to the notes Musical Example 7.6, bars 3-5 of the effort notation).
The float, and smaller version (float), basic effort actions were observed as preparatory movements prior to the commencement of notated, or implied, phrases (see Musical Example 7.4, line 2, first, fourth and eight symbols of the effort notation). These points usually coincided with rests notated in the score, or breath marks (see Musical Example 7.10, third and ninth symbols of the effort notation). Occasionally a floating action was observed after the completion of a phrase at a quiet dynamic (see Musical Example 7.6, last symbol of the effort notation). The flick, or (flick), basic effort actions were variations on float, or (float) basic effort actions. Out of a possible three, they have the effort elements of indirect space and light weight in common. They differ only in time with flick displaying a sudden approach to time and float a sustained approach. They both operate as preparatory movements to the commencement of a phrase, such as a sudden (flick) (see Musical Example 7.10, last symbol of the effort notation) or more sustained (float) inhalation that precedes a stream of speech.

The glide basic effort action was observed with the performance of several notes making up a short notated phrase at a quiet dynamic in projected performance at a fairly fast tempo (see Musical Example 7.16, bars 9-11 and 13-15 of the effort notation). A gliding motion was also observed as the performer moved in an expressive manner from the lower range of the instrument to play notes in the upper range (see Musical Example 7.8, bar 8 of the effort notation).

In general, projected performances of pieces of a fast and rhythmic nature featured a lot of dab and punch basic effort actions. Press was observed in projected
performances of pieces of a more sustained, lyrical style. Glide was observed in conjunction with the performance of short notated phrases at a quiet dynamic level. These occurred in the projected performance of a predominantly fast, rhythmic piece. Floating basic effort actions served as preparatory movements prior to the commencement of a phrase, or at the completion of a phrase at a quiet dynamic. A flick operated as a sudden preparatory movement to a phrase.

Observing and analysing the mood-like qualities of the metaphorically named passion, spell and vision transformation drives, was the most difficult part of the analytical process. Isolating basic effort actions and shaping features first aided observation. Kinaesthesis proved to be most important in the process. Mirroring the performers’ bodily movements helped to analyse transformation drives through experiencing the mood-like, or affective, qualities of vision, passion, and spell. Transformation drives were only observed in projected performances. All three transformation drives (vision, passion, and spell) were observed in conjunction with shaping features, but not basic effort actions. There were no particular links between transformation drives and explicit markings in the musical score. It appears they were employed as the performers’ individual musical interpretations saw fit. Transformation drives were more difficult to match precisely with individual notes, or specific locations, in the musical score as they did not feature distinct phases of initiation and completion as basic effort actions did. Additionally, their duration could be quite lengthy in comparison.

The vision transformation drive was observed at locations where the performer appeared to increase their focus on locating and striking the correct notes, or
concentrate on reading the musical score (e.g. see Musical Example 7.2, ninth symbol of the effort notation). The passion transformation drive, displaying the performer’s attitude or affective feeling towards a passage being performed, seemed evident in two states. In one type of state, the performer appeared more wild, or to ‘let go’ absolute control (see Musical Example 7.2, line 1, second last symbol of the effort notation). In the other state, passion seemed to be of a more gentle quality as if caressing something loved (see Musical Example 7.4, first and second symbols of the effort notation). The spell drive appeared as a hypnotic state where time seemed to briefly stand still (see Musical Example 7.2, third and ninth symbols of the effort notation).

7.5.3 Shape Analysis

The parts of the body not directly involved in the production of sound (e.g. the torso, head, upper arms and legs) displayed shaping features on the vertical, horizontal and sagittal axes of space. Shaping features deemed to be expressive, as compared to functional bodily movements incurred in reaching the notes to play, were only observed in projected performances. Observations of expressive shaping features occurring throughout the entire body, or evident in only one part of the body, were recorded. No shaping features were observed in the deadpan performances.

The projected performances featured a slightly sinking posture, or contracting of the upper body toward the abdominals, on the vertical axis throughout performance. This posture appeared to express postural effort, or involvement of the whole body in the performance (Bartenieff & Lewis, 1980). Rising and sinking (vertical axis), widening (horizontal axis), and advancing and retreating (sagittal axis) were observed as
deviations from the primary contracted posture. These shaping features appeared to reflect dynamic markings in the score. For example, a quiet dynamic was often correlated with a predominantly sunken posture and a loud or intense dynamic was often linked to a more upright rising posture (see Musical Example 7.16, bars 1-8 of the shape notation) (Camurri et al., 2004). Sinking postures were also observed at the bottom peaks of phrases, and rising postures at the top peaks of phrases in slow tempo excerpts (see Musical Example 7.10, line 1, last three symbols of the shape notation). Sometimes phrasing was notated, but at other times, the performers’ interpretation of implied phrasing was accompanied by postural adjustments. Changes between sinking and rising postures reflecting building or diminishing dynamics or phrasing, often involved other shaping features including widening, advancing, or retreating (see Musical Example 7.12, sunken posture leading to upright posture with some widening in shape notation). The amount and pattern of shaping able to be used in the context of dynamics and phrasing was constrained by the tempo and location of notes to be struck, or technical difficulty. Alternating rising and sinking postures also served as a rhythmic, pulsing motion to keep time in excerpts of a slower tempo (see Musical Example 7.10, line 1, of the shape notation).

Rising postures were often observed coordinated with a punching basic effort action. These were quickly followed by a sinking posture as recovery from the exertion of effort (see Musical Example 7.16, bars 2-9 of the shape notation). Sinking postures observed prior to punching actions were interpreted as preparatory for an exertion of effort to perform the punch (see Musical Example 7.16, bars 16-19 of the shape notation). The same pattern of postural movement was often observed in conjunction with a press basic effort action, though at a slower rate of change (see Musical
Example 7.6, bars 2-3 and 4-5 of the shape notation). Smaller punches and dabbing basic effort actions were sometimes observed with similar rising and sinking postures though of a smaller range of movement (see Musical Example 7.8, bars 9-12 of the shape notation). Shaping features seemed to be linked to exertion of effort and modified by functional bodily movement, musical structure, expressive markings and interpretive concerns as noted in the effort analysis above (Davidson, 1994, 2002b, 2007; Wanderley, 2002).

7.5.4 Elements of the Effort-Shape Analytical System Identified for Refinement

Two issues were raised in discussion with the expert auditors. One involved a decision as to the minimum amplitude of a shaping movement to be considered expressive and to be notated. We did come to a consensus relying on our own decision as to what point to differentiate between expressive and inexpressive bodily movement. While there was good agreement with the suggested analyses of shaping, one of the expert auditors offered a few extra suggestions for shaping features.

The other issue involved the point of decision for differentiation between basic effort actions, or transformation drives. While the expert auditors agreed in the main with the analysed interpretation of basic effort actions, there were occasional points of contention between borderline cases (e.g. dab and glide, or a small punch and dab). It was often the case that the two contentious basic effort actions had two of the three motion factor effort elements in common, indicating that they were very similar.

Therefore future research, possibly using motion tracking technology and perceptual responses, could examine the point at which one effort action becomes another, or the
minimum amplitude necessary to distinguish expressive and inexpressive shaping features.

7.6 General Discussion

The present study sought to build on previous research to develop an effective framework and tool for analysing and recording the qualities of gestures observed in music performance (Davidson 2001, 2007). Effort-shape analysis and notation systems provided an effective and efficient method for identifying, describing, and recording bodily gestures observed in marimba performance (McClaren, 1988). In addition, it was able to be understood and employed by two professional percussionist performing and teaching musicians (McClaren, 1988). LMA observation techniques and effort-shape analysis provided a framework for investigating the qualities displayed in the bodily gestures of solo marimba players revealing possible motivations behind such movements (Bartenieff & Lewis, 1980; Levy & Duke, 2003).

The concept of kinaesthetic empathy, covert imitation, or corporeal imitation was helpful in discerning different expressive qualities in observed bodily gestures (Cox, 2001; Leman & Camurri 2005-2006; Moore & Yamamoto, 1988). Physical mirroring appeared to play an important role in perceiving expressive qualities in bodily gestures (Laban, 1988). It may be that expressive qualities perceived through kinesthesia in the analytical process involve experiencing similar muscular tensions and relaxations as those of the performers (Gellrich, 1991). The significance of an embodied, or Dalcrozan, approach to expressive marimba practice and performance (Davidson & Correia, 2001, 2002; Galvao & Kemp, 1999; Juntunen & Hyvonen,
2004; Seitz, 2005) is great as it may result in embodied perception of intended expression by observers.

The effort-shape analyses presented here support and add to findings from other studies. Performances with an intended projected level of expression not only displayed a greater amount of movement than performances with an intended deadpan level of expression, but also demonstrated different qualities in bodily movement and stillness (Davidson, 1994, 2002b). The analyses of the projected marimba performances demonstrated evidence that effort and shape could occur in a somewhat continuous stream. However, this seemingly continuous stream, in fact, comprised discrete locations of basic effort actions and transformation drives with shaping features occurring in combination or isolation following another in fairly quick succession. Further, exertions of effort and shape comprising expressive bodily gesture could be related to specific locations in the musical score (Clarke & Davidson, 1998; Davidson, 2002b, 2007). In the deadpan performance, an exertion of effort was observed on only a few occasions linked to specific points in the musical score.

In seeking relationships between observed functional bodily movements, bodily gestures, and motivating factors evidenced in the musical score, anatomical/physiological, or technical constraints, issues of musical structure (Davidson, 2002b, 2007; Wanderley, 2002), and interpretive issues (Wanderley, 2002) influenced conclusions. The analyses and interpretation of bodily movements and gestures, with regard to the musical score, appeared to demonstrate the integration of technical, or functional bodily movements, bodily gestures (Davidson, 1994, 2002b; Wanderley, 2002) and postural attitudes (Ruggieri & Katsnelson, 1996) in the
performer’s motor program as suggested in other studies. In very general terms, all body parts seemed to operate together as a coordinated mechanism. In some cases, functional bodily movement and bodily gesture appeared inseparable. A similar assertion was made by Davidson (2001) who proposed that obvious bodily expression may be the combination of functional bodily movements and bodily gestures.

Analyses of performers’ expressive bodily movements need to consider the movements that are necessary for sound production. Bodily gestures were constrained, and probably shaped by the technicalities of functional bodily movements involved in producing the desired sonic interpretation through the instrument (Davidson, 1994; Wanderley, 2002). Movements in difficult passages were limited to those necessary for technical execution (i.e. the arms and to a lesser degree, the torso, head, legs and feet) (Wanderley et al., 2005). Passages that were easier to play did not always result in an increase in bodily gestures (Wanderley et al., 2005). There had to be a level of expression, either notated in, or able to be interpreted from, the score to warrant projection in an expressive performance.

Issues relating to musical structure and interpretation seem to be linked to performance components. Musical considerations influencing the use of particular qualities of bodily gestures involved notated and implied phrasing (Davidson, 2002b; Wanderley et al., 2005), and metrical considerations including notated and interpreted rhythmic groupings (Wanderley et al., 2005). The close association of bodily gestures and musical structure was evidenced by the prevalence of preparatory movements to phrases, and the usual absence of movement at rests between phrases (Clarke and Davidson, 1998). Other musical factors influencing expressive bodily movements
included dynamics (Camurri et al., 2004), and the performance of printed or interpreted accents (Dahl, 2000) and tenutos marking points of emphasis.

