AFFECTIVE LEARNING DESIGN: A PRINCIPLED APPROACH TO EMOTION IN LEARNING

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Action; Affect; Affective Constraints; Affective Learning Design; ALD; Cognition; Constraints; Cricket; DST; Dynamical Systems; Ecological Dynamics; Ecological Psychology; Emotion; Intention; Learning; Representative Learning Design; RLD; Metastability; Self-organisation; SLEQ; Sport

Abstract

This PhD programme set out to explore the role of emotion during learning in sport and provide evidence of how action, emotion and cognition might interact under the influence of targeted manipulations to constraints. Through theoretical modelling and applied findings, emotion has been advocated as an integral part of learning environments given the situational information variables that influence a learner's engagement and approach to a task. After reviewing relevant literature in the area, it was established that a principled approach for considering emotion in learning was lacking, particularly in the context of applied sport research. However, some examples of theoretical modelling were found, conceptualising individuals as dynamic systems, incorporating the self-organising tendencies of actions, emotions, and cognitions. Taking these conceptualisations into account the first major contribution of this thesis is the development of a principled approach to emotion in learning, *Affective Learning Design* (ALD). This concept advocates for: (i) the design of emotion-laden learning environments and (ii) the holistic recognition of individual emotion and coordination tendencies during learning. The term of *affective constraints* was also introduced referring to the manipulation of affective variables that have the potential to influence the emergent behaviour of learners (Chapter 3).

Based on the principles of ALD the subsequent chapters of the thesis set out to investigate how affective constraints could be incorporated and monitored in applied sport contexts. The first stage of this process was to decide on an appropriate measurement tool to adequately track emotion across specific time scales. A review of the existing methods revealed a dearth of appropriate tools and therefore the

development of a new method was warranted. Presented in Chapter 4, the development of the Sport Learning and Emotions Questionnaire (SLEQ) is an important output of this PhD given its specificity to learning environments in sport. The SLEQ provides an indication of emotion *intensity* overall, and in respect to four distinct subscales (Enjoyment, Nervousness, Fulfilment, and Anger). The questionnaire can be implemented at several time points to track fluctuations in emotion that are indicative of individualised tendencies following task manipulations. This tool was developed within the context of learning in sport, for use during learning in sport, and therefore provides a new method of analysis with implications for researchers and practitioners alike.

In order to demonstrate the effectiveness of ALD and the SLEQ in practice, the next stage of the PhD explored the interaction between actions, emotions, and cognitions in applied sport environments. Chapter 5 set about observing emotion intensity alongside action in systematically constrained games of the passing and possession game 'Endball'. Individual possession time was manipulated across four 4 v 4 games with the aim of producing observable changes in emotions and performance characteristics. Through the analysis of SLEQ and game event data (e.g. complete passes, goals, errors) clear interactions between SLEQ scores (e.g. Enjoyment subscale) and action (e.g. goals, complete passes) were observed, particularly during the transition from one game to the next. The second applied case example in Chapter 5 took this approach further, incorporating a measure of cognition in the form of confrontational interviews in a cricket batting task. In this case a more in-depth individualised approach was adopted providing detailed measures of movement characteristics, performance outcomes, emotion intensity, intentions, and game plans. To manipulate the demands of the task the distance of the pitch was shortened to replicate deliveries of increased speeds, by the same bowler. By collectively analysing all categories of variables, the critical links between actions, emotions, and cognitions were able to be observed across several time points. Findings revealed that shorter foot movement distances were associated with increased enjoyment, perception of achievement, and runs scored, particularly when the simulated delivery speed was increased from 125km/h – to – 130km/h. Therefore, both of these applied studies have demonstrated the novel approach advocated by the concept of ALD, highlighting how affective constraints can be incorporated in learning tasks, and the importance of considering actions, emotions, and cognitions in unison.

Chapter 6 of the thesis proposed a model of Affective Learning Design that draws on the theoretical conceptualisations, and highlights the findings of the two applied studies. This model advocates for ALD principles to be applied over interacting time scales, with an emphasis on individualised study and/or practice designs. Each of the four model phases (Evaluation, Planning, Implementation, and Observation / Monitoring) are informed by the experiential knowledge of a coach or practitioner, along with theoretical underpinnings, such as those discussed throughout this PhD programme. Through the discussion of these phases in relation to the two examples from Chapter 5, the practicality and relevance of this model for future applied work in sport is highlighted.

Summarising the theoretical and practical implications of this thesis highlights the major contribution of this PhD programme to the fields of skill development, motor learning, and applied sport psychology. The theoretical conceptualisations of ALD and affective constraints provide a pivotal framework that can be incorporated into future discussions regarding the crucial role of emotion in learning.

Furthermore, these conceptualisations also inform the design of future sport learning tasks, advocating strongly for the recognition and consideration of the intertwined relationships between actions, emotions, and cognitions. The practical component of this thesis developed a new emotion questionnaire (SLEQ), targeted specifically at tracking emotion intensity throughout learning tasks in sport. To exemplify the application of the SLEQ and ALD principles, two studies were designed to adopt these innovative approaches in both group and individualised examples. Finally, a model of ALD was conceptualised combining the key ideas and findings of the PhD into a succinct and accessible format with various implications available to coaches, researchers and practitioners.

Together the insightful theoretical conceptualisations, innovative methodological developments, rich findings, and abundance of practical implications demonstrate why the tangible outputs of this PhD are so critical to enhancing of learning environments in sport. Emotion must therefore be recognised as a key consideration in the design of representative learning tasks, alongside the actions, and cognitions of an individual.

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List of abbreviations

ALD – Affective Learning Design

ANG – Anger subscale of SLEQ

CFA – Confirmatory Factor Analysis

CFI – Comparative Fit Index

DS – Dynamic Systems

DST – Dynamic Systems Theory

EFA – Exploratory Factor Analysis

ENJ – Enjoyment subscale of SLEQ

FoBS – Forcefulness of Bat Swing

FUL – Fulfilment subscale of SLEQ

KMO – Kaiser-Meyer-Olkin measure of sampling adequacy

MI – Modification Indices

NERV – Nervousness subscale of SLEQ

PoA – Perception of Achievement rating scale

PoD – Perception of Difficulty rating scale

PoS – Perception of Speed rating scale

QoC – Quality of Contact

RLD – Representative Learning Design

RMSEA – Root Mean Square Error Approximation

SEM – Structural Equation Modelling

SEQ – Sport Emotion Questionnaire

SLEQ – Sport Learning and Emotions Questionnaire

χ^2 – Chi-Square

Statement of original authorship

The work contained in this thesis has not been previously submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

QUT Verified Signature

Signature:

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Research outputs

Peer reviewed journal articles:

Headrick, J., Renshaw, I., Davids, K., Pinder, R. A., & Araújo, D. (2015). The dynamics of expertise acquisition in sport: The role of affective learning design. *Psychology of Sport and Exercise*, 16, 83-90. doi: 10.1016/j.psychsport.2014.08.006

Articles in preparation for submission:

Headrick, J., Renshaw, I., Davids, K., Pinder, R. A., & Araújo, D. (in preparation). A conceptual model of affective learning design. *International Review of Sport and Exercise Psychology*.

Headrick, J., Renshaw, I., Oldham, A. R. H., Davids, K., & Pinder, R. A. (in preparation). Development of the Sport Learning and Emotions Questionnaire (SLEQ). Journal of Sport & Exercise Psychology.

Book chapters:

Pinder, R. A., Headrick, J., & Oudejans, R. R. D. (2015). Issues and challenges in developing representative tasks in sport. In D. Farrow & J. Baker (Eds.), *The Routledge Handbook of Sports Expertise* (pp. 269-281). London: Routledge.

Pinder, R. A., Renshaw, I., Headrick, J., & Davids, K. (2014). Skill acquisition and representative task design. In K. Davids, R. Hristovski, D. Araújo, N. Balagué - Serre, C. Button & P. Passos (Eds.), *Complex Systems in Sport* (pp. 319-333). London: Routledge.

Conference papers:

Renshaw, I., Headrick, J., & Davids, K. (2014). Affective learning design: Building emotions into representative learning design. Paper presented at the International Conference on Complex Systems and Applications, Le Havre, France.

Conference presentations (oral):

Headrick, J. (2015). Affective learning design and the role of emotions during learning in sport. Paper presented at the Australasian Skill Acquisition Research Group Conference – 12-14 June, Perth, Australia.

Conference presentations (poster)

Headrick, J., Renshaw, I., Davids, K. (2014). A conceptual model of affective learning design. *Institute of Health and Biomedical Innovation conference* – 20-21 November, Gold Coast, Australia.

Invited presentations:

Headrick, J. (2015). The role of emotion during learning in sport. *Queensland Academy of Sport – Performance Science Unit* – 14 January, Brisbane. Australia.

Other:

Headrick, J. (2015). Affective learning design: A principled approach to emotion in Learning. *PhD Final Seminar* – 29 May, Queensland University of Technology, Brisbane, Australia.

Headrick, J. (2013). A principled approach to emotion in Learning. *PhD Confirmation Seminar* – 13 March, Queensland University of Technology, Brisbane, Australia.

You must always believe you will become the best, but you must never believe you have done so

Juan Manuel Fangio

Chapter 1: Introduction

This chapter introduces the scope of the PhD programme and identifies the key theoretical and experimental shortcomings of the literature that will be discussed and examined throughout the following sections. Towards the end of the chapter an overview of the thesis structure is presented to highlight how each of the chapters fits within the thesis.

Ideas and concepts presented in this introductory chapter have also been incorporated into the following peer reviewed research outputs:

Pinder, R. A., Headrick, J., & Oudejans, R. R. D. (2015). Issues and challenges in developing representative tasks in sport. In D. Farrow & J. Baker (Eds.), *The Routledge Handbook of Sports Expertise* (pp. 269-281). London: Routledge.

Pinder, R. A., Renshaw, I., Headrick, J., & Davids, K. (2014). Skill acquisition and representative task design. In K. Davids, R. Hristovski, D. Araújo, N. Balagué - Serre, C. Button & P. Passos (Eds.), *Complex Systems in Sport* (pp. 319-333). London: Routledge.

Renshaw, I., Headrick, J., & Davids, K. (2014). Affective learning design: Building emotions into representative learning design. Paper presented at the International Conference on Complex Systems and Applications, Le Havre, France.

Introduction

> "Life is essentially a process of dynamic reorganisation, and therefore emotions are an inevitable part of the life process itself"

(Jarvilehto, 2000a, p. 56)

Learning is an inherently emotional experience where an individual is frequently exposed to periods of success, failure and challenges from both physical and psychological perspectives (Davids, 2012; Seifert, Button, & Davids, 2013). Each individual arrives at a learning experience with specific capabilities that must be modified or adapted in order to meet the demands of the new task (Kelso, 2003). Therefore a learning experience must be considered in relation to the individualised approach to concepts including perception, intentions, attention, cognitions, and emotions (Davids, 2012; Kelso, 2003).

Tasks that are emotion-laden are considered to facilitate a 'deeper' engagement for learning and performance (Jones, 2003; Solomon, 2008). Indeed, emotional engagement is seen as being essential for effective learning (Pessoa, 2011). However, the role of emotion during learning has often been neglected because emotion-laden responses are considered irrational or instinctive, and therefore perceived as negative (Hutto, 2012; Jarvilehto, 2000a; Lepper, 1994). Furthermore, the influence of emotion has historically been portrayed as a disturbance to the acquisition of knowledge or expertise (Jarvilehto, 2000a). Emotionless responses made from a purely informational stance have been described as 'cold cognition', whereas emotion-laden responses are viewed as 'hot cognition' (Abelson, 1963; Lepper, 1994). The expression of 'sit on your hands' in relation to choosing a move in a game of chess is an example of the view that it is necessary to suppress or remove emotions in order to make rational decisions (i.e. cold cognition) (Charness, Tuffiash, & Jastrzembski, 2004). Crucially in sporting contexts learners are often not afforded this 'thinking' time and must therefore act instinctively based on the interaction between their perceptions of the task and pre-existing physical, cognitive, and emotional capabilities (Davids, 2012). Therefore there is a need for an accurate and detailed description of emotional experiences in sport as emotions are often under-estimated or ignored, perhaps due to the paucity of a theoretical framework in sporting contexts (Hanin, 2007b; Vallerand & Blanchard, 2000). Additionally, progress in understanding emotions has also been limited by traditional linear cognitive thinking perpetuating the debate over the pre-eminence of cognition over emotion; where cognitions of events are thought to result in emotional reactions based on 'inner' processes or knowledge (Jarvilehto, 1998a, 2000a, 2009; Lewis & Granic, 2000). This outdated reductionist approach (discussed further in later sections) to understanding emotions by cognitivists has hampered the ability to model relations between goals, emotions and emotion regulation (Kiverstein & Miller, 2015; Lewis & Granic, 2000). However, some psychologists have recently begun to acknowledge the advantages of nonlinear dynamic systems (DS) reasoning in explaining behaviour and this has led to the emergence of a DS perspective of emotional development (Jarvilehto, 2000a, 2001; Lewis, 1996; Lewis & Granic, 2000). Yet to be seen in the literature, however, is a principled exploration of the role of emotions in learning for sports performance.