Effort and shape notations were useful in uniting qualities observed in bodily gestures and evidence in, and interpreted from the musical score. Motion tracking technology has enabled recording of performers’ bodily movements in real time (Clarke & Davidson, 1998; Davidson, 1994, 2002b; Wanderley, 2002; Wanderley et al., 2005). However, methods of analysing, interpreting, and recording the qualities of expression perceived in bodily gestures in music performance as they unfold in time has been a challenge for researchers in the field (Clarke & Davidson, 1998; Davidson, 1994, 2001, 2002b, 2007). There are problems hypothesising about causes of bodily gestures in real time kinematics only, as force or effort is not taken into account. Effort-shape analysis and notation systems may prove to be very useful in gaining greater understanding of bodily gestures in music performance. The new system while still in development may complement current technology and enable the test of specific hypotheses \textit{a priori}.

Outcomes of this study have the potential to inform innovative research in music performance for the benefit of students in music educational settings, right through to elite performance. Such research could explore whether the effort-shape analytical framework and notation systems can be employed in the study of bodily gestures of performers of other instruments, or even singers. It would be worthwhile to investigate whether, with training, musicians could apply effort and shape concepts and notation systems to analysing and interpreting scores in preparing their \textit{individual} embodied musically expressive performance. This is not a prescriptive system, but a
system that is flexible and open to many individual differences. Future research could also involve a physiological analysis for factors such as muscle contraction to confirm observers’ perception of movement qualities such as force.
7.7 Musical Examples

Musical Example 7.1. Selected excerpt - effort-shape analysis of Marimba Dances, II, by Ross Edwards (1990), lines 10-11 as performed by a male marimba player in a deadpan manner. This is a slow tempo excerpt. Experiment 1 mean expressiveness rating = 2.75, SD = 1.58.

Musical Example 7.2. Comparison excerpt - effort-shape analysis of Marimba Dances, II, by Ross Edwards (1990), lines 10-11 as performed by a male marimba player in a projected manner. This is a slow tempo excerpt. Experiment 1 mean expressiveness rating = 4.75, SD = 2.25. Shaping features, recorded below the horizontal action stroke line, are recorded using the first letter of the name of the shape – R = Rising, S. = Sinking, W = Widening, A. = Advancing, Re. = Retreating.
**Musical Example 7.3.** Selected excerpt - effort-shape analysis of *Marimba Dances, II*, by Ross Edwards (1990), lines 8-9 as performed by a female marimba player in a deadpan manner. This is a slow tempo excerpt. Experiment 1 mean expressiveness rating = 3.13, SD = 1.46.

**Musical Example 7.4.** Comparison excerpt - effort-shape analysis of *Marimba Dances, II*, by Ross Edwards (1990), lines 8-9 as performed by a female marimba player in a projected manner. This is a slow tempo excerpt. Experiment 1 mean expressiveness rating = 5.00, SD = 1.41.
Musical Example 7.5. Selected excerpt – effort-shape analysis of *Nancy*, by Emmanuel Séjourné (1989), bars 6-12 as performance by a male marimba player in a deadpan manner. This is a fast tempo excerpt. Experiment 1 mean expressiveness rating = 3.63, $SD = 1.41$. 
Musical Example 7.6. Comparison excerpt – effort-shape analysis of Nancy, by Emmanuel Séjourné (1989), bars 6-12 as performance by a male marimba player in a projected manner. This is a fast tempo excerpt. Experiment 1 mean expressiveness rating = 5.75, SD = 0.89.
Musical Example 7.7. Selected excerpt – effort-shape analysis of Marimba Dances, III, by Ross Edwards (1990), bars 60 (da capo)-81 as performed by a female marimba player in a deadpan manner. This is a fast tempo excerpt. Experiment 1 mean expressiveness rating = 4.00, SD = 1.85.
Musical Example 7.8. Comparison excerpt – effort-shape analysis of *Marimba Dances, III*, by Ross Edwards (1990), bars 60 (*da capo*)-81 as performed by a female marimba player in a projected manner. This is a fast tempo excerpt. Experiment 1 mean expressiveness rating = 6.63, $SD = 0.52$. 
Musical Example 7.9. Comparison excerpt – effort-shape analysis of Nancy, by Emmanuel Séjourné (1989), lines 2-3 as performance by a male marimba player in a deadpan manner. This is a slow tempo excerpt. Experiment 1 mean expressiveness rating = 5.50, SD = 1.31.

Musical Example 7.10. Selected excerpt – effort-shape analysis of Nancy, by Emmanuel Séjourné (1989), lines 2-3 as performance by a male marimba player in a projected manner. This is a slow tempo excerpt. Experiment 1 mean expressiveness rating = 6.25, SD = 0.89.
Musical Example 7.11. Comparison excerpt – effort-shape analysis of Merlin.I, by Andrew Thomas (1985), bars 21-24 as performance by a female marimba player in a deadpan manner. This is a slow tempo excerpt. Experiment 1 mean expressiveness rating = 5.00, SD = 2.14.

Musical Example 7.12. Selected excerpt – effort-shape analysis of Merlin.I, by Andrew Thomas (1985), bars 21-24 as performance by a female marimba player in a projected manner. This is a slow tempo excerpt. Experiment 1 mean expressiveness rating = 6.00, SD = 0.93.
Musical Example 7.13. Comparison excerpt – effort-shape analysis of *Marimba Dances, III*, by Ross Edwards (1990), bars 1-20 as performed by a male marimba player in a deadpan manner. This is a fast tempo excerpt. Experiment 1 mean expressiveness rating = 4.13, SD = 1.89.
Musical Example 7.14. Selected excerpt – effort-shape analysis of *Marimba Dances, III*, by Ross Edwards (1990), bars 1-20 as performed by a male marimba player in a projected manner. This is a fast tempo excerpt. Experiment 1 mean expressiveness rating = 6.38, SD = 0.74.
Musical Example 7.15. Comparison excerpt – effort-shape analysis of *Suite No.2 for Solo Marimba, 3 Dreams of Foreign Shores*, by Takayoshi Yoshioka (1990), bars 17-37 as performed by a female marimba player in a deadpan manner. This is a fast tempo excerpt. Experiment 1 mean expressiveness rating = 5.63, $SD = 0.74$. 
Musical Example 7.16. Selected excerpt – effort-shape analysis of Suite No.2 for Solo Marimba, 3 Dreams of Foreign Shores, by Takayoshi Yoshioka (1990), bars 17-37 as performed by a female marimba player in a projected manner. This is a fast tempo excerpt. Experiment 1 mean expressiveness rating = 6.88, $SD = 0.35$. 
CHAPTER 8

General Discussion
8.1 Preamble

The broad aim of this project was to investigate the production and perception of bodily gestures in solo marimba performance in the contemporary classical Western art music tradition. The marimba provided an excellent means for such an investigation as all the movements involved in playing the instrument occur externally to the body and are therefore visible. Due to the limited sonic expressive capabilities of the marimba (Fletcher & Rossing, 1998; Rossing et al., 2004), such an investigation was vital to build knowledge to develop marimba pedagogy and performance practice.

Music performance has often been approached primarily as an aural phenomenon. However, bodily movement is highly important in the process of bringing a musical score to sonic life. In the first instance, bodily movement is required to create sound from an instrument (Davidson & Correia, 2002). Flavouring that sound with expression requires controlled variations of refined motoric elements (Clarke, 1993a). Through physical interaction with their instrument, the performer can deliberately manipulate certain parameters of the performance for expressive purposes. The fundamental expressive devices available to the marimba player include timing and dynamic manipulations (Dahl, 2000; Dahl & Friberg, 2007). Therefore, physical interaction with the marimba in the creation of expressive musical sound likely involves a variety of visible bodily movements in styles that match the sound produced.

Performers’ bodily movements play a greater and conceptual and communicative role than merely creating expressive sound (Clarke, 2002b; Clarke & Davidson, 1998;
Davidson, 1993, 1994, 1995, 2002ab, 2007; Davidson & Correia, 2001, 2002; Truslit, 1938, see Repp, 1993). The literature reviewed in Chapter 2 presented various definitions for performers’ bodily expression evidenced in music performance. Bodily gesture was created as the term to refer to embodied expression employing the whole, or part of, the body identified as movement or stillness during marimba performance. Other bodily movements judged as lacking in expressive content, but fundamental to instrumental technique to create even sound, were referred to as functional bodily movements. Expressive functional bodily movements involved variations on mere functional bodily movements necessary to interact with the instrument and create expressive variations in sound.

An analogy parallel was drawn between bodily gestures naturally occurring with expressive musical sound, and gestures and bodily movements that accompany speech. Theoretical proposals regard gesture and speech as developing and emerging in tandem, or together with a common expressive goal (Kita, 2000; McNeill, 1992). While testing theories of gestures and speech coordination was not the focus of this project, the notion that gesture and speech operate as coordinated mechanisms in expression of an idea was likened to marimba players’ bodily gestures evident co-occurring with musical sound. The perceptual effects of bodily gestures on judgments of solo marimba performances were investigated in Experiments 1 and 2. The production of bodily gestures was described in Study 1. The outcomes of the experimental hypotheses and research questions are summarised below.
8.2 Outcomes of the Hypotheses and Research Questions

8.2.1 Experiment 1

The assumption that performers’ bodily gesture can influence the perception of expression in marimba performance was tested in Experiment 1. It was also assumed that an audio-visual performance featuring bodily gesture would guide and maintain audience attention and interest in the performance. The marimba players were requested to manipulate the manner in which they performed and perceptual responses of expressiveness and interest were gathered. The performance manner manipulation comprised two levels: projected performances were consistent with a public performance manner; in deadpan performances, all expressive features were minimised. In support of the first hypothesis, results showed that marimba players were successful in manipulating the level of expression with which they performed. Projected performances received significantly higher expressiveness and interest ratings than deadpan performances.

The hypothesised interactions between modality and performance manner were observed. For judgements of expressiveness, projected and deadpan performance excerpts were assessed as significantly different in an audio-only condition. However, the most significant differentiation occurred when they were presented audio-visually. It was concluded that the performers’ bodily gesturing lead to enhanced expressiveness ratings for projected performances, and diminished expressiveness ratings for deadpan performances when presented audio-visually compared to audio-only. The result that lack of bodily gestures diminished judgements of expressiveness when the observer could both see and hear the performer in comparison to hearing alone had not been observed in previous literature.
Projected performances were significantly more interesting to attend to when presented audio-visually in comparison to audio-only presentation. Deadpan performances, however, were no more interesting to see as well as hear than when presented in an audio-only condition.

From these results, it was concluded that the performers’ bodily gestures were highly important to communicating expression in marimba performance (Davidson, 1993, 1994, 2002ab; Davidson & Correia, 2002). The visual information provided by way of the performers’ bodily gestures enhanced the perception of the aural component of expressive marimba performance (Davidson, 1993; McClaren, 1988). Bodily gesturing provided increased opportunities for the performer to connect with their audience, arouse audience interest (Chen et al., 2001), communicate expressive intentions (Davidson, 1993; McClaren, 1988) and guide audience attention (Franconeri & Simons, 2003; Hillstrom & Yantis, 1994) through the performance.

The final hypothesis concerned the effect of musical expertise on rating behaviour. Musically-trained participants recorded higher ratings than their musically-untrained counterparts. This result could have been due to musically-trained participants being familiar with the task of assessing musical expression in performance, having greater exposure to the 20th Century classical art music genre (Bigand & Poulin-Charronnat, 2006; Clarke, 2002a; Gromko, 1993), or due to the frequency of their interaction with classical music as concert audience members.

The assumption that bodily gesture influenced the perception of expression, and interest in marimba performance was seemingly confirmed. However, Experiment 1
was conducted under laboratory conditions using short excerpts of marimba performance. Though this was justifiable for reasons of experimental control, there was a need to discover whether such results would generalise to a more ecologically valid setting.

### 8.2.2 Experiment 2

Experiment 2 was conceived to investigate whether bodily gesture, manipulated again through performance manner, would influence continuous self-reported perceptual responses to the performance of a solo marimba piece in a live concert. As hypothesised, higher mean ratings of engagement were recorded by observers responding to a section of music performed in a projected manner than a similar section of music performed in a deadpan manner within the same piece. However significant, or reliable, response signal was only observed in the projected performance sample. This lowered confidence in comparing mean engagement ratings in the projected and deadpan samples of the time-series data. It was concluded with caution that bodily gestures may have been a factor influencing higher mean engagement ratings in response to the section of music performed in a projected manner compared to mean engagement ratings in response to the deadpan performance section. Participants may have responded to a higher level of engagement shown by the performer, exemplified by their bodily gestures, in the projected performance section (Thompson, 2007). However, other factors may have influenced results.

With the deadpan performance section appearing before 20 seconds of the piece had elapsed, participants may have still been adjusting to using the pARF client device
and the rating task (Schubert, 2007). Participants’ confidence in performing the rating task may have increased over the duration of the performance leading to higher mean engagement responses to the projected performance section (Wapnick et al., 2005).

As the stimulus material was performed live in a naturalistic setting, certain extraneous variables could not be controlled as would happen in the laboratory. For example, the performer’s face could not be masked to eliminate the possible influence any facial expressions may have had on engagement assessments (Buck et al., 1972; Ekman, 1999). With the stimulus material comprising a portion of a real recital, it was not possible to have another performer play the same piece. One female performer (the researcher) performed the stimulus material, introducing the possibility of a gender bias on results (Davidson & Edgar, 2003; Elliot, 1995/1996). It is not possible to generalise observed effects to all marimba players, but especially male marimba players, without further investigation.

An order effect may have influenced results. Counterbalancing the order of presentation of performance manner was not possible as this experiment took place during a live concert. Responses to the second presentation of musical material, performed in a projected manner, may have been higher due to recognition or liking from prior exposure in the testing session (Hargreaves, 1984; Peretz et al., 1998; Zajonc, 2001).

Projected and deadpan performance section sound intensity levels could not be normalised in Experiment 2. The intensity levels (dB) in deadpan and projected performances were similar on the whole, diverging towards the end of the section. It
is possible that participants could detect the difference in intensity levels between the deadpan and projected performance sections (Moore, 1997). However, 2 minutes and 4 seconds elapsing between presentation of the deadpan and projected performance sections, and intensity levels ranged from 21.24dB to 70.01dB. It is not known if the slight variation in loudness between deadpan and projected performance sections affected results.

The results of Experiment 1, conducted in a laboratory setting, clearly demonstrated the effect that performers’ bodily gestures had on quality assessments and cognitive responses to excerpts of solo marimba performance. There were several limitations in Experiment 2 precluding confident conclusion that the results from Experiment 1 generalised into an ecologically valid setting. However, the results of Experiment 2 indicated that bodily gestures may have contributed to increased audience engagement responses to the projected section of the solo marimba piece performed in comparison to the deadpan performance section. Stemming from the significant results of Experiment 1, a study was mounted to investigate the qualities of bodily gestures evident in highly rated expressive marimba performances.

### 8.2.3 Study 1

Study 1 was designed to investigate marimba players’ bodily gestures through building a system to observe, analyse, describe and record the expressive qualities revealed through the performers’ bodies. The aim was to discover critical cues the performers’ bodily gestures provided to observers. Expressive qualities revealed through the body do not necessarily involve movement (Davidson 1994, 2002b, 2007). Therefore, kinematic measurements of movement quantity, such as those
provided by movement tracking technology, would not account fully for bodily gestures. In addition to temporal and spatial elements, motion is comprised force (Fitt, 1996), for which motion tracking technology, as it stands today, is unable to account.

Seeking a qualitative approach to investigating bodily gestures in music performance, a system of analysing, describing and recording the components of bodily gestures was required. No categorical definitions for the components of bodily gestures in instrumental music performance were found in the literature reviewed in Chapter 2. An approach to observe, analyse and record the expressive qualities revealed through marimba players’ bodies in performance was found in Laban Movement Analysis (LMA) observation techniques, and effort-shape analysis and notation (Bartenieff & Lewis, 1980; Davis, 1970; Levy & Duke, 2003). LMA observation techniques and effort-shape analysis not only relied on objective visual observation, but also kinaesthesis to understand and interpret the bodily gestures evident. Kinaesthetic empathy (covert imitation, or corporeal imitation) helped to discern different expressive qualities in observed bodily gestures (Cox, 2001; Leman & Camurri 2005-2006; Moore & Yamamoto, 1988). This observation technique employed embodied thinking to fully appreciate the expressive intentions displayed through the performers’ bodily gestures. Effort-shape analysis provided an effective means of categorising and accounting for all the marimba players’ bodily gestures witnessed co-expressing with musical sound.

As a movement meta-language, the metaphorical names for basic effort actions effectively categorised many of the bodily gestures observed. The metaphorical
names for basic effort actions directly referred to the visual appearance and kinaesthetic feeling of actions to perform interpreted musical concepts and create the desired sound. Basic effort actions observed were temporally and semantically coordinated with the expressive musical sound produced (Bull & Connelly, 1985; Goldin-Meadow, 2003; Kendon, 2004; McNeill, 1992). The phases of gestures accompanying speech: a preparation phase; a stroke phase; and a recovery phase, and on occasion, a hold phase, were also observed in the performing of basic effort actions (Kendon, 2004; McNeill, 1992). This strengthens the analogy that bodily gestures co-occurring with expressive musical sound are akin to gestures co-occurring with speech.

The particular basic effort actions observed could be seen as the gestural repertoire used by the performer (Davidson, 2001, 2007). However, the fact that not all eight basic effort actions were observed indicates that actions, such as wringing, were a) not appropriate to the act of marimba playing, or b) not musically justified. This highlights the influence that technical, anatomical, or material/physiological constraints had upon the employment of basic effort actions (Davidson, 1994, 2002b, 2007; Wanderley, 2002), as well as interpretive issues (Wanderley, 2002). The basic effort actions that were observed appeared linked to points of musical structure, (Clarke & Davidson, 1998; Davidson, 2002b, 2007; Wanderley, 2002), expressive markings (Schaffer, 1995) and interpretive issues (Wanderley, 2002). The majority of basic effort actions were observed in projected performances, however, only a select few occurred in deadpan performances. Those basic effort actions observed in deadpan performances were residual to the ones observed in the projected version of
excerpts performed – probably as a result of the performer trying to inhibit a rehearsed expressive motor program.

Bodily gestures were also observed as being expressive in an abstract manner, rather than directly referential to the sound produced (McNeill, 1992). The occurrence of transformation drives, only evident in projected performances, illustrated such occasions. Transformation drives were not rhythmic in nature as were basic effort actions. There were no particular links between transformation drives and explicit markings in the musical score. It appears they were employed as the performer saw fit from their individual musical interpretation of the musical score. Additionally, the occurrence of certain transformation drives demonstrated the performer’s effortful concentration on practical matters of performance such as visually locating the right notes to hit on the marimba, or locating the correct place in the music. The vision transformation drive was observed where the performer appeared to increase their focus or concentration. The spell drive appeared as a hypnotic state where time seemed to briefly stand still. The passion transformation drive appeared in two states: the performer appeared wild ‘letting go’ absolute control, or of a more gentle, affective quality.

The marimba players’ bodily gestures appeared to be spread throughout the body and involve the parts of the body working in a coordinated manner (Argyle, 1988; Bull & Connelly, 1985; Davidson, 1994). The performer’s whole body seemed to be engaged in the act of performing, demonstrating postural effort, as opposed to only the parts necessary for sound production exerting effort (gestural effort) (Bartenieff & Lewis, 1980; Lamb & Watson, 1979). Shaping features observed reflected the performers’
effortful and postural involvement in basic effort actions or transformations drives reflecting expressive features of performance. Additionally, shaping features reflected individual interpretation of other expressive features, either notated or implied, such as phrasing or dynamics. Postural shaping may account for the performer body sway observed in previous research (Clarke & Davidson, 1998; Davidson, 2002b, 2007).

Effort-shape analysis accounted for the variety of expressive qualities observed in marimba players’ bodily gestures in solo performance. Effort-shape notation was an effective tool for recording basic effort actions, and with minor modifications, transformation drives and shaping features. As an analytical and notation metalinguage system, effort-shape was effective in analysing, describing and recording bodily gestures in marimba performance for dissemination of interpretations (McClaren, 1988). The effort-shape analyses supported the notion the bodily gestures were constrained by technical, anatomical, or material/physiological, (Davidson, 1994, 2002b, 2007; Wanderley, 2002), musical structure (Clarke & Davidson, 1998; Davidson, 2002b, 2007; Wanderley, 2002), and interpretive issues (Wanderley, 2002).

Bodily gestures appeared to coordinate and co-express with musical sound as gesture and nonverbal behaviours do with speech (Argyle, 1988; Bull & Connelly, 1985; Goldin-Meadow, 2003; Kendon, 2004; Kita, 2000; McNeill, 1992). Some bodily gestures seemed additive to the expressive musical performances, whereas others seemed to be integrated with functional bodily movement necessary to create expressive musical sound. An example of bodily gesture integrated with expressive functional movement is the example of performing an accent with a loud dynamic on
the marimba. This requires a strong exertion of effort coordinated throughout the body. This would appear to the observer as a punching basic effort action. Preparation for the strong punching action would appear as a sinking shape gathering energy. The stroke phase of the action, the punch would evidence a rising shape as postural follow-through. The recovery phase would be observed as a return to the neutral starting position. Davidson (2001) alluded to the integrated functional bodily movements may play in the perception of bodily gestures in sung music performance. Illustrating the case of bodily gestures as additive to expressive musical performance are those basic effort actions, transformation drives, or postural adjustments as shaping features, where removal of such bodily gestures would not interfere with the production of expressive musical sound. For example, postural shaping reflecting the flow of phrasing in expressive musical performance could probably be withheld by the performer and not impact negatively on their production of expressive musical sound. The outcomes of Experiment 1 and Study 1 prompted the beginnings of a theory specific to bodily gesture in instrumental music performance created from interpretation of a musical score.

8.3 Theoretical Implications from the Present Study

Wanderley et al. (2005) noted the need for a theory that accounts for performers’ ancillary body movements (bodily gestures) in relation to musical intentions and mental representations of sound. The notion of a bodily basis for developing and expressing musical knowledge was supported by documentation of a flute player’s process of rehearsal leading to performance (Davidson & Correia, 2001). This supports the Dalcroze approach to music pedagogy stressing the importance of an integrated body and brain in learning and expressing musical concepts (Galvao &
The view that bodily gestures have physiological as well as mental origins supports the notion of expressive musical performance as embodied cognition (Davidson & Correia, 2001). Intentional bodily gestures may be physical metaphors evidencing cognitive, imagistic and biological thinking in a creative domain (Hadamard, 1945; Seitz, 2000). The following theory is offered to account for bodily gestures produced in musically expressive marimba performance considering motivational factors from interpretation of a musical score.