Dynamic systems approach

Complex dynamic systems, such as humans, have the capability to self-organise their actions or behaviour to achieve specific task objectives without direct input from higher order structures or predetermined rules (Kelso, 1995; Lewis, 2000b). Self-organising processes take place under the influence of organismic (individual), environmental and task constraints (see Newell, 1986) of the specific performance environment. Interacting constraints (individual – environment) can both limit and guide behaviour, shaping the affordances which are perceived to complete goal-directed action (Gibson, 1979; Newell, 1986). Through the detection of informational variables and subsequent perception of possible affordances, stable patterns of behaviour emerge; referred to as attractor states. Fluctuations in information flows (through changes in constraints) have the potential to perturb stable (attractor) states of behaviour and facilitate phase transitions to new states, requiring the system to adopt different states of organisation (Kelso, 1995, 2012; Kelso & Tognoli, 2009). By adopting novel and functional patterns of behaviour a complex system (i.e. performer) is considered to have gone through a process of learning or development, whereby stable patterns of behaviour become characteristic responses to specific information flows between the performer and environment (Lewis, 2000b; Thelen, 2002; Thelen & Smith, 1994). During learning the state of the system becomes unstable as learners search for functional coordination solutions (attractors) to the new constraints of the environment (Chow et al., 2007). Markers or predictors for phase transitions include increased variability in movements as learners are forced into metastable regions of performance (Chow, Davids, Hristovski, Araújo, & Passos, 2011; de Weerth & van Gert, 2000) From this complex systems approach, the role of the affective domain has yet to be fully incorporated into the study of learning, in regards to understanding how emotions can be linked with emergent human behaviour in contexts such as sport.

Affect, behaviour, and cognition

Emotion will be the focus of this thesis, but it must be acknowledged that the term emotion is part of the larger group of affective phenomena. The term ‘Affect’ incorporates phenomena that occur over different time scales such as emotions, feelings, moods and personality traits (Lewis, 2000a; Vallerand & Blanchard, 2000). Emotion can be distinguished from the concepts of mood and feeling, by a stronger affective state, sudden onset, and a relationship with an object, event or person (Moll, Jordet, & Pepping, 2010; Oatley & Jenkins, 1996; Zadra & Clore, 2011). Feelings relate more directly to subjective experiences emerging from a task, without physiological or behavioural changes. Moods do not display a relationship with an object, event or person, develop over longer time scales, and often emerge from an initial emotion (Frijda, 1994; Vallerand & Blanchard, 2000). Traits are more permanent and stable affective tendencies that have developed into inherent aspects of an individual's personality (Watson & Clark, 1994).

Affect, along with behaviour and cognition form a triad that represent feeling, acting, and knowing respectively (Breckler, 1984; Hilgard, 1980). Behaviour encompasses verbalisations about acting, intentions to act, and overt actions which in their simplest form involve moving towards or away from an object. Cognition frames our knowledge or intentions towards an object including thoughts, beliefs and perceptual reactions (Ajzen, 1989; Breckler, 1984; Hilgard, 1980). Similar conceptualisations are also captured by Bloom's (1956) Taxonomy, which described the cognitive, affective, and psychomotor domains within education.

The interaction between affect, behaviour and cognition can be described from a complex (dynamic) systems approach where the three components influence each other to form emergent appraisals of experiences (Frijda, 1993; Lewis, 1996). A complex systems approach considers an individual as many interacting parts that self-organise under the influence of constraints (see Newell, 1986) to achieve specific objectives (Kelso, 1995). For example, an individual experiencing an emotional event must perceive how an event or object relates to their own intrinsic dynamics to form emergent behavioural (action), cognitive, and affective responses (Bower, 1981; Ortony, Clore, & Collins, 1994). In this case, knowing of an object/event constrains a functional emotional response, as the same information may be construed differently by individuals (Jarvilehto, 2000a). That is, an object/event affording emotional behaviours. Similarly, the behaviour of an individual can be influenced by knowledge of an object and the emotional attachment that has previously been construed, such as a challenging rock climbing hold from which the climber previously fell or slipped (Davids, Brymer, Seifert, & Orth, 2014; Kiverstein & Miller, 2015; Lewis, 1996). Emotion then can be considered as the 'readiness to act' in an intentional manner (Frijda, 1986; Jarvilehto, 2001). Therefore, in the regulation of human behaviour the perceptions, actions and cognitions of an individual self-organize to form emergent physical and psychological responses (Warren, 2006).

Cognition and emotion

The relationship between cognition and emotion in particular has been discussed extensively from a complex systems perspective by Lewis (Lewis, 1996, 2000a, 2002, 2004). From this perspective emotions shape cognitions and these cognitions further influence emotions to form stable attractor states of system organisation (Kelso, 1995; Lewis, 2004). The cognition-emotion link must also be considered over interacting time scales, which influence each other in a reciprocal relationship to form characteristic personality traits, or shape immediate emotional responses (Lewis, 2002; Newell, Liu, & Mayer-Kress, 2001). Furthermore, the influential relationship between cognition and emotion has been found to distinguish the intensity at which individuals experience emotions. In this case the individualised nature of cognitions and thoughts were linked to the intensity of both positive and negative emotions when individuals were exposed to emotion inducing information or stimuli (Larsen & Diener, 1987; Larsen, Diener, & Cropanzano, 1987). More specifically, individuals displaying high emotion intensities were also found to engage in more personal and empathetic cognitive tendencies. Considering all the above concepts in relation to learning to perform skills, a combination of environmental (e.g. physical and visual) and individual (e.g. intentions, emotions, motivations) information sources constrain the emergent behaviour of each individual (Kelso, 1995; Masters, Poolton, Maxwell, & Raab, 2008; Renshaw, Oldham, & Bawden, 2012; Zadra & Clore, 2011). Maintaining an emotional investment or engagement in a learning task can therefore be the result of implicit (e.g. personal goals) and/or explicit (e.g. parent, teacher, coach) influences or challenges (Collins & MacNamara, 2012). This reinforces the importance of the relationship between an individual and his/her learning environment.

Individual – environment relationship

A key idea in Ecological Psychology concerns the link between the perceptual information provided by the environment and the resultant actions or behaviours of complex systems, such as humans (Araújo, Davids, & Hristovski, 2006). In the study of visual perception, Gibson (1979) determined that the movements of an individual bring about changes in information flow from which affordances (opportunities for action) are perceived to support further movement. Therefore, information and movement are deemed to be dependent on each other in a dynamically coupled relationship. As a result, a cyclic process is created where action and perception symbiotically support goal-directed movement behaviour (Davids, Button, & Bennett, 2008). Gibson (1979, p. 223) summarised this relationship by stating that "we must perceive in order to move, but we must also move in order to perceive". As such, perception and action are complementary aspects of behaviour shared between the individual and the environment, not distinct functions separated into sensory and motor components (Jarvilehto, 1999, 2001; Turvey, 2009). This concept provides a foundation for describing how goal directed movement emerges throughout a wide array of applications in the study of human behaviour. Consequently, perception-action coupling is an important consideration for the design of skill acquisition practice tasks and investigative methodologies in experimental research.

The work of Brunswik (1955, 1956) advocated the study of individual-environment relations in contexts where perceptual variables that would naturally be available to an individual are preserved or maintained (Dhami, Hertwig, & Hoffrage, 2004). To capture the concept of sampling perceptual variables from an individual's 'natural' environment in an experimental task, the term representative design was introduced (Brunswik, 1956). Therefore by incorporating representative design, the crucial cyclical relationship between perception and action in a performance environment is maintained (Gibson, 1979). More recent work has discussed the concept of representative design in relation to the study of human performance and behaviour in contexts such as sport (Araújo, et al., 2006; Araújo, Davids, & Passos, 2007). As a result, the term representative learning design (RLD) has been adopted to highlight the importance of creating representative environments for learning and practicing skills whereby key perceptual variables are sampled from the performance setting to guide and restrict behaviour in the learning/practice setting (Pinder, Davids, Renshaw, & Araújo, 2011b).

To this point, empirical work discussing RLD has focussed on visual information provided in performance tasks (Pinder, Davids, Renshaw, & Araújo, 2011a), practice in differing environments (Barris, Davids, & Farrow, 2013), and changes to the complexity of tasks (Travassos, Duarte, Vilar, Davids, & Araújo, 2012). However, to date no work has discussed the role of individual informational constraints such as affect in enhancing representative learning designs (for initial discussions see, Pinder, Renshaw, Headrick, & Davids, 2014). Some related conceptualisations have suggested that environments may be laden with both physical and emotional affordances that are of value to an individual (Heft, 2010; Roe & Aspinall, 2011) The aim of this proposed programme of work is to further consider the role of affect in learning environments with the aim of enhancing RLD.

Previous work investigating emotions in relation to human behaviour has focussed on a 'snapshot' of performance at one point in time (e.g. Lane, Beedie, Jones, Uphill, & Devenport, 2012). In contrast, the approach that will be advocated through this current project is that learning can be best understood through adoption of nonlinear dynamic processes, over interacting time scales. As such, the role that emotions play in learning events is expected to be dynamic, as individuals explore their perceptual-motor workspaces. Therefore, emotions should be studied throughout learning periods to understand their interactions with intentions, perceptions and actions. Furthermore, it is advocated that the presence of emotions during learning should be embraced rather than removed or ignored in order to create engaging and representative learning/practice environments (Renshaw, et al., 2012). This rejects the approach taken in much of the previous work on emotions in sport performance where emotions are seen as being either positive (e.g. joy) or negative (e.g. fear) with respect to performance (see, Campo, Mellalieu, Ferrand, Martinent,

& Rosnet, 2012; Lane, et al., 2012; Nesse & Ellsworth, 2009). Typically, researchers and practitioners have focussed on the negative impact of emotions; hence viewing them as dysfunctional for the performance of a given task, or as unwanted 'noise' (Davids, Glazier, Araújo, & Bartlett, 2003; Jones, 2003). Conceptually this is similar to the way movement variability has been traditionally viewed; it is the purpose of this PhD programme to discuss and demonstrate the need to develop a principled approach to considering affect as a functional aspect of learning design.

Thesis structure

This thesis is presented in a traditional format with a range of theoretical and experimental chapters arranged to reflect the emergence or flow of ideas throughout the PhD programme. Each chapter has been written to stand alone while also linking with the previous and following chapters to maintain the flow of ideas and findings. As a result, in parts there is a degree of repetition. Chapters that have been published as journal articles, or are in the final stages of preparation for submission (3 and 6 respectively), somewhat overlap in terms of theoretical background and implications, but have been edited to fit with the format of the thesis. Stage 1 represents the majority of the theoretical background and literature review (Chapters 1 & 2), culminating with Chapter 3 which is based on a published position paper. Stage 2 discusses the development of a new questionnaire for tracking emotions during learning in sport. As such, Chapter 4 is organised into three sub-phases reflecting the distinct methods and findings of each phase leading to the eventual questionnaire design. Stage 3 incorporates the theoretical principles and questionnaire of the previous stages in two preliminary experimental studies discussed in Chapter 5. These studies demonstrate the approach advocated throughout the thesis and the value of the newly developed questionnaire. Stage 4 brings the conceptualisations and findings of the PhD programme together to propose a conceptual model (Chapter 6), followed by an epilogue (Chapter 7). Therefore this final stage provides implications, limitations, and future directions of the thesis and highlights the extensive theoretical and applied contributions of this PhD programme.