8.3.1 Developing a Theory of Bodily Gestures in Marimba Performance - Perception and Action

This theory is based on the assumption that the score provides the blueprint for the marimba player to interpret and embody functional bodily movements and bodily gestures. It also assumes that the performer will have control over instrumental technique, an understanding of the musical style and culture from which the piece is drawn, and particularly knowledge of the symbol system of the musical score. In purposely seeking to bring a musical score to life, the performer transforms the written musical score into a myriad of imagined sound and motor concepts through her/his interpretive skill. The performer’s physical skill enables the creation of a precise, intentional motor plan to translate the imagined sound concepts for the symbols of written musical score into musically expressive sound. Musically expressive sound is the result of a performer’s expressive functional bodily movement interacting with their instrument. Expressive functional bodily movements differ from functional bodily movements in that the latter are the lowest level of movement necessary to make even sound on the marimba. Expressive functional bodily movements are particular to different sonic qualities of musical expression. Musical structure, expressive markings, and individual un-notated timing, dynamic and
articulatory interpretations of the notated score influence the production of expressive functional bodily movements. The employment of expressive functional bodily movements is modified by technical/anatomical concerns. The effort exerted in performing expressive functional movements to realise different expressive qualities of music in sound involves effortful incorporation of other parts of the body, and postural effort. This is perceivable by the observer as bodily gestures.

Bodily gestures may not only be the result of expressive functional bodily movements directly referential to the expressive musical sound they create, they may also exist as a performer’s effortful abstract embodiment of expressive qualities perceived through an individual interpretation of the musical score in movement or stillness. The production of abstract bodily gestures are, similar to expressive functional bodily movements, influenced by performers’ interpretation and embodiment of musical structure, expressive markings, and individual un-notated timing, dynamic and articulatory aspects of the notated score. These are modified by technical/anatomical concerns. Abstract bodily gestures incorporate postural effort and effortful bodily expression of the limbs. Such abstract bodily gestures could probably be eliminated from performance with minimal impact on the production of expressive musical sound. Removing expressive functional bodily movements from performance, on the other hand, would probably impact quite negatively on expressive musical sound. Therefore, bodily gestures produced and perceived in expressive marimba performance are both integrated with, and additive to, the creation and communication of expressive intentions.
In essence, the performer's mind and body operate in a unified sense embodying expressive intentions. Expressive functional bodily movements and abstract bodily gestures cooperate as the vehicle for the performer to share their expressive intentions with others through multiple sensory modalities. Perception of expressive functional bodily movements and abstract bodily gestures, as two categorical branches of bodily gestures, involves visual and kinaesthetic elements. Aside from quantifiable movement, observers perceive tensions and relaxations resulting from the performer’s bodily effort and postural shaping both in movement and stillness in performance. The observer kinaesthetically mirrors the tensions and relaxations they observe, heightening their experience of expressive performance and understanding the performer’s expressive intentions.

8.4 Practical Implications from the Present Study

Even though there were limitations in conducting Experiment 2 in a concert situation, none the less, it was encouraging to begin investigating observed perceptual effects from the laboratory in an ecologically valid setting. This is a vital form of research that warrants development to validate and generalise laboratory-observed effects. Additionally, such validation and generalisation would create knowledge with direct application to training teachers and performing musicians, and understanding audience behaviour.

Study 1 provided encouragement as to the effectiveness of LMA observation techniques and effort-shape analysis for deciphering marimba players’ bodily gestures. The observational approach and analytical system were understood by two professional percussionists reflected by an agreement rate with the researcher’s
suggestions greater than 96%. The notational system was similarly understood indicating that, with training, professional percussionists may be able to independently implement the notational system as a means of recording observations of others and their own bodily gestures on a musical score.

The concepts of effort and shape highlight expression in bodily action. Training performing musicians, teachers and students in effort and shape concepts through experiential movement may help to promote attention to this important, yet often neglected, facet of communication in music performance. Such a targeted and direct approach to awareness of bodily gesture in performance may provide a means for conceiving and embodying an individual interpretation of a piece of music in a non-prescriptive style. Additionally, experiencing and rehearsing effort and shape concepts may expand an individual’s range of bodily gestures that lead to a richer communication of expressive intentions to an audience. This supports a Dalcroze approach to music rehearsal as embodied experience of musical and expressive concepts can help to communicate embodied expressive intentions to observers’ through kinaesthetic mirroring in performance (Cox, 2001; Davidson & Correia, 2001, 2002; Galvao & Kemp, 1999; Juntunen & Hyvönen, 2004; Leman & Camurri 2005-2006; Moore & Yamamoto, 1988; Seitz, 2005; Sudnow, 2001).

It would be premature to confidently conclude that reliably higher engagement responses to the section of music performed in a projected manner were solely attributable to bodily gesture in Experiment 2. However, the results of Experiment 2 provided some support in this direction. One future direction for research is to refine the concert hall paradigm to include additional performers to address possible gender
biases. Counterbalancing presentation order of performance manner manipulations within the piece of music performed would control of order effects due to exposure. Performer order could also be counterbalanced through multiple presentations of the experimental ‘recital’. While this would not be a true ecologically valid experiment, it would provide a halfway point between laboratory-controlled experimentation and a complete naturalistic setting.

The effectiveness of LMA observation techniques and effort-shape analysis as a means for analysing bodily gesture in marimba performance warrants further investigation. There were some limitations to effort-shape analysis, such as the decision point as to when one basic effort action becomes another. This minor problem could be addressed possibly using a combination of motion tracking technology and perceptual responses in the future.

As the effort-shape system was able to be understood by professional percussionists, a step forward would be to have professional percussionists record their interpretation of their individual exertions of effort and shape on a musical score in rehearsal for performance. A test of the effectiveness of the LMA and effort-shape observational and analytical systems would be to have other professional percussionists observe and analyse performances to see the degree to which the performers’ intentions could be accurately deciphered. Another direction would be to analyse performances of the same piece by different performers. Perhaps this would reveal some commonalities among performances of the same piece of music. For example, exertions of effort and shape observed common style and locations among performers may be related to fixed elements of the performance such as musical structure, expressive markings, or
technical constraints (Davidson, 1994, 2002b, 2007; Shaffer, 1995; Wanderley, 2002). Differences in exertions of effort and shape between performers may indicate individual interpretations of the music.

The ultimate goal of this study was to develop an analytical and notational system for performers and teachers to approach preparation for performance in an embodied, expressive manner, and record their embodied interpretation of a piece of music on the score itself. Further investigation would involve training performing musicians, teachers and students to understand and perform effort and shape concepts, and to implement the notation system. An embodied approach to preparation would probably result in bodily gesture in performance helping to share musical intentions with the audience. A comparative study between a control group and an effort-shape trained group of performances of the same music may reveal significant differences in quality assessments. It would be expected that the effort-shape trained group would receive more favourable assessments.

Future research is needed to test the theory presented here and to investigate whether bodily gestures are integrated with and/or additive to expressive musical sound in marimba performance. Davidson (2001) suggested that movement practices a performer may have to help them in their technique may be interpreted by the audience as a contributor to purely aesthetic movement. A specific research question would address whether expressive functional bodily movements, required to create expressive musical sound, and bodily gestures always occur together, or whether they can be separated. A multimodal experimental paradigm would explore whether listeners are sensitive to acoustic differences that may occur due to the presence or
absence of expressive functional movements and/or bodily gestures. The stimulus material could feature expressive performances involving: expressive functional bodily movements and bodily gestures; attempts by performers to withhold their bodily gestures, yet still perform in an expressive manner using expressive functional bodily movements; performances in an inexpressive manner where expressive functional bodily movements and bodily gestures are withheld; performances in a sonically inexpressive manner without expressive functional movement, yet still employing bodily gestures. If listeners assess performances where expressive functional bodily movements are being employed yet bodily gestures withheld as expressive, this would seemingly indicate that bodily gestures are additive, rather than integrated with expressive musical sound.

An additional research question that could be explored is how the combinations of bodily gestures, expressive functional bodily movements and performance expression mentioned above impact upon quality assessments in audio-visual presentations. Of particular interest would be to investigate whether deliberately sonically inexpressive performances lacking in expressive functional movements would benefit from the presence of bodily gestures in terms of higher ratings than similar performances lacking bodily gestures. On the other hand, observers may detect this deceitful attempt to belie the information provided by one modality with information from another (Runeson & Frykholm, 1983).

Developing hardware and software to measure force in bodily gesture would add to movement tracking technology that apparently measures the temporal and spatial aspects of kinematics. The ability to measure force would enable objective measuring
of qualities in bodily gestures and objective validation of LMA observation techniques and effort-shape analysis.

8.5 Conclusions

Bodily gestures appear to be produced naturally by skilled performers in expressive performance in a public manner. Such bodily gestures are an important facet of musician-audience communication in marimba performance. Performers’ bodily gestures have the power to enhance communication of expressive intentions to an audience. An embodied approach to expressive marimba rehearsal results in bodily gestures that are perceived by an audience in performance. Embodied expressive intentions appear to be detected, or mirrored, by observers through kinaesthetic empathy. Bodily gestures appear to be integrated with, and additive to expressive musical sound in marimba performance, co-expressing musical intentions analogously to speech accompanying gestures. Understanding expressive intentions draws on the perceiver’s embodied thinking processes and embodied knowledge. Bodily gestures, through effort-shape concepts, warrant consideration by performers and teachers for their ability to assist in embodied conceptualisation of musical interpretation. An embodied approach to rehearsal could be encouraged by teachers to fully develop the range of expressive capabilities of developing performers. Bodily gestures have the power to enhance communication of expressive intentions through multiple sensory modalities and impact positively on performance assessments.
CHAPTER 9

References


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(Original work published 1978)


APPENDIX A

A Brief History of the Marimba
A.1 Origins of the Marimba

The marimba is an ancient instrument. Although its exact origins are unknown, keyboard percussion instruments have been traced back to the Stone Age Asia-Africa region (Blades, 1975). The development of the modern Western concert marimba appears to have followed two paths – one from Asia and one from Africa. The African origins will be discussed first.

A.1.1 African Origins of the Marimba

The African xylophone from the mid-16th Century featuring individual gourd resonators for each wooden bar most closely resembles the modern marimba (Blades, 1975). Though slightly different in different areas, the general method of construction is similar and has not changed. The rectangular wooden bars are arranged in order of pitch and suspended, by cords or secured to a frame, above the mouth of the gourds or calabashes acting as resonators or amplifiers for each note. The pitch of the note is matched by an appropriately sized gourd – small for high notes and large for lower notes. Into the side of the gourd near the bottom is a small hole covered with a thin membrane made of tightly woven material, animal skin or spider’s eggs. The wooden bars are in a single row and tuned to a scale foreign to the Western twelve-tone system. The bars are tuned by removing wood in an arch from the underside of the rectangular bar lowering the pitch. The size of such instruments varies averaging five to seventeen bars (Blades, 1975).