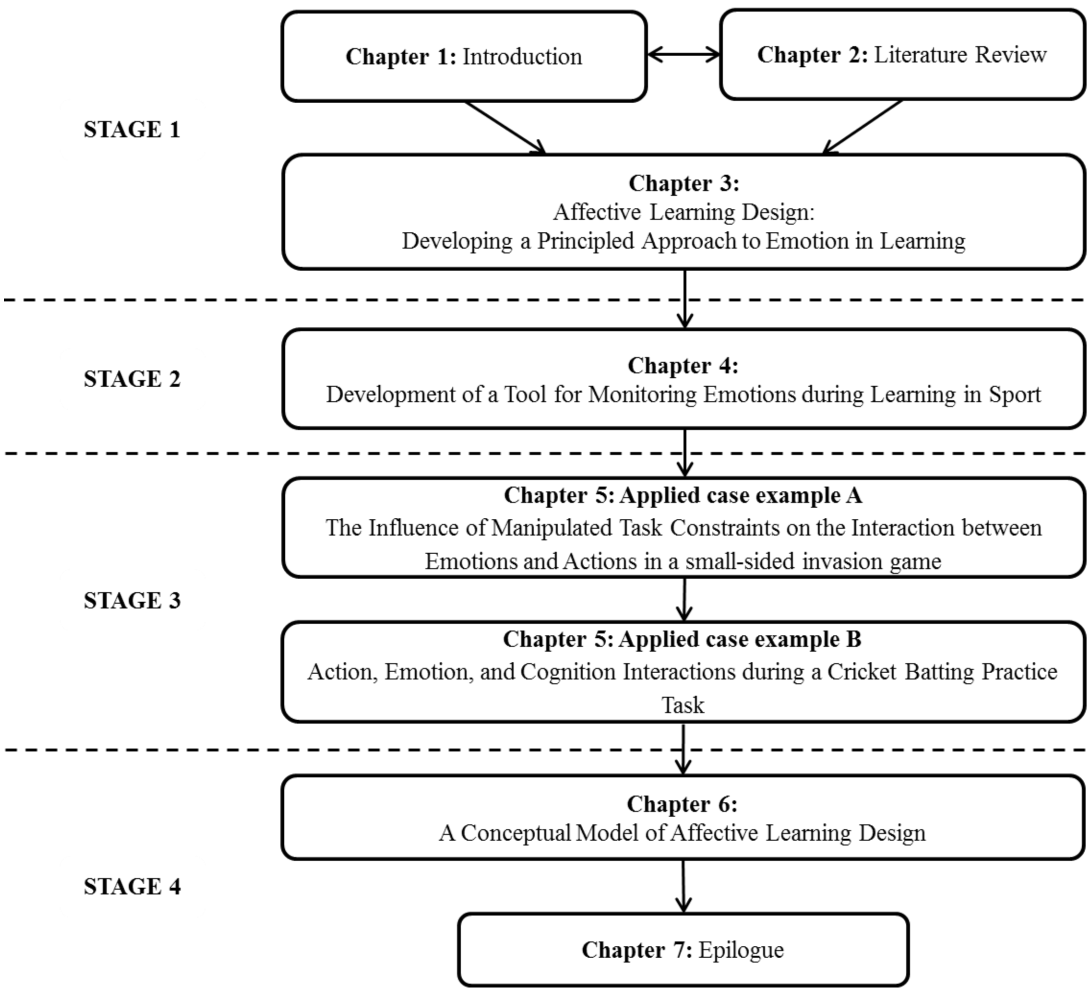

Figure 1.1. Thesis overview and structure

Chapter 2: Literature review

An ecological dynamics approach

Together, the theories of dynamic systems and ecological psychology are captured by the concept of ecological dynamics (Araújo, et al., 2006; Davids & Araújo, 2010). An ecological dynamics approach recognises the mutual relationship between an individual and the environment to understand behaviour from an ecological perspective with reference to dynamic systems concepts (Araújo, et al., 2006). In comparison, traditional approaches have focussed primarily on the processes and structures within organisms to understand behaviour, described as an organismic asymmetry (Bentley, 1941; Davids & Araújo, 2010; Dunwoody, 2006). Describing behaviour from the organism-environment scale takes into account how perceptions, actions, intentions and cognitions emerge under the constraints of information shared between the organism and environment (Seifert & Davids, 2012; Shaw & Turvey, 1999; Warren, 2006). An ecological dynamics approach to emotion in learning draws several comparisons with the organism-environment theory developed in the realm of experimental psychology and mental function (Jarvilehto, 1998a, 1998b, 1999, 2000b, 2009). The organism-environment theory posits that traditional 'functions' (e.g. emotion, perception, action) that contribute to the system as a whole are not found solely in the brain, but in a mutual relationship between the organism and environment (Jarvilehto, 1998a, 2000b; Kiverstein & Miller, 2015; Lewis, 2005; Turvey, 2009).

> "One doesn't find mental activity, psyche, or emotions within the organism (in its brain or stomach), as little as they can be found in external stimulation. Mental activity is not activity of the brain, although the brain is certainly an important part of the organism-environment system"
>
> (Jarvilehto, 2000a, p. 55)

Complex dynamic systems such as humans have the capability to self-organise their actions or behaviour to achieve specific task objectives without direct input from higher order structures or predetermined rules (Kelso, 1995; Lewis, 2000b). When considering a human as a complex dynamic system, the informational variables in an environment, along with associated goal objectives and intentions influence how an individual behaves in specific contexts. Indeed, a critical aspect of the individual-environment relationship surrounds the perception of affordances available to achieve a desired result or outcome (Jarvilehto, 2000a) This takes into account the self-organising processes of affects, behaviours and cognitions in relation to both physical and psychological activity (Kelso, 1994; Lewis, 1996). The theory of functional systems (developed from a neurophysiological approach - see Anokhin, 1974; Egiazaryan & Konstantin, 2007) supports this integrative notion. From this approach psychological concepts (e.g. emotion, perception, and action) are viewed as integrated components of holistic systems that self-organise with respect to goal-directed behaviour (Alexandrov & Jarvilehto, 1993; Anokhin, 1974; Jarvilehto, 2001). Therefore, the desired or required achievement of useful (functional) behaviour informs the organisation of relevant and necessary system components.

States of system organisation (behaviour) that are stable and functional for a given task are described as attractors. Attractor states are considered functional when system components are integrated in a manner that achieves desired results

(Jarvilehto, 2001). Stable attractors are considered to have deep 'wells', which represent previously learnt and commonly adopted patterns of behaviour (Kelso, 1995; Thelen & Smith, 1994). Depending on the depth or stability of an attractor, changes in informational variables (e.g. control parameters, see Balagué, Hristovski, Aragonés, & Tenenbaum, 2012; Passos et al., 2008) and/or task objectives have the potential to perturb stable states of behaviour. Perturbations lead to a phase transition in the state of the system, often producing instability. Unstable states, or repellors, correspond to a 'hill' above potential 'wells' where behaviour is highly variable and usually less functional. Therefore unstable states are easily influenced by changes to informational variables both internal and external to the individual or system.

Through the process of learning and development a previously unstable repellor may emerge into a more stable attractor, initially as a shallow well, before potentially progressing to a deep well (Kelso, 1995; Kelso & Tognoli, 2009; Vallacher & Nowak, 2009). Therefore, an individual adopts a novel and functional response, portrayed as a stable pattern of organisation that over time becomes a characteristic response to a specific experience or environment (Lewis, 2000b; Thelen, 2002; Thelen & Smith, 1994). Conversely, as a result of negative experiences and/or poor performances a large repellor may develop, emerging as a characteristic and dysfunctional response to particular situations. The role of a coach or practitioner in sport is to recognise and manipulate key constraints in order to perturb a dysfunctional repelllor, and subsequently drive the system (i.e. individual learner) towards a more functional state of organisation (Davids, Araújo, Hristovski, Passos, & Chow, 2012; Warren, 2006).

In some cases an individual may develop several coexisting attractor states that are available to choose from, referred to as multistability. A system displaying multistability, therefore, has the ability to switch between selected attractor states as necessary, which can be advantageous with regards to adaptability, but also potentially detrimental due to inconsistency in performance (Chow, et al., 2011; Kelso, 2012; Kiverstein & Miller, 2015). A system can also display metastability, which acts as a pivot when a system is poised to emerge into a different stable state (i.e. multistability) (Kelso, 2012; Kelso & Tognoli, 2009). Metastability reflects the tendency of system components competing in an attempt to function both individually, and in unison concurrently (Kelso, 2008). Therefore metastability is a state of partial organisation that allows a system to function while transitioning between co-existing states of coordination (Chow, et al., 2011; Pinder, Davids, & Renshaw, 2012).

Ecological dynamics concepts are commonly used to describe the acquisition and coordination of physical movement behaviour, recently in relation to sport (see Araújo, et al., 2006; Balagué, Torrents, Hristovski, Davids, & Araújo, 2013; Chow, et al., 2011; Davids, Araújo, & Shuttleworth, 2005; Vilar, Araújo, Davids, & Button, 2012). However, many of the same principles have also been applied to describe how individuals develop interpretations of events in relation to the self-organising relationship between cognition and emotion (Lewis, 1996, 2000a, 2000b, 2002, 2004, 2005). While cognition and emotions are often treated as separate entities in psychology (for an overview see Mathews & MacLeod, 1994; Pessoa, 2008; Zajonc, 1980), the three components of affect, behaviour and cognition have been shown to influence each other to form emergent appraisals of experiences (Frijda, 1993; Larsen & Diener, 1987; Lewis, 1996).

The process of forming a cognition-emotion appraisal can be described from both a ‘bottom-up’ and ‘top-down’ approach (Cromwell & Panksepp, 2011; Lewis, 2004; Panksepp, 1998). The bottom-up approach involves the detection of information relating to a task with intrinsic or learned affective value, evaluated by structures such as the amygdala, before appropriate outputs are sent to areas including the hypothalamus and brain stem to facilitate action tendencies (see Pessoa, 2011). Traditionally the amygdala has been referred to in relation to fear processing or conditioning, but more recently has also been shown to be involved with attention, associative learning and affective value (LeDoux, 2000; Pessoa, 2008; Zadra & Clore, 2011).

A top-down approach (often likened to the function of a computer) provides an understanding of how humans can cognitively appraise the same situation differently according to the situational context and their goals (Uphill, McCarthy, & Jones, 2009). From this approach informational variables are attended to through the anticipation of emotion-laden stimuli. Therefore, humans can regulate emotion and associated action tendencies through the use of higher cognitive processes such as selective attention and memory. This involves taking into account the individualised intentions and motivations towards a task (Ochsner & Gross, 2007; Tucker, Derryberry, & Luu, 2000). The individual differences in the appraisal of the same perceptual variables also highlight the critical role of emotion in learning or practice environments. Every individual brings an intrinsic disposition to a task based on previous experiences, which determine how they will interpret and approach specific tasks.

Traditional cognitive theorists have attempted to identify specific regions of the brain that are solely responsible for emotional responses. Alternative approaches suggest that neural activity can be observed throughout various regions at the same time during emotional events (Cromwell & Panksepp, 2011). For example the limbic region ('system') has long been associated with emotion, but also has been found to be involved with learning, memory, motor function, along with cognitive and sensory processing (Pessoa, 2008). Therefore, it cannot be said for sure that areas such as the limbic region are solely responsible for emotional responses given the vast array of neural connections throughout the brain, and the other interrelated functions linked to this region (Jarvilehto, 2000b; LeDoux, 2000). Of particular importance is the finding that cognitions and emotions appear to develop in similar areas of the brain, which highlights the close, intertwined relationship that they are considered to share (Lewis, 2004).

The previous ideas fit well within a complex systems approach that considers an individual as many interacting parts that self-organise under the influence of constraints to achieve specific objectives (Kelso, 1995; Newell, 1986). From this approach, cognition and emotion are considered to influence each other in a coupled feedback loop (similar to perception and action) where cognitions bring about emotions, and emotions shape cognitions (Lewis, 2004). This cyclical interaction is considered to underpin the self-organisation of cognitive, emotional and perceptual aspects of experiences to form Emotional Interpretations (EI) (Lewis, 1996, 2000a). Emotional Interpretations are stable attractor states that form when emotional and cognitive changes/responses become linked or synchronised, and subsequently facilitate an appropriate functional action tendency (behaviour) to emerge (Lewis, 2000a). From a developmental perspective these stable attractors can be considered as personality traits, which over time become characteristic responses to specific experiences.

During development the relationship between cognitions and emotions in respect to an experience may change, resulting in phase transitions from unstable to stable states of organisation (Fogel et al., 1992; Lewis, 2004; Thelen & Smith, 1994). Like physical behaviour, the development of EI's may lead to metastable periods where an individual has the potential to adopt one of a 'cluster' of possible cognition-emotion states, reflecting sensitivity to changes in constraints and contexts (Hollis, Kloos, & Van Orden, 2009; Lewis, 2000b, 2004). During a period of metastability (i.e. learning), the behavioural tendencies would be expected to exhibit increased variability until a more stable state of self-organisation emerges (Chow, et al., 2011; Hollis, et al., 2009). Accompanying this variability in behaviour, variable and individualised emotional responses also emerge reflecting the instability of a metastable period (de Weerth & van Gert, 2000; Lewis, 1996, 2004). Much like movement variability, emotion during learning (and performance) has been considered, mistakenly, as unwanted noise (Davids, et al., 2003; Nesse & Ellsworth, 2009; Seifert & Davids, 2012; Smith & Thelen, 2003) Therefore sport scientists, teachers, and coaches often attempt to remove or suppress emotion from learning and experimental environments to facilitate controlled and predictable behaviour (e.g. de Weerth & van Gert, 2000). Suppressing emotions during learning suggests a focus on predictable teaching outcomes rather than allowing individuals to explore the environment and learn from their own positive and negative experiences (Gruber, Kogan, Quoidbach, & Mauss, 2013). By distancing emotions from learning, the role of individual differences in learning is also diminished, preventing individuals from finding their personal responses or solutions (Davids, et al., 2003; Seifert & Davids, 2012). Therefore removing emotional stimuli from a learning event disrupts the crucial relationship between the individual and environment.

The role of emotions should be considered an essential part of the learning experience because of the previously mentioned relationship between affect, behaviour and cognition. During the appraisal of an experience the interaction between cognition and emotion in particular is critical (Frijda, 1993). Evidence suggests that emotions emerge subconsciously before perceptions or cognitions, meaning that an appraisal of an experience cannot be completed without the influence of emotion (LeDoux, 2000; Lewis, 2000a, 2005). Emotional experiences are also considered to be vivid and memorable (Todd, Talmi, Schmitz, Susskind, & Anderson, 2012), influential on attentional processes (Padmala & Pessoa, 2008; Pessoa, 2011), and associated with increased arousal (Anderson, Yamaguchi, Grabski, & Lacka, 2006). Therefore, emotions should always be considered as a primary influence or precursor of learning experiences.

A working definition of emotion

Evidently what constitutes an emotion is difficult to conclusively define and measure. Appendix A provides a selection of emotion definitions representing several interpretations spanning across hundreds of years (see page 257). Incorporating key aspects of these interpretations, the following working definition of emotion is presented reflecting the approach adopted throughout this thesis. Drawing prominently on ecological dynamics concepts, this working definition outlines the overarching perspective of emotion discussed in subsequent sections and chapters.

> Emotions are dynamic self-organising states (intertwined with actions and cognitions) that can constrain, describe, and predict emergent behaviour across interacting time scales, with respect to the reciprocal individual-environment relationship.

Examining the definition more closely reveals several key concepts that have been discussed previously. The self-organising nature of emotions, actions, and cognitions is integral to the definition in that these domains must be considered in unison rather than as separate entities. Next, the ability of emotions to constrain, describe, and predict emergent behaviour is recognised, linking with the two principles of Affective Learning Design introduced in Chapter 3. In short these principles recognise the role of emotion-laden environments in shaping emergent behaviour, and also the potential to interpret emergent behaviour through the consideration of emotional responses (along with actions and cognitions). The importance of considering emotions over various interacting time scales reflects the dynamic moment-to-moment nature of emotion. Recognising the reciprocal relationship between individuals and the environment forms the final, and most crucial, aspect of the working definition. This conceptualisation is a key tenet of this principled approach, where emotions emerge through the mutual individual-environment duality, rather than being considered exclusively 'internal' to an individual (see, Bruineberg & Rietveld, 2014; Davids & Araújo, 2010; Jarvilehto, 1998a; Kiverstein & Miller, 2015; Lewis, 2004).

Emotions and human behaviour

This section discusses the scope of previous literature studying emotion, with an emphasis on sport. In particular, the popularised and frequently studied emotional constructs of anxiety and fear are reviewed. This overemphasis on emotions with negative connotations is then highlighted and contrasted with work incorporating both positive and negatively valenced emotions.

Anxiety

Anxiety is arguably the most frequently investigated and discussed emotion, particularly in the context of sport (Hanin, 2000b). State anxiety refers to the moment – to – moment, short time scale fluctuations in feelings of apprehension and tension with associated arousal of the autonomic nervous system (Martens, Vealey, & Burton, 1990; Spielberger, 1966). Trait anxiety is a more permanent part of an individual's personality that has developed over time and reflects acquired behavioural tendencies (Spielberger, 1966; Weinberg & Gould, 2015). Anxiety is further categorised as either cognitive or somatic reflecting the multi-dimensional characteristics of the broad construct (Borkovek, 1976; Davidson & Schwartz, 1976). Cognitive anxiety represents the worries, negative thoughts, and concerns about performance. Somatic anxiety reflects perceptions of physiological (arousal) and affective changes produced by the autonomic system (Gould & Krane, 1992; Martens, Vealey, et al., 1990). To conceptualise the relationship between anxiety and sport performance a range of models and theories have been proposed based on increasing levels of physiological arousal, for example Drive Theory, and the Inverted-U hypothesis (for overviews see - Gould & Krane, 1992; Martens, Vealey, et al., 1990; Weinberg & Gould, 2015). A related model that incorporates ideas presented throughout this thesis is the Cusp Catastrophe Model (Fazey & Hardy, 1988; Hardy & Fazey, 1987). This model recognises the multi-dimensional factors of physiological arousal (somatic anxiety) and cognitive anxiety on performance, whereby these variables are facilitative of successful performance up to a specific threshold, but detrimental beyond the threshold. Therefore, performance is deemed to be dependent on the intensity of these linked control parameters (arousal, cognitive anxiety), which have the potential to destabilise system behaviour when increased beyond individualised thresholds (Hardy, 1996; Newell, et al., 2001).

The influence of anxiety on psychological processes in a range of interceptive actions has been widely investigated by a number of researchers. For example, the influence of induced anxiety on attentional processes in driving tasks has been examined to determine how performance and peripheral awareness might be affected (Janelle, Singer, & Williams, 1999). Participants were required to complete a primary task of driving a race car simulator while also attending to peripheral stimuli and distractions in the form of flashing lights. Performance anxiety was created by designating sessions that were for familiarisation (low anxiety), practice (moderate anxiety) or competition (high anxiety). Results revealed that in conditions of higher anxiety participants were less accurate and slower to respond to the peripheral lights, in addition to demonstrating decreased performance in the primary driving task. In conditions of high anxiety and peripheral distraction the visual search tendencies of participants were found to be erratic with more fixations to peripheral locations. This was deemed to be as a result of attentional narrowing ('tunnel vision'), where heightened anxiety and/or arousal restricts the attention to relevant stimuli in the environment, particularly in dual tasking activities (Easterbrook, 1959). Therefore the emotional responses, in the form of increased anxiety in relation to a pending task (see Öhman, 2008), influenced the cognitive attentional processes and subsequently impacted performance. Similarly, anxiety was found to influence the perception of affordances for simple reaching, grasping and passing tasks (Graydon, Linkenauger, Teachman, & Proffitt, 2012). Participants in anxiety conditions were found to display more conservative behaviour traits (avoidance, freezing) which were detrimental to their perceived performance capabilities.

Anxiety has also been found to influence the performance of individuals in complex movement tasks in sport. Anxiety was manipulated in wall climbing through the use of identical climbing routes (traverses) of different heights (Pijpers, Oudejans, Bakker, & Beek, 2006). In three related experiments the higher route (i.e. high anxiety) was found to produce differences in perception and performance when compared with the lower route (low anxiety). Both perceived and actual maximal overhead reaching height were found to be reduced in the high anxiety condition indicating that the higher traverse influenced the perceived action capabilities of the climbers. Secondly, an increase in the number of holds used in the high anxiety condition was reported, suggesting that the increased emotion intensity (anxiety) influenced the climbers in terms of being more conservative in the manner they completed the course. The third experiment required climbers to detect lights projected around the climbing surface. Results revealed that in the high anxiety condition there were fewer lights detected and therefore it can be assumed that the climbers narrowed their attention as a result of anxiety. Closely related studies also found that high anxiety was responsible for physiological responses including increases in heart rate, muscle fatigue, and blood lactate. Movement behaviour was also found to be influenced by higher anxiety conditions through measures such as hold time, course completion time, and exploratory movements (Pijpers, Oudejans, & Bakker, 2005; Pijpers, Oudejans, Holsheimer, & Bakker, 2003). Hence, the manipulation of anxiety through different traverse heights was found to influence the intensity of performance and the affordances perceived, and acted on, by the climbers. Height was also used as a method for increasing anxiety when investigating the influence of anxiety, dual tasking, and expertise on dart throwing performance (Nibbeling, Oudejans, & Daanen, 2012). Here the performance of novices in particular was found to decrease in high anxiety conditions. High anxiety also led to reduced performance in the secondary cognitive task in the form of less frequent responses to a counting task. Finally, gaze fixations on the target were found to be shorter in length and moved away from the target earlier in the high anxiety conditions.

Fear

Closely related to anxiety is the emotional state of fear, which motivates the need to escape or avoid situations and objects that are perceived as dangerous or threatening (Frijda, 1986; Öhman, 2008; Öhman & Mineka, 2001). Throughout mammalian evolution, responses to fearful stimuli (e.g. predators) have included escaping, freezing, and attacking depending on the constraints of the environment (Blanchard & Blanchard, 1988). Fear is also an influential factor on human performance in sporting contexts where there is the potential for physical injury. For example, the ability of gymnasts to overcome the fear of suffering injury (and re-injury) has been examined to determine psychological and emotional factors that influence their continued performance (Chase, Magyar, & Drake, 2005; Mace, Eastman, & Carroll, 1986). Furthermore, by manipulating the height of balance beams the interaction between functional and dysfunctional emotions in performance was investigated (Cottyn, De Clercq, Crombez, & Lenoir, 2012). For the higher beam heights, dysfunctional emotions (i.e., fear, anxiety) were more evident and resulted in decreased performance, particularly on the first attempt. These findings suggest that manipulating the perceived difficulty and/or intensity of a performance task has the potential to influence the emotional tendencies of performers. In the next section, the discussion is broadened to consider the influence of positive and negative emotions on performance.

Positive and negative emotions

The emotions of fear and anxiety are generally viewed as negative and are the most commonly studied emotions in relation to human performance because of the evolutionary significance of identifying objects or experiencing events that are potentially threatening (Burgdorf & Panksepp, 2006; Öhman, Flykt, & Esteves, 2001; Woodman et al., 2009). The influence of positive emotions (e.g. happiness, joy) has also been investigated, often in direct comparison with negative emotions. For example, when positive, negative, and neutral photographs were shown to participants, the photographs eliciting positive emotions were found to be most memorable in a recall task (Becker, 2012). Further investigation of emotions other than fear and anxiety suggest that positive emotions can also influence performance (Raedeke, 2007; Woodman, et al., 2009). Positive emotions have been linked with widening the scope of attention, and behavioural tendencies (thought-action repertoires) in a video based investigation including positive, neutral, and negative visual stimuli (Fredrickson & Branigan, 2005; Fredrickson & Losada, 2005). This is in congruence with early ideas of James (1884) who outlined that emotions should be considered as valenced, relating to either positive or negative experiences (Oatley & Jenkins, 1992). On the other hand it is difficult to categorically specify that emotions can be described as positive/negative, or functional/dysfunctional because of individual differences in how emotion-laden environments are perceived (Bhalla & Proffitt, 1999; Friesen et al., 2013; Nesse & Ellsworth, 2009; Proffitt, Bhalla, Gossweiler, & Midgett, 1995). For example, anxiety might be perceived as negative by one individual and therefore dysfunctional, a second individual might find increased anxiety to be functional for performance and therefore a positive (Fazey & Hardy, 1988; Hardy, 1996). Some have considered positive and negative items to be opposing extremes of the same emotion continuum (Diener, Larsen, Levine, & Emmons, 1985). Investigations comparing the frequency and intensity of contrasting emotions suggest otherwise, advocating that positive and negative emotions should be treated independently (Carver & Scheier, 1990; Diener, et al., 1985; Warr, Barter, & Brownbridge, 1983).

From the perspective of the organism-environment theory put forward by Jarvilehto (1998a), positive and negative emotions are referred to in terms of different states of system organisation relating to the achievement of results (Jarvilehto, 1998a, 2000b; Turvey, 2009). Positive emotions indicate transitions in the organism-environment system organisation involving the integration of new experiences relating to successful action or results (Jarvilehto, 2000a; Spinoza, 1674/2006). The combination of successful results and positive emotions accompanies the development of a system to new states of organisation through differentiation (i.e. learning) (Jarvilehto, 1999, 2000b, 2009). On the other hand, negative emotions represent situations where a desired result is not achieved and the system disintegrates (reorganises) to a prior functional state (Jarvilehto, 2000a, 2000b; Spinoza, 1674/2006). This eventuality indicates that a key component of the organism-environment system is ‘missing’, which acts as a rate limiter (see Thelen, 1995) or barrier for the transition and development to new functional states. Self-organisation (integration – disintegration) of a system constantly takes place with the ever present interaction between emotion and action, or as stated by Jarvilehto (2000b, p. 43) “there is no action without emotions”. Therefore it is possible that an organism-environment system might be in a state of partial (i.e. metastable) integration/disintegration exhibiting positive and negative emotions in unison (Jarvilehto, 2000a).

Intentionality

The concept of intentionality refers to the ‘aboutness’ of and reason for some process, act or experience in relation to an object or event (Searle, 1983; Shaw, 2001). All of the concepts and examples discussed below are in some way related to intentionality, because they are directed at or about a property of an environment, whether it is a previous performance, or an object that is feared. Intentionality can be considered to focus or concentrate the attention of an individual on situations that are perceived to be potentially beneficial or harmful (Bruineberg & Rietveld, 2014; Lewis, 2004). Emotion and intentionality must therefore be considered alongside each other on account of emotions inherently being ‘about’ or ‘toward’ something (Dewey, 1895; Jarvilehto, 2001). For example, an emotion might be about or towards a specific object, event, situation or performance outcome that is deemed to be of some value to the individual across interacting time scales (Bruineberg & Rietveld, 2014; Lewis, 2002; Newell, et al., 2001). Jarvilehto (2000a, p. 56) suggested that “emotion could be very generally defined as a process of reorganisation (integration – disintegration) of the organism-environment system, expressed most clearly in relation to the realisation of the expected behavioural result”. In other words, emergent emotions about an event or situation reflect an individual’s evaluation of how their current capabilities meet their goals or expectations (Jarvilehto, 2001).

Considering the influence of intentionality on practice and learning tasks should not be underestimated. Designing tasks that involve objectives, goals and aims provide some context to a learning task and subsequently a reason or motive for participation (Araújo, et al., 2006; Shaw & Turvey, 1999). For example, manipulating instructional constraints in basketball (i.e. time and score) to manipulate scoring pressure introduced an intentionality for both attacking and defending players, representative of situations experienced in a game (Cordovil et al., 2009). Similarly, through the manipulation of the proximity to goal in association football, the intentions (strategies, tactics) of players were found to differ reflecting the situation specific information that was included (Headrick et al., 2012). As a result, the performers in the two given examples have been given some context for action, either through explicit instructions or by task constraints defining their purpose in the specific situation. As a result, an 'engagement' with the performance environment is maintained reflecting the key link between perception and action in complex systems (Kiverstein & Miller, 2015; Lewis, 2005; Solomon, 2008). These ideas have clear implications for the design of experiments and practical activities in sport and exercise.