The African xylophone is identified by different names, depending on region, including: marimba, malimba, jimba, madjimba, akadinda, amadinda, balinga, mandjanga, balafon, manza, mbila and timbila (Blades, 1975). Instruments are played
in groups, up to 30 at a time, as seen in the *timbila* bands from East Africa (Blades, 1975). Traditionally, African xylophone mallets were made of sticks with a small ball of sinew on one end of each or sticks with a head covered in leather. Players would usually hold one stick in the right hand and one or two sticks in the left hand (Blades, 1975).

**A.1.1.1 Development of the African Marimba in Mexico and Central America**

It is believed the marimba was introduced to Mexico and Central America with the slave trade where it was adapted to suit the performance style of these peoples (Garfias, 1983). A Guatemalan marimba builder, Sebastian Hurtado is credited with replacing the gourd resonators with wooden resonators (“What is Marimba”, n.d.), and restructuring the bars in a two rows in a chromatic layout, like the piano keyboard (Zeltsman, n.d.). The marimbas of Central America still feature resonators with a hole cut in the bottom and covered with animal intestine that creates a buzzing sound and amplifies the lower notes. This is known as *charleo* in Guatemala (Chenowith, 1964). In Mexico the hole in the resonator is covered using a membrane made from pig’s intestine and called *tela* (Moreno, 2001). Marimbas have been made in Chiapas of up to six and a half octaves (Moreno, 2001). In this culture, marimba groups are more common than soloists. These groups use marimbas ranging from two to six octaves (Moreno, 2001). Mexican mallets are made of huizizil wood sticks with a natural rubber mallet head on one end (Moreno, 2001). The marimbas of Central America are closest in construction to the Contemporary Western concert marimba. So popular was the marimba, it became the national instrument of Guatemala. In 1908, Sebastian Hurtado began a tour of the United States of America with his
marimba band to great popularity and acclaim introducing the Guatemalan version of
the marimba to Northern America (Smith, 1995).

A.1.2 South-East Asian Origins of the Marimba
The other path of development the Western concert marimba followed began in
South-East Asia. It is believed the xylophone came to Europe from Indonesia.
Records of such an instrument date from the early to the middle 16th Century (Eyler,
2003). The xylophones consisted of wooden bars laid over a wooden trough
constructed as a resonating chamber. Examples of such instruments can be seen in
Indonesian Gamelan today.

A.1.2.1 Development of the Xylophone in Europe
The xylophone was popularised as a solo instrument in early 19th Century Europe
(Eyler, 2003). Popular pieces, original compositions, and transcriptions were
performed on an instrument with bars laid out, chromatically, in four rows on bundles
of straw. A xylophone was later constructed with the bars laid out like a piano
keyboard in two rows. Xylophone performances would have been witnessed by
notable composers such as Mendelssohn, Chopin, Liszt and Saint-Saëns. These
encounters heralded the beginning of the xylophone in the orchestra.

The European xylophone found its way to the United States of America where
American manufacturers began building them in the late 19th Century (Eyler, 2003).
The Deagan company of Chicago made the first orchestral xylophone in 1888. This
instrument had brass tubes as resonators and placed under each of the bars which were
arranged in two rows like the piano keyboard (Eyler, 2003). The xylophone became
popular as a solo vaudeville stage act in the late 19th Century and into the 20th Century (Strain, 2002). It was also a featured instrument in the orchestras accompanying motion pictures in the early 20th Century (Strain, 2002).

The xylophone was extremely popular in Japan as well as America in the early part of the 20th Century after military musicians brought the instrument back to Japan from Europe (Kite, 2000). The type of repertoire performed included transcriptions of classical, popular, and folk music, as well as original compositions for the instrument (Kite, 2000).

**A.2 The Contemporary Western Concert Marimba**

Having constructed an orchestral xylophone in 1888, the Deagan company manufactured a marimba, between 1910 and 1918, under the name *nabimba* (Smith, 1995). This instrument featured the buzzing resonator of the marimbas of Central America. The instruments ranged from five to seven octaves with the five octave instruments covering C2 to C7. Marimba bands were popular at this time (Smith, 1995). The period around World War I witnessed the demise of these instruments due to manufacturing costs (Smith, 1995). Post World War I, xylophones were in more demand than marimbas due to the popularity of Vaudeville acts (Smith, 1995). As demand increased for marimbas, so did the range of the instrument up to five octaves (Smith, 1995).

The 1930s and 1940s saw the popularity of the marimba soar (Smith, 1995). In the 1930s a five-octave range marimba called a *marimba-xylophone* was a popular instrument for solo performance (Blades, 1975). During this time the marimba gained
popularity as a solo instrument as well as marimba bands (Smith, 1995). With the advent of World War II, materials usually used in marimba construction were required for the war effort. Resonators were therefore made from cardboard and plywood was used for the frame (Smith, 1995). After the Second World War, marimba production increased with instruments being built, again with metal resonators, of a four and a third octave range (Smith, 1995). The modern marimba is comprised of rosewood bars and metal (brass or aluminium) resonators. The Western concert marimba most popular today covers a range of five octaves.

A.2.1 Contemporary Western Concert Marimba Performance Style

The United States of America and Japan are two cultures that have developed a strong tradition of solo xylophone and solo marimba playing (Kastner, 1995; Kite, 2000). The marimba was introduced to Japan during the middle of the 20th Century from the United States of America (Kastner, 1995). This period saw the rise of the concert marimba soloist in America and Japan (Kastner, 1995; Kite, 2000, 2005). The popularity of modern classical marimba performance has spread around the world. World marimba competitions attract participants from almost every continent. In the United States of America, Europe, and Asia solo marimba performance degrees can be pursued at many conservatoriums. The tradition of performing transcriptions of classical works, as well as compositions specifically for the instrument continues today. Although the marimba has been scored for in the percussion section of the orchestra in works, such as Malcolm Arnold’s Fourth Symphony (Blades, 1975), it shines as a solo instrument.
A.2.2 Modern Marimba Mallet Construction and Performance Techniques

Modern marimba mallets are comprised of a shaft which the player holds, and a mallet head which strikes the bar. The shaft is most commonly made of birch wood or rattan, though fibreglass also exists. A player may use birch if they prefer a firmer feel to the mallet and rattan if they prefer a more flexible feel. The head of the mallet is made of a core of some substance, usually rubber or plastic, wrapped in a wool or synthetic yarn outer layer. The marimba is played with between one and three mallets in each hand. The solo repertoire is usually performed with a total of four mallets – two in each hand.

There are three main grips for playing the marimba with two mallets in each hand (called four-mallet technique). In Traditional (or Crossed) grip, the mallet shafts cross under the palm of the hand. Stevens grip, developed by late 20th Century marimba soloist Leigh Howard Stevens, evolved from an earlier grip - the Musser grip, developed by early 20th Century marimba soloist Clair Omar Musser. In Stevens grip and Musser grip the mallet shafts do not cross in either hand. Another popular grip, although found more widely in jazz, is Burton grip – named after its creator, Gary Burton. Burton grip is similar to Traditional grip although the sticks are crossed the opposite way in the palm of the hand. This allows for ease of playing single note melodic lines. The individual performer chooses which grip suits their musical context, anatomy and comfort. Traditional grip is most popular in the Japanese marimba culture whereas Stevens and Burton grip are more popular in the United States (Kite, 2000). Some performers use six mallets, three in each hand, though it is not as easy to manipulate three mallets in the hand as it is two.
APPENDIX B

Experiment 1 Stimulus Material

DVD
The details of the clips comprising the six sets of stimulus material for Experiment 1 are outlined in the following six tables (B.1 to B.6). These DVDs will only play on a computer.

### Table B.1

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APPENDIX C

Information Sheet and Consent Form

Experiment 1
Dear Participant,

Research Project – Music, movement and marimba: Investigating the role of movement and gesture in communicative marimba performance

This project investigates the role that movement plays in communicating a musical performance on marimba. For example, when you witness a captivating marimba performance, what you hear and what you see seems to be in expressive synchronicity. The results of this study are expected to contribute to theory and practice in music performance and education, and be of relevance to arts organisations. The task will take about 45 minutes. If you are a Psychology student at UWS, credit for participation in the experiment will be given in the normal way. Only participants with self-reported normal (or corrected) vision and hearing will be included in this study.

The procedure involves you rating recorded excerpts of marimba performances on two rating scales. Excerpts will be presented under two conditions:

- Audio only: You will only hear the music as performed and
- Audiovisual: You will see and hear the performance simultaneously.

You will do the task individually in front of a computer screen wearing headphones. The test session will last approximately 50 minutes. In addition, you will be required to complete a brief questionnaire for background information.

Participation in this study is voluntary and you are free to withdraw at any time without penalty. Data will be averaged across all participants before any analysis is carried out and results will remain anonymous.

If you would like additional information on the project please do not hesitate to contact me at m.broughton@uws.edu.au.

Sincerely,
Mary Broughton
PhD Candidate, University of Western Sydney

NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (email: K.BUCKLEY@uws.edu.au; tel: +61 2 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome. Ethics Protocol No: HREC 04/087
Research Project – Music, movement and marimba: Investigating the role of movement and gesture in communicative marimba performance

Consent Form

I __________________________ have read the information provided and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising that I may withdraw at any time. I agree that research data gathered for the study may be published.

_____________________________________ __________________________
Participant’s signature     Date

_____________________________________ __________________________
Investigator                  Date

NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (email: K.BUCKLEY@uws.edu.au; tel: +61 2 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
APPENDIX D

Solo Marimba and Chamber Music Recital

Marimba Plus...Perception and Action in Music Performance
D.1 Marimba Plus…Perception and Action in Music Performance –
A Recital of Solo Marimba and Chamber Music

The stimulus material for Experiment 2 was performed at the beginning of a 50
minute recital, *Marimba Plus…Perception and Action in Music Performance*. This
recital concluded the Perception and Action Workshop on 30\textsuperscript{th} November, 2006 at the
HCSNet (Australian Research Council Research Network for Human Communication
Science) SummerFest ’06, Sancta Sofia College, University of Sydney. The recital
exemplified human perception, action, communication and reaction in a social context
for sharing artistic endeavours.

*Marimba Plus…Perception and Action in Music Performance* comprised
performances of works for solo marimba as well as duets with for flute and marimba,
French horn and marimba, and French horn and percussion. A recording of the recital
is available on the enclosed DVD (Appendix J). The concert program and program
notes are provided below.
D.2 Concert Programme

Two Mexican Dances for Marimba, 2                      Gordon Stout

Mary Broughton (Marimba)

Self-balance (*world premiere)                  Michael Dixon

Dom Harvey (French horn) and Mary Broughton (Marimba)

Cinq Pantomimes pour Flute et Marimba                Jean-Michel Damase

I. Allegretto

II. Allegro vivace

III. Moderato

IV. Allegretto

V. Presto

Sarah Broughton (Flute) and Mary Broughton (Marimba)

Monody                                      Jarmo Sermila

Dom Harvey (French horn) and Mary Broughton (Percussion)

The Source                        Toshi Ichiyanagi

Mary Broughton (Marimba)
D.3 Programme Notes

Two Mexican Dances for Marimba, 2 (1974)

Gordon Stout (1952-) (USA)

Gordon Stout is a percussionist, composer and marimba specialist. He has premiered and recorded many works by contemporary composers, as well as his own. Stout is well known to the marimba and percussion community and often serves as lecture-recitalist for the Percussive Arts Society as well as a jurist for international marimba competitions. Stout is currently Professor of Percussion at Ithaca College, Ithaca, New York.