Representative design

Based on the relationship between perception (information) and action (movement) it is imperative to consider Egon Brunswik's (1956) concept of *representative design* when designing tasks for experimental, learning and practice purposes (Araújo, et al., 2007). Brunswik advocated the study of organism-environment relations in psychology through the preservation of stimuli that would naturally be available to a performer/participant in an environment (Dhami, et al., 2004). Furthermore, Brunswik (1955) proposed that the tendency of (at the time popular) systematic design to isolate and manipulate individual variables or stimuli destroyed the organic relationship between perceptual information offered by the environment and the actions of a performer. Systematic design focussed on maintaining a high internal validity by identifying causal relationships between isolated variables. However, this was often to the detriment of external validity, where the finding may not be generalised when other confounding variables are reintroduced (Dhami, et al., 2004; Pinder, Davids, et al., 2011b). A term often confused with external validity and representative design is another Brunswikian concept – ecological validity (see Araújo, et al., 2007; Hammond, 1998; Pinder, Davids, et al., 2011b). Ecological validity refers to the statistical correlation between perceptual cues (proximal effects) present in the environment and an eventual (distal) outcome state. In other words, the likelihood of proximal variables inferring a distal outcome, such as deciding whether a criminal may reoffend (distal) based on their previous actions (proximal) (Dhami, et al., 2004). Consequently, ecological validity refers to the reliability of a perceptual cue, compared with representative design where findings pertaining to cues can be generalised in settings outside of a laboratory, such as sport (Kirlik, 2009).

Representative learning design

To increase the relevance of Brunswik's (1956) concept of representative design for use by sport scientists, coaches and physical educators, Pinder et al. (2011b) introduced the term *representative learning design.* The overall premise of representative learning design (RLD) is to consider the inclusion of representative constraints in sport performance simulations, and thereby evaluate the degree to which practice and learning tasks simulate a particular environment (Araújo, et al., 2007; Pinder, Renshaw, Davids, & Kerhervé, 2011). Key aspects deemed to uphold representative learning design are the functionality and action fidelity of practice or learning contexts. Functionality refers to the performer being able to complete specific behaviours (i.e. decision making, movement coordination) in both practice and performance environments because of direct comparisons between information available in each context. Action fidelity refers to the level of transfer in performance from a simulation (e.g. learning or practice tasks in sport) to the simulated system (e.g. sport performance/competition), originating from the study of flight simulators (Stoffregen, Bardy, Smart, & Pagulayan, 2003). Therefore, practice and learning tasks which are high in action fidelity must provide conditions that accurately simulate the performance environment of interest (Pinder et al., 2012). As an example, the use of dynamic game-based training in team ball sports provides practice conditions akin to competition, rather than highly constrained and structured 'drills' that decompose the perception-action relationships experienced in match contexts (Chow, et al., 2007; Renshaw, Chow, Davids, & Hammond, 2010).

Currently, the literature discussing representative (learning) design in sport has focused on physical and visual informational variables of a practice environment and how they relate to actual match or competition contexts (Pinder, et al., 2014). One example is the comparison of live versus simulated visual information in cricket batting to establish the representativeness of popular practice methods (Pinder, Davids, et al., 2011a). Here the movement organisation of cricket batters was compared when batting against real 'live' bowlers, video simulations of the same bowlers, and a ball projection machine. Results revealed that the movement characteristics of batters when facing the live bowlers were more comparable with the video simulations than with the ball projection machine, positing that the availability of visual information from the bowlers' action in the video condition provided a more representative simulation. Video simulation and live (in situ) conditions were also used to examine football goalkeeper gaze and movement behaviour under a range of conditions (Dicks, Button, & Davids, 2010). Goalkeepers were found to spend more time fixating on the body movements of penalty takers rather than the ball in conditions where responses were restricted to little or no movement (i.e. verbal, joystick and simplified body movements). When asked to physically intercept penalty kicks, the goalkeepers fixated on the ball and penalty taker for similar periods of time. These findings illustrate that different gaze behaviour was evident when the goalkeeper was required to act as they would in a match compared with when merely perceiving information for restricted movements or verbal responses that are not representative of responses required in a match.

Through different task vehicles and scales of analysis the previous examples summarise some recent findings and approaches regarding the representativeness of sport practice/performance settings. These studies provide clear implications for upholding the representativeness of physical and visual variables in practice environments, therefore allowing performers to perceive affordances from informational variables that they would expect to encounter in match or competition settings. However, while sampling environmental information is a good start, through the following sections it will be argued that the influence of emotion on learning and performance should also be considered when designing learning environments.

Learning and performance

Motor learning and performance are difficult to separate from each other, with learning processes derived from observable performances typically under different and highly controlled conditions, such as learning to perform (Schmidt & Wrisberg, 2008). From a complex systems approach, learning can be described as the transition to a preferred functional movement pattern (attractor) from a previously learnt movement pattern (Chow, Davids, Button, & Rein, 2008; Liu, Mayer-Kress, & Newell, 2006; Thelen, 1995). Learning and development are often discussed alongside each other as distinct, yet integrated concepts (Newell, et al., 2001). In general, learning relates to changes (e.g. performance, ability) over short time scales while development describes changes over longer periods of time (Granott & Parziale, 2002; Newell, et al., 2001). As learning is inferred from performance, learning and experimental environments should sample the conditions of the relevant performance environment to uphold representative learning design (Pinder, Davids, et al., 2011b).

Learning takes place over different interacting time scales that shape how an individual might approach a task (Newell, et al., 2001). The different time scales are often described as real and developmental, or micro and macrodevelopment, respectively (Granott & Parziale, 2002; Lewis, 2002; Thelen, 1995). From a complex systems perspective real time events shape long term developmental patterns or states, and conversely the established developmental states influence learning and microdevelopment in real time (Lewis, 2000a, 2002). These reciprocal influences between micro and macrodevelopment have been described as 'cascading constraints' on learning and performance (Lewis, 1997, 2002). Therefore, established emotional interpretations (EI) of an experience influence how an individual will approach learning a new task and in turn the process of learning will modify the overall EI (Lewis, 2000a, 2004). Taking a practical perspective to this concept highlights the critical role of an initial experience (e.g. first teacher or coach) for shaping an individual's approach to learning, as an early EI constrains subsequent learning experiences. For example, if a performer has few opportunities to be involved in initial training sessions, they are not likely to become engaged in future activities based on these prior experiences.

Goal orientation

The emergence of positive (e.g. joy, love, happiness) and negative (e.g. fear, anxiety, anger) emotions must be considered in relation to the goals an individual has for specific tasks. In a study on achievement tasks in children with equal abilities, different emotional responses were found to coincide with the outcome of failure, namely mastery and helpless responses (Diener & Dweck, 1978, 1980). Children displaying an adaptive mastery response displayed persistence, pursued the challenge and related failure to insufficient effort, while those exhibiting a helpless response were observed to be maladaptive, avoided the challenge and related failure to insufficient ability (Dweck, 1986; Elliot, 2005; Elliott & Dweck, 1988). To determine why individuals of equal ability performed in such different ways the concept of goals was introduced, where the goals of an individual create the framework for their performance (Dweck & Elliott, 1983; Dweck & Leggett, 1988). Various achievement goal theorists have commonly defined two distinct types of goals, for example, performance and learning goals (Dweck, 1986), ego and task involvement goals (Nicholls, 1984), amongst others. Despite subtly different labels and definitions, two types of goals can be distinguished. Performance goals relate to being successful, and being judged by others as competent, while mastery goals refer to the development of skills and competency (Ames & Archer, 1987; Elliot, 2005). Achievement motivation theorists have for many years incorporated an approach-avoidance distinction in the study of competence in human behaviour (Atkinson, 1957; McClelland, Atkinson, Clark, & Lowell, 1953). Competence can be defined as one's mastery of a task in relation to the task requirements, an individual's own previous and potential standard, and in comparison to the standard of others (Elliot, 2005). The approach-avoidance concept describes the valence of competence whereby individuals are motivated to either approach success and demonstrate competence, or attempt to avoid failure and the display of incompetence (Oatley & Jenkins, 1992).

Several studies have investigated the role of goals and an individual's approach to emotion-laden tasks. For example, the perspectives of extreme sports (e.g. BASE jumping, big wave surfing) participants were studied to understand how individuals perceive such tasks and overcome the fear of failure, which would almost certainly result in serious injury or death (Brymer & Oades, 2009). In this case, fear was found to be interpreted and experienced in a way that was meaningful and constructive for performance and continued participation (Brymer & Schweitzer, 2013). In a less extreme example, youth athletes from various sports were questioned to determine why younger athletes may fear failure in the achievement orientated setting of various sports (Sagar, Lavallee, & Spray, 2007). The most frequent consequences of failure feared by athletes were diminished perception of self (e.g. decreased confidence), no sense of achievement (e.g. losing), and the emotional cost of failure (e.g. guilt, criticism from others). Finally, the goal involvement states of Judokas (Judo competitors) were observed during a practice bout to determine whether the goal orientations fluctuated during performance (Gernigon, d'Arripe-Longueville, Delignieres, & Ninot, 2004). Through both quantitative and qualitative analysis techniques the Judokas were found to frequently alter their goal orientations depending on the various properties of the dynamic system (e.g. opponent's actions, success of attacks). This study was particularly interesting in that it measured goal states throughout the performance; an uncommon methodology in many of the studies of psychological factors in sport performance. Goals have also been found to differ between competition and training contexts in golf putting and football (soccer), with the overall finding of higher task (mastery) orientation during training and increased ego (performance) orientation in competition (van de Pol, Kavussanu, & Ring, 2012a, 2012b). This is a critical finding in relation to the design of practice environments as it details that individuals approach the two contexts very differently. Therefore, the distinction between goals associated with different learning and performance tasks is a critical consideration for this project.

Motivation

As action tendencies, motivational consequences may lead a performer toward (motivated) or away (unmotivated) from an object, or task (Jones, 2003). Self-determination theory (Deci & Ryan, 1985, 1991) states that performers engage in tasks for reasons, which originate from internal or external influences. Internal motivations are more self-deterministic in comparison with external motivations that are influenced by outside sources (e.g. coach or parent), however both varieties interact to develop individualised characteristics and interpretations of experiences (Vallacher & Nowak, 2009). Hence from this perspective, the two basic types of motivation are intrinsic and extrinsic motivation (Deci & Ryan, 1985). Intrinsic motivation refers to participating in an activity for the inherent satisfaction, fun or challenge involved without the influence of external pressure, rewards, instructions and consequences. In other words intrinsic motivation represents the 'free choice' of an individual to be involved in an activity or task (Deci, 1971; Ryan & Deci, 2000a).

Conversely, extrinsic motivation occurs when an activity is performed to achieve an outcome other than for pure enjoyment or satisfaction. Consequently, the majority of day-to-day activities such as going to work are extrinsically motivated because they pertain to a separate outcome (i.e. earning a living). The completion of some tasks may be both intrinsically and extrinsically motivated, for example going to work may be a source of enjoyment (intrinsic), while also a means to earn an income (extrinsic). Ryan and Deci (1985; 2000a) defined the key regulators of extrinsic motivation as external regulation, introjection, identification, and integration (often not discussed, see Vallerand & Blanchard, 2000). External regulation concerns the rewards or punishment associated with completing a task (or not). The ego involvement (see Nicholls, 1984) of a performer is described by introjected regulation whereby a task is completed to uphold or improve self-esteem, whilst also avoiding anxiety or guilt. Identification refers to a performer consciously recognising and accepting the value of an activity in relation to his or her goals. Integrated regulation occurs when tasks and goals are fully incorporated with existing values and needs of a performer much like intrinsic motivation, however tasks are still completed for the value of their outcome rather than pure enjoyment. Finally, the term amotivation describes the motivational state of a performer when they lack any intention to act from either intrinsic or extrinsic influences. Therefore a low-to-high continuum of self-determination begins with amotivation increasing through external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic motivation (Deci & Ryan, 1985, 1991; Ryan & Deci, 2000a). By considering emotion as a key aspect of representative learning design, the self-determined motivation of a performer to engage in a practice environment may be improved.

Summary

The previous sections have discussed the influence of emotion on human behaviour and advocated for the recognition of emotion as an integral feature of learning events. Emanating from dynamic systems and ecological psychology concepts a principled ecological dynamics approach to emotion during learning, has been put forward, representing the theoretical background of this PhD. This approach recognises the key relationship between an individual and the environment for the detection of information that is perceived in order to afford goal orientated behaviour. Several substantial gaps in the current literature have been identified, highlighting that a principled approach to emotions during learning in sport is severely lacking. With this is mind it was proposed that the concept and practice of representative learning design could be enhanced by embracing emotions as part of learning events. To provide background and rationale for investigating these issues, evidence was presented detailing the role of emotion in learning and performance, and reasons why it may have received little attention. This included discussion of the relationship between affect, behaviour (perception-action), and cognition from a systems perspective to reveal how these three domains influence each other. Drawing from the interaction between affect, behaviour, and cognition, in-depth individualised approaches were advocated, incorporating the influence of interaction time scales of learning. Following this, a range of examples highlighted how emotion and interrelated psychological concepts (e.g. attention, goal orientations, and motivation) influence behavioural tendencies of individuals. When combined with a principled theoretical approach, these practical findings highlight potential research directions based on creating and studying emotion-laden learning environments in sport.

Chapter 3: Affective learning design: Developing a principled approach to emotion in learning

Through the review of literature in Chapter 2 it was identified that a principled approach to the role of emotion in learning during sport was lacking. This chapter incorporates and builds on the reviewed literature to develop principles of *Affective Learning Design*, underpinned by Representative Learning Design (Pinder, Davids, et al., 2011b) and Ecological Dynamics concepts. Affective learning design (ALD) will be referred to throughout the following chapters as it represents the key theoretical premise of the PhD programme.

This chapter is based on the following peer reviewed article:

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Abstract

This chapter discusses the role of affect in designing learning experiences to enhance expertise acquisition in sport. The design of learning environments and athlete development programmes are predicated on the successful sampling and simulation of competitive performance conditions during practice. This premise is captured by the concept of representative learning design, founded on an ecological dynamics approach to developing skill in sport, and based on the individual-environment relationship. Here it is discussed how the effective development of expertise in sport could be enhanced by the consideration of affective constraints in the representative design of learning experiences.

Based on previous theoretical modelling and practical examples two key principles of *Affective Learning Design* are proposed: (i) the design of emotion-laden learning experiences that effectively simulate the constraints of performance environments in sport; (ii) recognising individualised emotional and coordination tendencies that are associated with different periods of learning. Considering the role of affect in learning environments has clear implications for how sport psychologists, athletes and coaches might collaborate to enhance the acquisition of expertise in sport.

Introduction

In sport, performers must adapt to the constraints of dynamic performance environments, with commensurate variable conditions and situations, while performing under different emotional states that constrain their cognitions, perceptions and actions (Jones, 2003; Lewis, 2004). Despite the documented presence of emotions[1] in sport performance, thus far (see Vallerand & Blanchard, 2000), limited attention has been paid to the role that emotions might play during the acquisition and development of expertise. Traditionally, emotions have generally been viewed as negative and detrimental constraints on behaviour, considered better to be removed from practice task contexts until a skill is well established (Hutto, 2012). This reductionist approach to learning design is in line with traditional thinking in the acquisition of skill in which practice tasks are decomposed to putatively reduce the cognitive loading on performers as they attempt to enhance expertise (Lewis & Granic, 2000). Here questions are raised on the reductionist approach to learning design and discuss an alternate principled approach suggesting how affective constraints on behaviour may be included during the acquisition of expertise in sport, drawing on the theoretical rationale of ecological dynamics.

In existing research on movement behaviours, ideas from dynamical systems theory have been integrated with concepts from Gibsonian ecological psychology, forming the ecological dynamics approach to understanding performance and learning (Araújo, et al., 2006; Davids, Williams, Button, & Court, 2001; Warren,

[1] The broad term of affect refers to a range of phenomena such as feelings, emotions, moods, and personality traits that interact over different time scales. Here affect will be used interchangeably with emotion to follow previous modelling of cognition, emotion and action (Lewis, 2000a; Vallerand & Blanchard, 2000).

2006). An ecological dynamics approach to enhancing expertise recognises the need for individuals to form mutual functional relationships with specific performance environments during practice and training (Araújo & Davids, 2011; Davids, Araújo, Vilar, Renshaw, & Pinder, 2013; Seifert, Button, et al., 2013). In a functionalist approach to the study of perception and action, Gibson (1979) emphasised the role of the environment and proposed that an individual's movements bring about changes in informational variables from which affordances (invitations for action) are perceived to support behaviours (Withagen, de Poel, Araújo, & Pepping, 2012). As a result a cyclic process is created where action and perception underpin goal-directed behaviours in specific performance environments (Gibson, 1979).

Studying emergent behaviours and the acquisition of expertise at this individual-environment scale of analysis takes into account how perceptions, actions, intentions, feelings and thoughts continuously emerge under the constraints of information external and internal to the individual (Seifert & Davids, 2012; Warren, 2006). Humans, conceptualised as complex dynamic systems, exhibit self-organising coordination tendencies during learning and performance to achieve specific task objectives (Kelso, 1995; Lewis, 2000b). The informational variables in a specific performance environment, along with associated goals and intentions, constrain how each individual behaves (Davids, et al., 2001; Freeman, 2000; Juarrero, 2000). Coordination tendencies (e.g., behaviours in human movement systems) that are stable are described as attractors (Kelso, 1995; Zanone & Kelso, 1992). Stable attractors are states of system organisation that represent well learned, stable patterns of behaviour (Kelso, 1995; Thelen & Smith, 1994). It is important to note that coordination tendencies may be functional or dysfunctional in terms of meeting the demands of a specific task, or during learning (Warren, 2006).

Depending on the depth or stability of an attractor, changes in informational variables that act as control parameters have the potential to perturb (disrupt) coordination tendencies (e.g., Balagué, et al., 2012; Passos, et al., 2008). Perturbations can lead to phase transitions in coordination tendencies, often producing changes in behaviour. Unstable system states correspond to a 'hill' above potential 'wells' where coordination tendencies may be variable and possibly less functional (Kelso, 1995; Vallacher & Nowak, 2009). Unstable system states are more open to influence by changes to informational variables both internal and external to an individual during performance (Davids, et al., 2001). Through practice and experience in sport, athletes, considered as dynamic movement systems, can learn to enhance stability of performance behaviours and increase their resistance to perturbations, including negative thoughts, and emotions (e.g., differences in ice climbing performance between experts and novices, see Seifert, Button, et al., 2013; Seifert et al., 2013). An important question for sport psychologists and coaches concerns how practice programmes can be designed to provide athletes with learning experiences that help them to exploit functional coordination tendencies (i.e. system states which are stable yet adaptable) under the affective constraints of sport performance.

Ecological dynamics is an integrated theoretical rationale of human behaviour that can underpin a principled approach to learning design in clinical (Newell & Valvano, 1998) and sport performance environments (Araújo, et al., 2006). The basis of behavioural change through learning involves the systematic identification and manipulation of system control parameters (informational constraints) to perturb stable states of organisation and facilitate transitions to more functional system states (Kelso, 1995, 2012). Attractors can take the form of intentions, and/or goals that a performer is 'attracted to' following changes in values of system control parameters (Davids, et al., 2013; Davids, et al., 2001; Warren, 2006). Stable system states often represent desired forms of organisation that are functional. Enhanced functionality, i.e. ‘what works’ (see Thelen & Smith, 1994), is achieved when an athlete establishes a successful relationship with a performance environment and individualised task goals are achieved (e.g., through more accurate or faster performance outcomes). Simultaneously, functional coordination tendencies can satisfy the psychological needs (i.e. ‘what feels good’) of each individual performer in particular performance situations (Carver, Sutton, & Scheier, 2000; Hollis, et al., 2009; Lewis, 2004). In order for a behavioural attractor to become stable through learning, the intrinsic dynamics (the predispositions and tendencies) of each performer and the task dynamics (e.g., specific performance requirements) must converge (Davids, et al., 2001; Zanone & Kelso, 1992). The relative stability of behavioural attractors is important to facilitate achievement of successful performance at specific points in time. But, learning environments also need to be dynamic and variable to allow an individual to adapt to changing individual, task and environmental constraints over the short and long time scales of development (Lewis, 2002; Newell, 1986). A key task for sport psychologists and practitioners is to understand how to effectively manipulate constraints to facilitate the development of new behavioural attractor patterns essential for expertise acquisition.

Sport psychologists have begun to identify control parameters to design effective learning environments that are carefully matched to each individual’s intrinsic dynamics, or predispositional behavioural tendencies. Carefully designed learning environments can guide athletes towards *metastable* performance regions, in which a functional blend of coordination stability and adaptability can result in rich behavioural solutions emerging (Hristovski, Davids, Araújo, & Button, 2006; Pinder, et al., 2012). Metastability is a state of partial organisation where a system 'hovers' in a state of dynamic stability, switching between functional states of organisation in response to changing constraints, and displaying subsequent behavioural flexibility (variability, instability) (Fingelkurts & Fingelkurts, 2004; Phillips, Davids, Araújo, & Renshaw, 2014). Metastability allows a system to transit rapidly between co-existing functional states of organisation, essential for adaptive performance behaviours in dynamic environments (Chow, et al., 2011; Kelso, 2012; Kelso & Tognoli, 2009). During learning events in specific performance environments, being in a state of metastability allows performers to discover and explore performance solutions (Kelso, 1995; Seifert, Button, et al., 2013). In sport, empirical data has revealed how locating samples of boxers and cricketers in metastable performance regions during practice helped them to explore and exploit rich and creative performance solutions to achieve their task goals (Hristovski, et al., 2006; Pinder, et al., 2012).

Adopting novel and potentially functional states of system organisation is a consequence of learning and/or development, as individuals transit from the 'known' to the 'unknown', i.e., moving from a familiar task or situation to one that is new or different. Of interest to sport psychologists is that increases in movement variability during phases of learning are often accompanied by increased intensity and range of emotions (Lewis, 2004, 2005). These emotions can be attributed to: (i) the challenges of learning a new movement pattern; (ii) the perceived risk of failure to achieve specific performance outcomes; and (iii), the underlying uncertainty and/or excitement associated with performing in an unknown situation. For example, the changes in infant sensorimotor and emotion regulation during developmental transition periods (Lewis & Cook, 2007). Observable changes in behaviours and emotions of athletes are of importance since they can act as predictors for potential phase transitions in system behaviours, such as coordinated movement response characteristics (Chow, et al., 2011; Kelso, 1995). The theoretical rationale of ecological dynamics suggests that it is essential to design learning environments that guide athletes towards metastable regions of a perceptual-motor workspace during performance (physically and emotionally) to aid the acquisition of expertise in sport (Oudejans & Pijpers, 2009; Pinder, et al., 2012). In achieving this aim, an important challenge for sport psychologists and practitioners is how to design learning environments that successfully simulate key constraints of competitive performance environments in sport. Egon Brunswik (1956) advocated that, for the study of individual-environment relations, cues or perceptual variables should be sampled from an organism's environment to be *representative* of the environmental stimuli that they are adapted from, and to which behaviour is intended to be generalised (Araújo, et al., 2007; Pinder, Davids, et al., 2011b). The term *representative design* captures the idea of sampling perceptual variables from an individual's performance environment to be designed into an experimental task (Brunswik, 1956). Recent work has considered how the concept of representative design can be applied to the study of sport performance (Araújo, et al., 2006; Araújo, et al., 2007). Inspired by Brunswik's (1956) insights, the term *representative learning design* (RLD) has been proposed to highlight the importance of creating representative environments for learning skills and developing expertise (Davids, et al., 2012; Pinder, Davids, et al., 2011b).

Previous empirical work on RLD (Pinder, Davids, et al., 2011a) has focussed on visual information provided during practice in training environments of elite athlete programmes (Barris, Davids, et al., 2013), and changes to the complexity of organisation in tasks for practising passing skills in team games (Travassos, et al., 2012). These examples advocate expertise acquisition by nurturing the relationship between key environmental information sources and coordination tendencies of a performer in order for more adaptable and effective movement behaviours to emerge (Davids, et al., 2013; Phillips, Davids, Renshaw, & Portus, 2010). From this perspective the development of expertise is predicated on the accurate simulation of key performance constraints during practice/learning. This approach differs from traditional methods of decomposing tasks to isolate individual components, in order to manage the information load confronting learners (Phillips, et al., 2010; Pinder, Renshaw, & Davids, 2013).

An aspect of RLD that needs attention in future conceptualisation of learning and practice is the role of affective constraints on behaviour (for initial discussions see, Pinder, et al., 2014). In sport, performers need to be able to adapt to task constraints while performing under differing emotional states induced in competitive performance that can influence their cognitions, perceptions and actions (Jones, 2003; Lewis, 2004). Previous work investigating affect in sport performance has tended to focus on capturing the emotions of athletes in 'snapshots' of performance at one point in time, such as before or after competition (for a recent example see Lane, et al., 2012). Such an approach, however, has not considered how emotions might continuously interact with intentions, cognitions, perception and actions to constrain the acquisition of functional coordination patterns and the development of expertise. A holistic approach should consider task demands of learning environments and the dynamic psychological state of each individual learner as interacting constraints influencing behavioural (perception-action couplings), cognitive, and emotional tendencies (Davids, et al., 2013; Newell, 1986). These ideas suggest how sport psychologists and practitioners may seek ways to sample the intensity of emotionally-charged performance conditions in learning environments and practice simulations. To address this issue, the following sections of this paper, will discuss why and how emotions could be incorporated into representative learning designs to enhance acquisition of expertise in sport.

Affective learning design

Yet to be seen in the literature is a principled exploration of the role of emotions in developing expertise in sport (Pinder, et al., 2014; Renshaw, Headrick, & Davids, 2014). The role of affect in developing expertise might be harnessed by adhering to two principles: (i) the design of emotion-laden learning experiences that effectively simulate the constraints and demands of performance environments in sport; (ii) recognising individualised emotional and behavioural tendencies that are indicative of learning. These principles suggest, two complementary perspectives on *Affective Learning Design* (ALD), linking the development of representative learning designs with the identification and recognition of individual behavioural tendencies exhibited while learning.

Benefits of creating emotion-laden learning events have been demonstrated within the psychology literature. Emotions influence perceptions, actions and intentions during decision-making, with the intensity of emotion generated reflecting the significance of stimuli to an individual, shaping the strength of the response on the visual cortex (Pessoa, 2011). Emotion also acts to strengthen memories (positive or negative) and produces greater engagement in ambiguous, unpredictable, or threatening situations when individual and group goals are influenced (e.g. learning when failure might have significant consequences such as non-selection for a team, or a team failing to qualify for a future event) (LaBar & Cabeza, 2006; Pessoa, 2011).