The Two Mexican Dances for Marimba, 2 is the second of two seminal works for solo marimba. The first of these two works originated as the Night Etude from Etudes for Marimba, Book 2. At the suggestion of Warren Benson, one of Stout’s composition teachers, it was removed from the book of etudes and the second Mexican dance was composed to accompany it. Benson heard something in the first Mexican dance which made him think of Mexico, which led to the title. Hence, the Two Mexican Dances for Marimba are dedicated to Warren Benson. While the first Mexican Dance was composed in a single day, the second took far longer to compose.


Michael Dixon (1961-) (Australia)

Michael Dixon has had an extensive playing career as a French hornist. He has held full-time positions in the Tasmanian, West Australian and Queensland Orchestras, and
has played as a casual with the AOBO, Sydney Symphony and Adelaide Symphony Orchestras among other esteemed ensembles. Currently Michael holds a scholarship as a Doctor of Creative Arts candidate at the University of Wollongong, freelances in Sydney, and teaches horn, brass and composition. Michael Dixon’s compositions include works for his ensemble LOCANA, a number of songs (many for Grevillea Ensemble), along with works for brass ensemble, horn ensemble, percussion duo and ensemble, string quartet, orchestra, concert band and music theatre.

*Self-balance*, written for Mary Broughton and Dom Harvey, explores a 9-note scale. Subtle tuning differences between the marimba and French horn result in shimmering pulsations between certain notes from the horn’s harmonic series and the equal divisions from the marimba. The music is balanced between the two instruments, not always easily. This increases in intensity through the piece, which ends in a sense of calm and good balance. The title and inspiration comes from a chapter from Lao Tzu’s classic *The Tao Te King* concerned with the balance between inward and outward views and understanding.

*Cinq Pantomimes pour Flute et Marimba* (2002)

I. Allegretto

II. Allegro vivace

III. Moderato

IV. Allegretto

V. Presto

Jean-Michel Damase (1928-) (France)
Jean-Michel Damase was born into a musical family in France in 1928. He began his musical career as both a pianist and composer and won acclaim and many awards as a pianist and recording artist. Damase currently dedicates himself to composition and teaching. His understanding of the character and possibilities of instruments is best demonstrated in his chamber and concertante works. His compositional style is elegant and typical of the mid-20th Century French school. His works are in the post-tonal vein, following on from composers such as Ravel and Debussy, in contrast to the Modernist styles of Messiaen and Boulez. *Cinq Pantomimes pour Flute et Marimba* reflects Damase’s fondness for the flute. His intimate knowledge of writing for the piano has led to a challenging marimba part. Each of the five pantomimes displays differing characters.

*Monody* (1970)

Jarmo Sermila (1939-) (Finland)

Jarmo Sermila began his career in music as a jazz trumpet and flugelhorn player in the 1960s. In the 1970s, Sermila’s career focus shifted to classical concert music composition as a means of stable employment. During his early compositional career in the 1970s, Sermila was pigeonholed as a “Modernist”. Edgard Varese, and his concepts of organised sound and free tonality, was an important early influence on Sermila. *Monody* hails from this period. *Monody* explores variety in tone colours and textures typical of Sermila’s compositional style. The Varese influence on *Monody* is apparent by the use of the siren (whistle), echoing Varese’s iconic percussion ensemble work, *Ionisation*. Another feature of Sermila’s style at this point in his career is the favouring of static or free rhythms rather than a regular pulse. His
fondness of improvisation stemming from his past life as a jazz muso is evident in the form of aleatoric counterpoint. The bulk of Sermila’s compositional output is in the form of chamber music. Avoiding traditional compositional formats and combinations of instruments provides him with opportunities to explore timbres and textures and the interaction between them. His compositional style is in a melodic, linear fashion rather than vertical and harmonic.

_The Source (1989)_

Toshi Ichiyanagi (1933-) (Japan)

Avant-garde composer John Cage was a source of inspiration for Toshi Ichiyanagi. This influence is reflected in compositions such as _Distance_ where the performers are required to perform at a distance of three metres from their instruments, and _Music for Piano #5: Fluxvariation_ where darts are to be launched into the back of the piano. Ichiyanagi was married to Yoko Ono from 1956-1963. _The Source_ was written for, and premiered by, Japanese virtuoso marimbist, Momoko Kamiya in Tokyo in 1990. It consists of two movements and makes use of a variety of motives or cells which are repeated ‘as is’, or transformed. In this piece, the performer is required to play the instrument in the normal manner (using mallets) without featuring any extended (or destructive) techniques.
D.4 Performers

Mary Broughton

Mary has a Bachelor of Music (Queensland Conservatorium, Griffith University) and a Master of Music (School of Music, Australian National University) degree in percussion performance. At present, Mary resides in Sydney where she is undertaking a PhD investigating the role of movement and gesture in communicative marimba performance at MARCS Auditory Laboratories, University of Western Sydney. She is currently the recipient of a University of Western Sydney Postgraduate Research Award.

Mary holds the positions of Acting Principal Timpanist with the Canberra Symphony Orchestra and Principal Timpanist with the newly established Wollongong Symphony Orchestra. She has performed in chamber music settings and as a soloist throughout Australia, including performances in the Brisbane Festival, the Rhythms of Life Festival (Perth), the Canberra International Chamber Music Festival, the Kings Cross Arts Festival (Sydney), and internationally in the United Kingdom, USA and Singapore.

As an academic, Mary has given presentations on her music performance research at the 2\textsuperscript{nd} International Conference on Music and Gesture (Manchester, UK), and the 9\textsuperscript{th} International Conference on Music Perception and Cognition (Bologna, Italy).
Dom Harvey

Dom Harvey has been a member of the academic staff at the Australian National University’s School of Music since 1991. A well-known Australian horn player, Harvey continues as a member of the Canberra Wind Soloists (since 1989), as Principal Horn with the Canberra Symphony Orchestra, and as founding member and director of the brass group 5+. He has performed as Principal Horn with the Australian Brandenburg Orchestra (1988 – 2001) and as guest Principal with most of the Australian Orchestras during his career. Whilst known primarily as a horn player, Harvey’s talents encompass the piano, singing and narration, and across to electric bass.

As a conductor, Harvey currently holds positions with the Canberra Youth Orchestra and the ANU School of Music Symphony Orchestra. Additionally, he has been guest conductor with the Adelaide, West Australian and Willoughby Symphony Orchestras. Future engagements will see him returning to these professional groups in addition to work with the Auckland, Sydney Sinfonia and SOV orchestras. Harvey has conducted everything from mainstream classical orchestral works to new music (including numerous premieres of new compositions), as well as engagements working with contemporary popular musicians such as the Zep Boys, Tim Rogers (You Am I), Tex Perkins (The Cruel Sea).
In terms of solo performance, Dom Harvey maintains his activity in this arena by giving numerous recitals. In 2006, he has been active in many regional and metropolitan areas particularly in NSW and the ACT in collaboration with artists such as Bernadette Balkus (Piano). He will also be undertaking numerous solo and collaborative performances of newly constructed, improvised and contemporary music with colleague Charles MacInnes (Bass Trombone).
Sarah Broughton

Sarah Broughton has a Post Graduate Diploma in Performance from the Royal College of Music (London), where she was a Senior Exhibitioner supported by a Leverhulme Award. She studied with Paul Edmund Davies and Gareth Davies at the Royal College of Music, and with Vernon Hill and Virginia Taylor at the Canberra School of Music, Australian National University. She has been the recipient of a Foundation for Young Australians Centenary Award, and a Banff Centre for the Arts (Canada) scholarship.

Sarah has performed throughout Australia with the Australian Chamber Orchestra, the Australian Youth Orchestra, Camerata Australia, and the Sydney Conservatorium Chamber Orchestra. Other tours have taken her throughout the United Kingdom, China and Singapore. Sarah performs regularly with the Australian Opera and Ballet Orchestra. She has also performed with members of the Philharmonia Orchestra in Elastic Band, giving educational concerts throughout London.

Sarah has recorded for Tall Poppies with the Australian Youth Orchestra, and for Channel Classics with Pieter Wispelway ('cello) and the Australian Chamber Orchestra.
APPENDIX E

*Information Sheet and Consent Form*

*Experiment 2*
Information Sheet – Experiment 2
HCSNet SummerFest
Sancta Sophia College, University of Sydney

Dear Participant,

Research Project – Music, movement and marimba: Investigating the role of movement and gesture in communicative marimba performance

This project investigates the role that movement plays communicating a musical performance on marimba. For example, when you witness a captivating marimba performance, what you hear and what you see seem to be in synchronicity. The results of this study are expected to contribute to theory and practice in music performance and education, and be of relevance to arts organisations. The task will take 10 minutes after a training session of about 15 minutes. If you are a Psychology student at the University of Western Sydney, credit for participation in the experiment will be given in the normal way. Only participants with self-reported normal (or corrected) vision and hearing will be included in this study.

The procedure involves you responding continuously as to how engaged you are by a solo marimba performance, as you witness the performance live. You will be tested individually as an audience member in a live concert situation. Your will be responding continuously throughout the performance via a PDA device (ARF). Prior to the testing session will be a training session of approximately 15 minutes. The test session will last approximately 10 minutes.

Participation in this study is voluntary and you are free to withdraw at any time without penalty. Data will be averaged across all participants before any analysis is carried out and results will remain anonymous.

Sincerely,

Mary Broughton
PhD Candidate, University of Western Sydney

NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (email: K.BUCKLEY@uws.edu.au; tel: +61 2 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome. Ethics Protocol No: HREC 04/087
Research Project – Music, movement and marimba: Investigating the role of movement and gesture in communicative marimba performance

Consent Form

I __________________________ have read the information provided and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising that I may withdraw at any time. I agree that research data gathered for the study may be published.

_____________________________________ __________________________
Participant’s signature     Date

_____________________________________ __________________________
Investigator       Date

NOTE: This study has been approved by the University of Western Sydney Human Research Ethics Committee. If you have any complaints or reservations about the ethical conduct of this research, you may contact the Ethics Committee through the Research Ethics Officers (email: K.BUCKLEY@uws.edu.au; tel: +61 2 4570 1136). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
APPENDIX F

A Brief Summary of the Life and Work of Rudolph Laban
Rudolph Laban (1879-1958) was born in the Austro-Hungarian Empire into a military family (Newlove, 1993). As a young man, Laban studied painting and architecture in Paris (Bartenieff, Davis, & Paulay, 1970). With an interest in human movement, Laban experimented with “free” dance at cabaret clubs during his time in Paris (Bartenieff, Davis, & Paulay, 1970). Laban soon altered his course and went on to study movement from artistic and scientific perspectives (Laban & Lawrence, 1974).

Between World War I and World War II Laban was most prolific in the field of dance choreography, collective dance, and theory and notation of movement (Bartenieff, Davis, & Paulay, 1970). Laban’s approach was driven by contemporary interest in the human sciences, biological and psychological, maths and physics (Bartenieff, Davis, & Paulay, 1970). During this period, Laban was best known as a choreographer and held the post of Director of Movement in the Berlin State Opera (Laban & Lawrence, 1974). The movements of ordinary people carrying out the tasks of their everyday lives continued to fascinate him. Laban shared his skills in the art and philosophy of movement with ordinary people through choreography of a contemporary non-professional form of dance, or movement choirs called Bewegungshcor (Bartenieff, Davis, & Paulay, 1970). At this time, Laban’s philosophy regarding movement was applied therapeutically with centres being established to advise craftsmen suffering from stresses and strains resulting from their work (Laban & Lawrence, 1974).

In 1939 Laban left due to the Nazi regime and travelled to Paris, and from there to England (Bartenieff, Davis, & Paulay, 1970). During World War II Laban, along with management consultant F.C. Lawrence, applied his research into the natural rhythms
of human movement to the selection, training, work procedures and assessment of men and women in an industrial setting (Laban & Lawrence, 1974). Post World War II, Laban and his student Warren Lamb applied his research to coaching British collegiate athletes (Hamburg, 1995). Laban spent his last years in England involved in dance education in the English school system and strengthening his theories of movement, particularly his theory of effort (Bartenieff, Davis, & Paulay, 1970).

Laban’s legacy includes theories of human movement, and systems for analysing and recording movement based on his theories. Choreutics is a theoretical examination of movement principles based on space forms and relationships. A theory of effort (originally Eukinetics) addressed the expressive aspect of human movement involving the concept of ‘force’. A method of movement observation and analysis, known as Laban Movement Analysis (LMA), incorporates Laban’s theories of movement enabling conclusions to be drawn regarding psychological implications of movement, or motivation for movement (Bartenieff & Lewis, 1980; Laban & Lawrence, 1974 Levy & Duke, 2003). Effort-shape notation facilitates recording the qualitative aspects of bodily expression (Bartenieff & Lewis, 1980; Laban & Lawrence, 1974). Laban also developed a notational system for recording primarily the spatial and temporal aspects of human movement - Labanotation (originally published as Kinetography in 1928) (Hutchinson-Guest, 2005). Labanotation has been widely used for recording classical ballet steps and movements. The work of Laban is known throughout the world and continues to be used in dance, drama, sport, education and therapeutic settings, and scientific enquiry (Laban & Lawrence, 1974, Newlove: 1993, Sandlos, 1999), and more recently in designing software for human interaction with technology (Loke, Larssen, & Robertson, 2005).
APPENDIX G

Study 1 Stimulus Material

DVD
## Contents

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<td>Marimba Dances, II</td>
<td>Ross Edwards</td>
<td>Slow</td>
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<tr>
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<td>Male</td>
<td>Marimba Dances, II</td>
<td>Ross Edwards</td>
<td>Slow</td>
</tr>
<tr>
<td>3</td>
<td>Deadpan</td>
<td>Female</td>
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*Note.* This DVD will only play on a computer.
APPENDIX H

A Preliminary Case Study
H.1 Aims of the Preliminary Study

The aims of the preliminary study were to: 1) identify, catalogue, describe, and interpret the observed expressive bodily movements of a marimba player; 2) explore whether Laban Movement Analysis (LMA) concepts, particularly effort observation and analysis, could be used to describe movement in performing music on the marimba; 3) develop a symbolic notation system as a means of relating the observed movements qualities and evidence in the musical score; and 4) see if professional percussionists and marimba players could understand LMA concepts and effort observation and analysis with minimal training.

H.2 Materials, Method, and Discussion

The stimulus material for this preliminary study was one audio-visual excerpt of marimba playing which had been performed in a projected manner. This excerpt received the highest mean ratings for ‘expressiveness’ in Experiment 1 and was performed by the female performer. Several viewings were made of the selected projected performance excerpt given by the female marimba player (the researcher). Following the analytical framework developed by Davidson (2001), a catalogue of the parts of the performer’s body involved in movement was made accompanied with descriptive notes for each movement (see Table H.1). Descriptions were made of the roles different parts of the body involved in the movements played noting amplitude and direction of movements, and style and intensity of movements. The descriptions of bodily movements were interpreted with regard to technical constraints, musical structure, and expressive features as evidenced in the musical score. The need to interpret expressive bodily movements with regard to technical (Davidson, 1994,
structural (Clarke & Davidson, 1998; Davidson, 2002b, 2007; Wanderley, 2002), and interpretive (Wanderley, 2002) concerns has been noted in previous research reviewed in Chapter 6.

Table H.1

<table>
<thead>
<tr>
<th>Parts of the body involved</th>
<th>Description of movement (amplitude, direction, style &amp; intensity)</th>
<th>Analysis and interpretation of movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet and legs</td>
<td>Feet make small and larger sideways steps in both directions (left and right).</td>
<td>Move body (torso and arms) into position to enable the mallets to strike the bars – necessary for technical execution.</td>
</tr>
<tr>
<td>Feet and legs</td>
<td>Stance - feet either shoulder width, or wider apart.</td>
<td>Stance - distance between feet depends on the range of notes to be played. The wider the range of notes to be struck, the wider the stance. A wider stance enables the performer to transfer weight from one leg to the other to move body into the best playing position efficiently. This can minimise foot movement and “plant” the body for fast or technically demanding passages – technical movement.</td>
</tr>
<tr>
<td>Feet and legs</td>
<td>Bent knees (small and larger amplitudes).</td>
<td>Slightly bent knees are evident throughout the performance – as if the performer is ready for action. Also as preparation for efficient sideways movements (transferring weight from one leg to the other) – technical. To aid the direction of effort downwards into the keyboard. More pronounced knee bends occur when the volume is loud (forte in the musical score). ‘Planting’ the body – expression of force.</td>
</tr>
<tr>
<td>Feet and legs</td>
<td>Knee bends and jumping action.</td>
<td>Occur when the volume is loud and a note is emphasised (forte and accent in the musical score). ‘Jumping’ as a recovery from application of force into the instrument ‘Planting’ the body and ‘springing’ into action – expression of force with emphasis.</td>
</tr>
<tr>
<td>Torso</td>
<td>Located in the vicinity of the notes being played.</td>
<td>Feet and legs move torso into the vicinity of the notes to be played to deliver the arms into the best position to strike the required notes – necessary for technical execution.</td>
</tr>
<tr>
<td>Torso and head</td>
<td>Operate together as a unit bending forwards, standing erect, or</td>
<td>Postural positioning indicating dynamics – bending forwards over the instrument in passages of a quiet volume (piano in the</td>
</tr>
</tbody>
</table>
sometimes moving in other directions. musical score); standing erect in loud passages (*forte* in the musical score) – expression of volume or intensity. Postural positioning also expressing different interpretations of phrases. Signal expressing phrasing – punctuating or linking, emphasising rhythmical groupings or particular points in the music.

| Torso and head | Rise and fall of upper body. |
| Head | Head movements left and right (small and larger amplitudes). |
| Arms | Arms move horizontally and vertically making movements of small and large amplitude. |

Arms lifting then lowering (gentle movement as if coordinated with the breath). Signal expressing the beginning of a phrase.

Two professional percussionists and experienced marimba players then studied the audio-visual excerpt and catalogue of descriptive and interpretive notes with the researcher. In discussion, they were asked to confirm, reject and/or suggest alternative observations or interpretations. It was agreed that many of the observed movements the performer made were related to technical execution and these often appeared to be expressive in nature as well. It was also noted that while the descriptions applied most often to individual parts of the performer’s body (e.g. legs, torso, and arms) the parts appeared to operate in a coordinated manner showing whole body involvement in the activity.
The terminology for effort-shape analysis was introduced in discussion. The researcher and the two professional percussionists described observed expressive functional bodily movements and bodily gestures in effort analysis terms with reference to the relevant motion factors and each one’s bipolar continuum of effort elements: weight (strong-light), time (sudden-sustained), space (direct-indirect) and flow (bound-free) (Bartenieff & Lewis, 1980). This verified the usability of the terminology as a movement meta-language. Effort analysis, motion factors and effort elements are introduced and explained in detail in Chapter 6. Such an approach to the study of bodily gesture in music performance had not previously existed.

An iconic notation system was created, based on the qualitative transcript and interpretation of observed bodily gestures, and their relation to evidence in the musical score. It was intended to record the observed movements across the top of the musical score to assist with direct correlation of the expressive features interpreted from the musical score and the performer’s bodily gestures. This notation system drew on concepts from Labanotation (Hutchinson-Guest, 2005), and incorporated analysis in Laban’s terms of the motion factors and effort elements involved (Bartenieff & Lewis, 1980). Table H.2 provides examples of elements of music notation, representative iconic notation developed by the researcher, and Laban’s related motion factors and effort elements. These icons were applied to the musical score at the locations in which bodily gestures were noted. Musical Example H.1 shows the analysis of the researcher’s bodily gestures witnessed in the audio-visual projected excerpt of marimba performance recorded using the developed iconic notation system on the related section of musical score.
Table H.2  
Correlation of Music Notation Element Examples, Representative Iconic Notation Developed by the Researcher, and Laban’s Motion Factors and Effort Elements

<table>
<thead>
<tr>
<th>Music notation element examples</th>
<th>Representative iconic notation and explanation</th>
<th>Motion factors</th>
<th>Effort elements (fighting or yielding)</th>
</tr>
</thead>
<tbody>
<tr>
<td>f (forte), ff (fortissimo)</td>
<td><img src="image" alt="Body postures indicating a feeling of strength/energy in the body. The darker colour reflects a more forceful feeling in the body." /></td>
<td>Weight</td>
<td>Firm</td>
</tr>
<tr>
<td>&gt; (accent), sf (sforzando), - (tenuto)</td>
<td><img src="image" alt="Body postures indicating emphasis. Directs the performer to use their body as if emphasizing a point in speech. Of course the level of accentuation indicated in the score would determine the subtlety of movement." /></td>
<td>Weight</td>
<td>Firm</td>
</tr>
<tr>
<td>p (piano), pp (pianissimo)</td>
<td><img src="image" alt="Body postures indicating a less strong/energetic feeling in the body. The darker colour reflects a more forceful feeling in the body. The lighter colour reflects a lighter, less forceful feeling in the body." /></td>
<td>Weight</td>
<td>Gentle</td>
</tr>
</tbody>
</table>

**Tempo**
- Speed and duration of movement also determined by tempo marking.  

**Phrasing** (either notated or implied) or movement between phrases.
- Indicates movement phrases. Instructs the performer to move in directly to their next position. Movement could be slow or quick depending on other factors such as tempo and interpretation. The length of the tail on the arrow implies long (slow) or short (quick) movement.

**Phrasing, Legato** (bound together/smooth)
- Indicates movement phrases and directs the performer to move in a flowing manner. The performer could demonstrate (physically) their conception of phrasing (either
notated or implied). Movement could be quick or slow depending on other factors such as tempo and interpretation.

• Indicates preparation for movement/playing. Directs the performer to prepare their movement in the style immediately to follow.

\( \text{Flow Bound} \)

Rests (musical silence), Staccato (detached)

\( \text{Flow Free} \)

Pause (pause in the flow of music)

Crescendo (gradually becoming louder)

\( \text{Flow Free} \)

Combining the some of the above elements into a movement.

\( \text{Rests (musical silence), Staccato (detached)} \)

\( \text{Flow Free} \)

Phrase directing the performer to physically embody the musical element crescendo.