Despite these proposed benefits, the role of emotion in the pursuit of expertise in sport has often been neglected (or removed) during practice because emotion-laden responses are traditionally considered irrational or instinctive, and therefore perceived as a negative influence on action (Hutto, 2012; Jarvilehto, 2000a). A neglected issue is that a significant constraint in competitive performance environments is the emergent emotional tendencies of each individual. Therefore a key question is, how can individuals be supported while exploring and exploiting emotional constraints when learning to perform in competitive performance environments? Emotionless responses made from a purely informational stance have been described as 'cold cognition', and emotion-laden responses as 'hot cognition' (Abelson, 1963). The expression of 'sit on your hands' in relation to choosing a move in a game of chess exemplifies a traditional view that it is necessary to suppress or remove emotions in order to make more rational decisions (i.e. cold cognition) (Charness, et al., 2004). However, during competitive performance in sport, athletes are often not afforded this 'thinking' time and need to be able to act immediately based on the initial, fleeting interaction between their perceptions of the task and pre-existing physical, cognitive, and emotional capabilities (Davids, 2012). This performance capacity has been referred to as 'ultrafast' behaviours (Riley, Shockley, & Van Orden, 2012).

Progress in understanding emotions during learning has also been limited by a tendency towards traditional linear thinking, where cognitions related to events are considered to result in preconceived emotional reactions (Lewis & Granic, 2000). Some psychologists have recently begun to acknowledge the advantages of considering humans as complex, highly integrated dynamical systems in explaining emergent behaviours (Lewis, 1996; Lewis & Granic, 2000). From this approach cognition and emotion are considered to constrain each other interactively (similar to processes of perception and action), with cognitions bringing about emotions, and emotions shaping cognitions (Lewis, 2004). This cyclical interaction underpins the emergent self-organisation of cognitions and emotions experienced during task performance (Lewis, 1996, 2000a). Established emotional experiences represent stable patterns of behaviour that are formed when emotional and cognitive changes/responses become embodied in behavioural tendencies (Lewis, 2000a). In other words, intertwined emotions, cognitions, and actions can become stable, characteristic responses to particular experiences (Lewis, 1996, 2004). In this line of thinking, affect, cognition, and behaviours exhibit self-organisational tendencies to underpin characteristic performance responses, and shape the intrinsic dynamics of an individual (Davids, et al., 2001; Schöner, Zanone, & Kelso, 1992). For example, in the development of personality, trait-like behaviours, thoughts and feelings become predictable, stable responses of an individual under certain performance conditions (Lewis, 1996).

During the development of emotional interpretations, changes in performance constraints may lead to metastable periods where an individual could rapidly transit towards one of a ‘cluster’ of possible cognitive-emotive states (Hollis, et al., 2009; Lewis, 2000b, 2004). When in a metastable performance region (for example during learning), behavioural tendencies of an individual would be expected to fluctuate (exhibit increased variability) until a more stable state of behaviour emerges (Chow, et al., 2011; Hollis, et al., 2009). Accompanying this variability in performance behaviours, variable and individualised emotional responses also emerge (Lewis, 1996, 2004). Much like movement variability, emotion during learning (and performance) has previously been considered as 'unwanted system noise' (Davids, et al., 2003; Smith & Thelen, 2003). An ecological dynamics approach questions this assumption, suggesting that the presence of emotion during learning is indicative of a performer being engaged in task performance as they seek to utilise available affordances to satisfy their intentions and goals (Jones, 2003; Seifert, Button, et al., 2013).

For example, gymnasts attempting routines on balance beams of increasing height have been found to display performance decrements, elevated heart rate, and increased prevalence of perceived dysfunctional emotions (e.g. reporting feeling nervous or scared) particularly on a first attempt (Cottyn, et al., 2012). Similarly, comparisons of performance during climbing traverses, identical in design but differing in height from the ground, have revealed that higher traverses increased anxiety, elevated heart rates, lengthened climbing duration, and increased exploratory movements in climbers (Pijpers, et al., 2005). Such findings highlight the intense emotions often involved with moving out of a 'comfort zone' when confronted with a new or more challenging task. This idea can also be interpreted through work in cybernetics where individuals are viewed to adapt to situations until reaching a critical point where they must undergo a shift or reorganisation to maintain effective action and emotion characteristics (see, Carver & Scheier, 1998, 2000; Carver, et al., 2000).

A relevant body of work has investigated the potential advantages to learning outcomes when training under pressure and the constraints of induced performance anxiety in a range of tasks (Oudejans, 2008; Oudejans & Nieuwenhuys, 2009; Oudejans & Pijpers, 2009, 2010). This work focused on the task constraint of anxiety and training under pressure, with findings providing clear implications for developing context-specific expertise by acknowledging the role of emotions in learning. For example, in a dart throwing task participants who trained under the task constraint of mild anxiety were found to more successfully maintain their performance levels in high anxiety conditions, compared with those who trained in low anxiety conditions (Oudejans & Pijpers, 2010). In this case anxiety was manipulated by positioning dart throwers at different heights on an indoor climbing wall (also see, Oudejans & Pijpers, 2009). Similar findings were revealed in a study comparing the role of pressure in a handgun shooting task involving police officers (Oudejans, 2008). Here the control group (low pressure) shot at cardboard targets, while a high pressure group shot at opponents who could fire back with marking cartridges. Prior to practice, the performance of both groups was found to deteriorate when switching from low to high pressure task constraints. After completing three practice sessions, performance scores indicated that the shooting performance of the experimental group was maintained for the high pressure condition. In comparison, the performance of the control group deteriorated under high pressure as observed prior to the practice sessions. Induced anxiety was again used as a task constraint during practice sessions in an attempt to improve basketball free throw shooting under pressure (Oudejans & Pijpers, 2009). Participants in an experimental group were made aware that their practice sessions were being recorded, viewed and evaluated, along with being constrained by simulated competitive performance scenarios and the possibility of receiving performance rewards. As with the previous examples, the experimental group was found to maintain free throw performance during low pressure tasks into high pressure tasks. The performance of the control group, who practiced under low anxiety, deteriorated in high pressure conditions following five weeks of practice.

The findings of these studies have clear implications for how affective task constraints can be manipulated for the acquisition of expertise in sport. The data highlight that sport psychologists need to consider how behaviour and performance outcomes can be constrained by simulated emotional and cognitive states of individual performers during practice. In acquiring expertise, performers will experience periods of failure or success as they strive to achieve a high level of 'fitness' for specific performance landscapes (Collins & MacNamara, 2012). Learning environments need to be designed to include situation-specific informational constraints that shape and regulate movement behaviours and the emotional constraints of a task in relation to the intentions of a performer (Davids, et al., 2001). From this approach, emotions are influenced by the constraints of the task and also act as constraints on future behaviours emerging across interacting time scales (i.e. performance, learning and development time scales) (Lewis, 2000a, 2004). Drawing on this interaction, ALD advocates for the design of emotion-laden learning experiences that represent the constraints of competitive performance and promote the acquisition of expertise within/for that context. Underpinning the design of representative experiences is the observation and analysis of emotions in conjunction with movement behaviour to identify periods of learning.

Affective learning design in practice

The intertwined relationship between movement behaviour and emotions poses many challenges and implications for sport psychologists and other practitioners interested in understanding how the concept of ALD can be applied to the acquisition of expertise in sport. Key considerations for implementing ALD include (i) adopting an individualised approach, (ii) acknowledging different time scales of learning, and (iii) embedding emotions in situation -specific task constraints. Sport psychologists implementing ALD need to sample, predict and plan for the potential emotional and cognitive circumstances in competition, and adequately sample them in learning simulations. This premise links to the two previously identified principles of ALD regarding the design of representative emotion-laden learning experiences, and identifying emotional and behavioural tendencies that are indicative of learning. The following discussion of these ideas includes a series of practical examples of how ALD might be embraced by sport psychologists, pedagogues, coaches, and athletes.

The individualisation of affect

Of major significance for the design of affective learning environments is catering for individual differences between performers. Sport psychologists must collaborate with coaches to exploit their experiential knowledge to individually tailor learning experiences based on skill level, personalities, learning styles, and psychological strengths/weaknesses (Renshaw, Davids, Shuttleworth, & Chow, 2009). For example, it is worth considering some data on how skill-based differences might interact with emotions to constrain cognitions, perceptions and actions of different individuals (Seifert, Button & Davids, 2013). A comparison of the performance of ice climbers revealed that the intra-individual movement choices (e.g. kicking, hooking into the ice) and inter-limb coordination modes of novices displayed less variability than those of experts (Seifert & Davids, 2012). In this research novices tended to intentionally adopt an ‘X’ position with their arms and legs that provided highly stable interactions with the surface of the ice. These coordination patterns were functional for novices since they provided stability on the ice surface. However, adoption of these highly secure patterns was not functional for the goal of climbing the ice fall quickly, as demonstrated by the levels of variability in positioning of the experts. The implication is that energy efficiency and competitive performance were not prioritised in the goals of novice performers, whose specific coordination tendencies emerged as a function of their uncertainty in interacting with the ice surface.

In this example, the intentions (i.e. stable position vs. efficient and effective climbing movements) of each performer, based on their individualised perception of affordances, provide scope for a coach or sport psychologist to design targeted learning events. Key constraints can then be implemented and manipulated to simulate challenges that are anticipated to enhance situation-specific expertise at an individualised level, based on identified stable emotional and behavioural tendencies. For example a novice climber might be encouraged by a coach to move away from the 'X' position through the narrowing of available climbing area, forcing the individual to explore climbing options with foot and hand holds closer to the body. In implementing this approach a coach could develop an understanding of the most successful methods for pushing each performer into metastable regions, where established action-emotion tendencies become destabilised. As a result, the performer will be forced to explore performance environments simulated during learning to harness new functional states of stable system organisation, or at least experience situations with different task demands (Chow, et al., 2011; Renshaw, et al., 2009). This approach is synonymous with psychological 'profiling' and shares some ideas with the notion of individual zones of optimal functioning (IZOF) model advocated by Hanin (e.g. Hanin, 2007b; Hanin & Hanina, 2009) in which the interaction between emotions and actions during optimal performance is considered to be highly individualised.

Time-scales and affects

The individualised nature of emotions must also take into account the different interacting time scales of learning that influence the development of expertise (Newell, et al., 2001). The critical relationship between the time scale of perception and action (short term over seconds and minutes) and those of learning and development (longer term over days, weeks and months) predicates how an individual might approach specific situational constraints. From a complex systems perspective, perception and action constrain the emergence of long term patterns or behavioural states (Lewis, 2000a, 2002). Initial experiences of a performer will influence how he/she approaches tasks in the future, which emphasises the importance of tailoring the design of learning tasks to individual needs at all stages of the expertise pathway (Côté, Baker, & Abernethy, 2003).

For example, qualitative evidence from interviews with expert team sport athletes revealed that the roles and expectations of coaches (and performers) change along the pathway to expert performance (Abernethy, Côté, & Baker, 2002). Perceptions of 'expert' coaches at early stages of sport participation were based on creating positive environments (leading to positive emotions) that were engaging and fun while also developing basic skills. Essentially, these early experiences were more concerned about meeting the basic psychological need of learners to demonstrate competence (Renshaw, et al., 2012), leading to higher levels of intrinsic motivation that sustain engagement over longer time frames necessary to achieve expertise. As athletes progressed through the developmental phases (i.e. from Romance to Precision to Integration, see Bloom, 1985) the relationship with the coach became more tightly coupled and tended to increasingly emphasise the acquisition of sport specific knowledge for managing the physical, emotional, and cognitive needs at an individual level (Abernethy, et al., 2002; Côté, et al., 2003).

Hence, by designing learning environments that cater for changing emotions, cognitions and actions, performers are more likely to engage with or 'buy into' the rigorous demands of long term development programmes (Renshaw, Chow, et al., 2010; Renshaw, et al., 2012). This reinforces the importance of recognising individualised physical and psychological tendencies across various periods of learning, as well as the critical role of a coach or sport psychologist in designing learning programmes that simulate and sample the intended performance environment to effectively accommodate such behavioural tendencies.

Emotions are embedded in situation-specific task constraints

Emotion-laden experiences are considered to energise behaviour and facilitate an investment in tasks because emotions add context to actions, rather than an athlete merely 'going through the motions' in isolated practice drills (Jones, 2003; Renshaw, et al., 2012). Creating individual and/or group engagement in learning experiences through the manipulation of specific constraints enhances the representativeness of a practice task. Through the inclusion of situation-specific information, the demands of a competitive performance environment can be simulated (Pinder, Davids, et al., 2011b; Pinder, et al., 2014). Based on this premise, to facilitate the holistic development of expertise, performers should be immersed in learning environments that challenge and stimulate both physically and psychologically to coincide with the constraints of prospective performance environments (Davids, et al., 2013; Renshaw, et al., 2012).

For example, rather than allowing an athlete to practise shots on a driving range, a coach might walk alongside a trainee golfer, creating specific ‘vignettes’ (e.g., 1 shot behind with one hole to play or 2 shots ahead in the same situation) to simulate competitive performance conditions under which a learner might need to adapt their golf shots (e.g., play more conservatively or take more risks). Some previous work in team sports research has incorporated vignettes into the design of practice and performance tasks to investigate how manipulating situational constraints might influence emergent behaviours in athletes. In basketball 1v1 sub-phases, the manipulation of instructional constraints to simulate competitive performance conditions was found to influence the specific intentions and emergent behaviours of attacking players (Cordovil, et al., 2009). In that case game time and score-based scenarios were implemented to encourage players to experience adopting risk-taking, conservative, or neutral strategies that might emerge in competitive game play. Similarly, in football, 1v1 attacker-defender dyads, located at different locations on the field of play (by manipulating distance to the goal area) were found to constrain how attacking and defending players interacted with each other (Headrick, Davids, et al., 2012). Providing contextual information through vignettes engaged the players in the task by specifying goals or objectives that simulated typical game situations for each field position.