### H.3 Conclusions

In the preliminary study agreement was reached through discussion between the two professional percussionists and marimba players and the researcher in identifying, cataloguing, describing, and interpreting the observed expressive bodily movements of a marimba player. The concept of effort and its analysis was well understood and able to be implemented in an analytical discussion of the performer’s observed expressive bodily movements. It was decided that as movements of parts of the body
were usually integrated with movements of other parts, future analysis should view the whole body rather than in sections. Though the iconic notation system created as a means of relating the observed movements and evidence in the musical score was effective in this context, there were concerns as to the limits of its generalisation to other performances/performers, and the large amount of symbols possibly requiring creation. As such, Laban’s effort and shape notation was selected to replace the iconic notation system as a movement metalanguage relating the performers’ expressive bodily movements observed to the musical score (Bartenieff & Lewis, 1980). Having decided on an effective analytical framework and notation system, a qualitative study of several projected and deadpan performance excerpts performed by both the male and female performers was conducted. This study (Study 1) is reported in Chapter 7.
APPENDIX I

Information and Instructions Distributed to Expert Auditors

Study 1
Whom
Address

Laban Movement Analysis of
Marimba Performers’ Body Movements with
Effort-Shape and Motif Notation

Dear

Thank you so much for your expertise in analysing this movement material.

This package includes a DVD of sixteen 20-25 second excerpts of marimba performance and the musical scores associated with each excerpt with my attempt to record the quality of the performers’ movements.

**DVD**

Of the sixteen excerpts of marimba playing on the DVD, eight are performed by a male marimba player and the other eight are performed by a female marimba player. Eight performances by both the female and male marimba players are performed in a ‘projected’ manner and the same excerpt, performed in a ‘deadpan’ manner, is also presented. A ‘projected’ performance manner was defined as one with a level of expression being, “consistent with public performance”. A ‘deadpan’ performance manner was defined as being one, “with minimal expressive interpretation of the music”. An opaque box is present on the screen to mask any facial expressions. Aside from the face, the head and any head movements are visible.

**Musical Scores and Movement Analysis**

I’ve attempted to analyse and record the quality of the performer’s movements in Effort and Shape terms and notation, based on the work of choreographer and movement analyst Rudolph Laban. Effort refers to the qualitative, dynamic aspect of movement and Shape refers to the way the body takes form in the space around it. I’ll now explain the analysis of these qualities in a bit more detail.

**Analysis of Effort**

Laban identified four motion factors involved in human movement: Space, Weight, Time and Flow. A person’s attitude towards each of these motion factors reveals the effort in their action. Each motion factor has a bipolar continuum of effort associated with it ranging from an “indulging” quality to a “fighting” quality. Analysis requires both visual inspection of movement and kinaesthetic observation. Kinaesthetic
observation involves sensing within one’s own body how it may feel to perform the movement.

Please take a moment to experience the four motion factors and their associated effort elements in the table below. The goal is to recognise how the movement might look visually, and feel kinaesthetically.

<table>
<thead>
<tr>
<th>Motion Factors</th>
<th>Effort Elements</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space</td>
<td>Indulging</td>
<td>Does the movement take a wavy path, or go straight from point a to point b?</td>
</tr>
<tr>
<td></td>
<td>Fighting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Indirect</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Direct</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>Light</td>
<td>Does the movement appear and feel light or heavy?</td>
</tr>
<tr>
<td></td>
<td>Strong</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Sustained</td>
<td>Does the movement seem unhurried or urgent?</td>
</tr>
<tr>
<td></td>
<td>Sudden</td>
<td></td>
</tr>
<tr>
<td>Flow</td>
<td>Free</td>
<td>Does the movement flow freely (relaxed), or are does it seem to be stopping and staring (constrained)?</td>
</tr>
<tr>
<td></td>
<td>Bound</td>
<td></td>
</tr>
</tbody>
</table>

The Action Drive is comprised of three motion factors: Space, Weight and Time. The combination of the bipolar effort elements of these three motion factors results in eight possible Basic Effort Actions. Each of these Basic Effort Actions displays two rhythmic phrases of exertion and relaxation. They are goal directed actions. The eight Basic Effort Actions were first observed by Laban through his work in industry, observing factory workers’ movements for greater productivity. They represent the complete range of working actions performed in human movement. Have a go at a few of these actions to understand how they feel and look.

<table>
<thead>
<tr>
<th>Metaphoric name (Kinaesthetic feeling)</th>
<th>Space (effort elements below)</th>
<th>Weight (effort elements below)</th>
<th>Time (effort elements below)</th>
<th>Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Float</td>
<td>Indirect</td>
<td>Light</td>
<td>Sustained</td>
<td>N/A</td>
</tr>
<tr>
<td>Glide</td>
<td>Direct</td>
<td>Light</td>
<td>Sustained</td>
<td>N/A</td>
</tr>
<tr>
<td>Wring</td>
<td>Indirect</td>
<td>Strong</td>
<td>Sustained</td>
<td>N/A</td>
</tr>
<tr>
<td>Press</td>
<td>Direct</td>
<td>Strong</td>
<td>Sustained</td>
<td>N/A</td>
</tr>
<tr>
<td>Flick</td>
<td>Indirect</td>
<td>Light</td>
<td>Sudden</td>
<td>N/A</td>
</tr>
<tr>
<td>Dab</td>
<td>Direct</td>
<td>Light</td>
<td>Sudden</td>
<td>N/A</td>
</tr>
<tr>
<td>Slash</td>
<td>Indirect</td>
<td>Strong</td>
<td>Sudden</td>
<td>N/A</td>
</tr>
<tr>
<td>Punch</td>
<td>Direct</td>
<td>Strong</td>
<td>Sudden</td>
<td>N/A</td>
</tr>
</tbody>
</table>

A Transformation Drive occurs when one of the motion factors: Space, Weight or Time is replaced by Flow. There are three possible combinations. Transformation Drives differ from the Action Drive in that they are more expressive of mood or quality rather than goal oriented. Whereas the Basic Effort Actions of the Action Drive have distinct rhythmic phases of exertion and relaxation and are performed over a relatively short duration, the Transformation Drives can occur for longer periods of
time. A Transformation Drive and a Basic Effort Action can not occur at the same
time. They follow one another in qualitative movement phrases.

### Chart of Transformation Drives

<table>
<thead>
<tr>
<th>Metaphoric name (Kinaesthetic feeling)</th>
<th>Space</th>
<th>Weight</th>
<th>Time</th>
<th>Flow</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passion</td>
<td>N/A</td>
<td>Light or Sustained</td>
<td>Free or Bound</td>
<td>Has a feeling or emotive focus – either wildly passionate or gentle and sensitive. Weight and Time are highlighted. Flow pulsates.</td>
<td></td>
</tr>
<tr>
<td>Spell</td>
<td>Indirect or Direct</td>
<td>Light or Strong</td>
<td>N/A</td>
<td>Free or Bound</td>
<td>Has a focus of fascination or hypnotic quality as if time is standing still. Space and Weight are highlighted. Movement has a stabilised quality.</td>
</tr>
<tr>
<td>Vision</td>
<td>Indirect or Direct</td>
<td>N/A</td>
<td>Sustained or Sudden</td>
<td>Free or Bound</td>
<td>Has a mentally alert focus. Precision in Time and Place. A disembodied state as if one is drawn out of oneself. Can be as if concerned with thought rather than the here and now or concentration. Space and Time are highlighted.</td>
</tr>
</tbody>
</table>

### Shaping features involve movement of the torso (and may include head or leg movements) that deviate from the neutral upright standing posture. Shaping reveals to what degree the whole body or person is involved in the activity. “Postural Effort” shows that the person’s whole body is involved in the activity they’re performing, rather than just the body parts required to perform the job.

### Chart of Shaping Features

<table>
<thead>
<tr>
<th>Vertical Plane</th>
<th>Rising</th>
<th>Falling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Plane</td>
<td>Widening</td>
<td>Narrowing</td>
</tr>
<tr>
<td>Sagittal Plane</td>
<td>Advancing</td>
<td>Retreating</td>
</tr>
</tbody>
</table>

### Method of Recording Movement Observations on the Musical Score

I’ve recorded my observations of the performers’ body movements in words referring to the motion factors and related effort elements, and metaphoric names. I’ve also recorded my observations symbolically using the Effort Graph (see Illustrations 1, 2 & 3). The Effort Graph depicts the motion factors in a linear fashion, with each end of the continuum representing the indulging or fighting quality of effort.

Two parallel vertical lines indicate the beginning and the end of the action sequence for observation. Between these two markers runs a horizontal line, parallel to the musical score (the Action Stroke) (see Illustration 4). The Action Stroke indicates movement is taking place. A break in the Action Stroke represents no movement, or stillness.
I’ve notated my interpretation of the Action Drive (Basic Effort Actions) and Transformation Drives (Passion, Spell and Vision) above the Action Stroke, and the presence of Shaping features below the Action Stroke. The symbolic notations made to record the Drives and Shaping Actions are positioned at specific points on the musical score corresponding to where they were observed. Their descriptions are noted close by on the page.

Illustration 1. Effort Notation Graph. The Effort Elements.

Illustration 2. Effort Notation Qualifying the Effort Elements.

Illustration 3. Shaping Features. Related to the Effort Notation Graph and Shape of Movement.

Illustration 4. Motif Notation - The Action Stroke
The Action Stroke rotated from its vertical position for use in dance, to a horizontal position for the current study’s purposes: To sit across the top of the staves of music in order to be able to be read along with the music.
Instructions
The same procedure applies to each of the sixteen excerpts of marimba performance.

I would like you to watch the excerpt on the DVD as many times as you need:
1. with sound - to focus attention on how the performer’s movements relate to the musical score provided
2. without sound – to focus attention on the movements alone, without

Please place a tick (✔) next to the recorded movement analyses in the musical score with which you agree. Please indicate your disagreement with an analysis with a cross (✗). Please feel free to record any differences you observers or alternate in analyses.
I am really appreciative of your expert opinion of the analysis I’ve attempted.

Please contact me on 02 9772 6589 (work), 0414 93 80 29 (mobile), or m.broughton@uws.edu.au if you require any clarification or would like to talk with me.

Yours sincerely,

Mary Broughton

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University of Western Sydney
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Email: m.broughton@bigpond.com
http://marcs.uws.edu.au/
APPENDIX J

Solo Marimba and Chamber Music Recital

Marimba Plus...Perception and Action in Music Performance

DVD
# Concert Programme

1. *Two Mexican Dances for Marimba*, 2  
   Gordon Stout  
   Mary Broughton (Marimba)

2. *Self-balance* (*world premiere*)  
   Michael Dixon  
   Dom Harvey (French horn) and Mary Broughton (Marimba)

3. *Cinq Pantomimes pour Flute et Marimba*  
   Jean-Michel Damase  
   I. Allegretto  
   II. Allegro vivace  
   III. Moderato  
   IV. Allegretto  
   V. Presto  
   Sarah Broughton (Flute) and Mary Broughton (Marimba)

4. *Monody*  
   Jarmo Sermila  
   Dom Harvey (French horn) and Mary Broughton (Percussion)

5. *The Source*  
   Toshi Ichiyanagi  
   Mary Broughton (Marimba)
APPENDIX K

Raw Data

Experiment 1
Experiment 2
Study 1

CD-ROM
## Contents

<table>
<thead>
<tr>
<th>Experiment 1 raw data</th>
<th>Microsoft Excel workbook</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment 2 raw data</td>
<td>Microsoft Excel workbook</td>
</tr>
<tr>
<td>Study 1 raw data</td>
<td>Microsoft Excel workbook</td>
</tr>
</tbody>
</table>