Further work originating from elite sport programmes has discussed the importance of designing practice tasks that effectively replicate competitive performance conditions for athletes. An example is the development of the ‘Battle Zone’ in cricket as an alternative to traditional, decomposed, net-based or centre wicket batting and bowling practice (Renshaw, Chappell, Fitzgerald, & Davison, 2010). The Battle Zone concept combines a regulation cricket pitch with a downscaled netted field area to increase involvement and intensity for all players, compared with full sized centre wicket practice. Vignette-based tasks such as the Battle Zone, maintain the critical performer-environment interactions while also affording coaches the opportunity to manipulate specific performance constraints to physically and psychologically engage batters, bowlers and fielders simultaneously (Renshaw, Chappell, et al., 2010; Renshaw, et al., 2012).

Practice task designs, such as the Battle Zone, manipulate the space and time demands on players which is captured by the *Game Intensity Index* (GII) concept (Chow, Davids, Renshaw, & Button, 2013). The GII (pitch area in m^2/number of players) can be used in various team and invasion games to create game intensities representative of competition, compare types of games, and cater for different levels of expertise. Coaches can systematically manipulate GII to match task demands to current performance capacity (i.e., place the player's in their comfort zones) before pushing learners into metastable regions that correspond with instability in conjunction with increased range and intensity of emotions, cognitions and actions. For example, if a coach wished to observe how a young player could cope at the next performance level, (s)he could manipulate the GII to simulate the spatiotemporal demands of that level.

In fast ball sports like cricket and baseball, the temporal demands of batting become more severe as performance levels increase. In cricket, while present methods of preparing for this added temporal constraint often include resorting to bowling/ pitching machines or intensive net sessions with 'throw-down's by coaches from shorter distances, previous research has shown that removing essential information in practice tasks (i.e., the bowler) results in changes in batter's timing and co-ordination (Pinder, Davids, et al., 2011a; Renshaw, Oldham, Davids, &

Golds, 2007). A more effective way, could be to face current fast bowling teammates in Battle Zone vignettes, to replicate the time demands of facing faster bowlers. For example, to replicate a 150 kmh^{-1} delivery a 140 kmh^{-1} bowler would need to release the ball closer (1.75 m) to the batter than the 'legal' delivery distance to replicate the time (0.41 s) available when facing the 150 kmh^{-1} bowler. As well as requiring the batter to adapt on a perception-action level, simulating the faster bowling speed also enables the batter to experience the potentially intense emotions associated with facing bowlers of this speed. These task constraints also allow learners to experience the consequent changes in perception, cognitions and actions associated with the interaction between internal and external constraints underpinning performance.

Other work in the sport of springboard diving studied the practice methods of athletes from an elite-level squad (Barris, Davids, et al., 2013; Barris, Farrow, & Davids, 2013). In these studies, elite divers were observed to baulk (preparation occurs but divers do not leave the board) during practice when the preparation phase was perceived as not being ideal for the performance of a selected dive (Barris, Farrow, et al., 2013). This behaviour posed problems for performance in competitive events where baulked dives result in reduced scores from judges. In a planned intervention, divers were required to avoid baulking unless it was perceived that an injury might occur. Barris and colleagues (2013) reported no significant differences in movement patterns between baulked and completed dives under these new task constraints. However, quantitative analyses of variability within conditions, revealed greater consistency and lower levels of (dysfunctional) variability amongst dives completed *prior to* the training program, and greater levels of (functional) variability amongst dives completed *after* experiencing the training programme. It was concluded that divers should be encouraged to complete (where safe) all attempts to more functionally simulate the adaptive performance requirements of competition conditions. From an ALD approach, data suggested that under these practice task constraints, divers would be more frequently exposed to metastable regions enabling them to explore variable take off positions. These metastable regions were expected to enhance the development of expertise (through increased adaptability) by encouraging divers to complete dives where less than 'optimal' preparatory movements were evident. These changes to practice task design created more physically and emotionally demanding performance environments that better simulated competitive performance conditions. As predicted, the elite springboard divers displayed greater consistency in key performance outcome (dive entry). At the end of a twelve-week training program that required divers not to baulk, athletes demonstrated enhanced performance through increased levels of functional movement variability. Data suggested that the intervention resulted in them being able to adapt their movements in the preparatory phase and complete good quality dives under more varied take-off conditions. These results bring to light some important practical implications for athletes in training and competition by means of improving training representativeness, reducing performance anxiety and enhancing feelings of self-confidence (Barris, Davids, et al., 2013).

Each of the examples in this section illustrate how including representative, situation-specific constraints has the potential to embed emotions in learning environments. Considering such examples, in conjunction with the previously discussed body of work focussing on anxiety and training under pressure (e.g. Oudejans, 2008; Oudejans & Nieuwenhuys, 2009; Oudejans & Pijpers, 2010), provides support for embracing emotions present in learning environments. The advantages to learning and performance outcomes reported (e.g. in dart throwing and basketball shooting) when training with anxiety, and the well-established benefits of creating representative learning environments provide diverse, yet complementary, perspectives for how ALD can enhance the development of expertise in sport. By implementing ideas such as these, sports psychologists and coaches will be able to observe and analyse the integrated emotional and behavioural tendencies of athletes during learning. In turn, the identification of these emergent physical and psychological tendencies has the potential to underpin the design of further effective learning experiences.

Conclusions

Founded on ecological dynamics principles, previous work has conceptualised and advocated a representative learning design for effective development of skill and expertise in sport. To take forward the understanding and application of this approach the importance of emotions in learning has been highlighted and introduced an integrated concept of ALD with potential scope for future theoretical modelling. Two key interlinked principles of ALD have been identified: (i) the design of emotion-laden learning experiences that effectively simulate the constraints and demands of performance environments, and (ii), recognising individualised emotional and behavioural tendencies that are associated with different periods of learning. Here it has been argued that these key principles of ALD will be valuable in the acquisition of sport expertise by considering affect, cognitions, and actions together as intertwined individualised tendencies which constrain performance and learning. Enhanced understanding of individualised behavioural tendencies during learning will also aid the design of representative learning environments that more effectively develop situation-specific skills.

The concept of ALD also advocates designing learning environments at an individualised level, acknowledging different interacting time scales, and implementing vignettes or scenarios to provide context to tasks. This allows performers to experience the emotional feelings associated with performing in learning situations that simulate the external task demands of a 'new' environment. Therefore performers are provided the opportunity to experience how they would (potentially) respond emotionally (e.g. know what emotions were created and how intense they were), how this impacted on the way they thought (e.g. influencing their intentions/goals/motivations), and acted (how this affected their actions). ALD also allows the performer, sport psychologist, and coach to understand the impact of being placed in a metastable region (i.e. in a learning task) and the influence this has on affect, cognitions and behaviours. By recognising this interaction it is envisaged that performers and sport psychologists will begin to understand that variability is a normal (in fact desirable) consequence of learning that can be incorporated to develop enhanced learning experiences in the future.

Future research should aim to investigate the relationship between affect, cognition, and action during learning experiences to provide further support for this, and potentially expanded, ALD models. Upholding a focus on individualised approaches is imperative to effectively capture how individual learners interact with specific task demands and environments. This theoretical conceptualisation of how affect, cognition, and action interact provides implications for the design of integrated, systems-oriented learning environments that enhance the acquisition of expertise in sport through enhancing the functionality of individual-environment relationships

Chapter 4: Development of a tool for monitoring emotions during learning in sport

The Sport Learning and Emotions Questionnaire (SLEQ)

Following the conceptualisation of Affective Learning Design (ALD) in Stage 1, this chapter (Stage 2) discusses the development of a tool for measuring emotion intensity during learning in sport. Through several phases of item refinement the Sport Learning and Emotions Questionnaire (SLEQ) was conceived, providing a suitable tool for tracking and measuring emotions as discussed during subsequent stages of the PhD.

Overview

Measuring and analysing emotion during learning in sport is a complex and challenging task that has often been overlooked or neglected. Existing methods tend to be derived from tools that are developed in contexts other than sport, are designed for pre / post competition contexts, focus on one or a select few emotions, and are static rather than dynamic in nature. The following chapter takes on the challenge of developing an emotions questionnaire designed within the context of learning in sport, for use during learning in sport. Through several phases of inquiry, emotion items (words / phrases) were identified, refined, compared, and validated. By means of confirmatory factor analysis a four-factor, 17 item model emerged, forming the structure of the *Sport Learning and Emotions Questionnaire* (SLEQ). The SLEQ provides an overall score of emotion intensity, along with subscale scores of Enjoyment, Nervousness, Fulfilment, and Anger. Designed to be implemented across several interacting time scales, the SLEQ is an innovative and much needed tool that has the potential to be adopted by researchers and sport practitioners interested in tracking emotion intensity throughout various learning tasks.

Introduction

Research investigating the type, intensity, and influence of emotions experienced in sport contexts is an area of great interest to athletes, coaches, pedagogues, and sport psychologists alike. Previous work has discussed the role of emotions in relation to: decision-making (Tenenbaum, Basevitch, Gershgoren, & Filho, 2013); reaction time, force production and accuracy (Beatty, Fawver, Hancock, & Janelle, 2014); interactions between dysfunctional and functional emotions (Cottyn, et al., 2012); and goal orientations (Dewar & Kavussanu, 2012). As such, emotions have the potential to interact with and influence physical, cognitive, and motivational functioning of sport performers (Hanin, 2000b; Jones, 2003; Lazarus, 2000; Vallerand & Blanchard, 2000).

Understanding how emotions and actions might interact under the influence of changing constraints provides many challenges regarding how to effectively measure or quantify the emotions of an individual (Headrick, Renshaw, Davids, Pinder, & Araújo, 2015). Typically, attempts to measure emotions involve the use of a self-report tool or scale that is implemented before, during, or after an event or performance (Hanin, 2000a; Jones, Lane, Bray, Uphill, & Catlin, 2005). Alternate methods ask performers to recall emotions retrospectively in relation to specific experiences such as best or worst performances (Cottyn, et al., 2012; Hanin, 2000a, 2007b; Tenenbaum & Elran, 2003). Other approaches have concentrated on single, or a select few emotional constructs such as anxiety or happiness using specifically designed measures (Nibbeling, Daanen, Gerritsma, Hofland, & Oudejans, 2012; Pijpers, et al., 2003; Woodman, et al., 2009).

Currently employed techniques for measuring emotion can also be categorised into individualised and group (standardised) approaches. The individualised approach to identifying and measuring emotions in sport has been led by the work of Hanin, culminating in the Individual Zones of Optimal Functioning (IZOF) model (Hanin, 2000a, 2007a; Hanin & Syrjä, 1995). The IZOF model focuses on the subjective emotional experiences of individual performers during successful, average and poor performances. By interpreting the interaction between emotions (positive vs. negative) and performance, predictions are made regarding the functionality of a performer in specific situations (Hanin, 2000a). An IZOF orientated approach affords many benefits for profiling the emotion-performance relationships of individual performers, however, it is limited in terms of the extent to which data can be compared with other studies, or athletes (Jones, et al., 2005).

Measuring emotions associated with performance from a group perspective commonly involves the use of a standardised scale. Two popular scales or tools adopted for use in sport are the Profile of Mood States (POMS, see McNair, Lorr, & Droppleman, 1971), and the Positive and Negative Affect Schedule (PANAS, see Watson, Clark, & Tellegen, 1988). While both of these tools (and versions of them) have been used in sport environments they were originally designed for clinical or everyday living contexts respectively, and are therefore not ideally suited to sport populations (Jones, et al., 2005; Syrjä & Hanin, 1998). Other popular tools have concentrated on measuring anxiety in relation to performance in isolation, for example, the Competitive State Anxiety Inventory-2 (CSAI-2, see Martens, Burton, Vealey, Bump, & Smith, 1990), and the Sport Anxiety Scale (SAS, see Smith, Smoll, & Schutz, 1990). Tools such as these have been designed specifically for use in sports contexts, but are limited due to the sole focus on single emotions and hence there is a lack of consideration for other contributing factors (Hanin, 2007b; Jones, et al., 2005). Such tools are also quite static in design, therefore not effectively capturing the dynamic nature of emotions over different time scales.

Taking into account the advantages and disadvantages of the previous approaches to studying emotions and performance, Jones and colleagues (2005) developed a measure of precompetitive emotions, the Sport Emotion Questionnaire (SEQ). The SEQ focuses on measuring the emotions experienced in relation to a specific event or competition (validated for pre-competition). The rationale for this design is to appropriately capture emotional experiences, which by nature are associated with particular antecedents (e.g. an event, object, or person), are short lived, and are often intense in comparison to other affective phenomena (Beedie, Terry, & Lane, 2005; Lane & Terry, 2000; Vallerand & Blanchard, 2000; Watson & Clark, 1994). Moreover, emotions are understood to have intentionality or be 'about something' in particular (Solomon, 2008). This approach incorporates some context to the SEQ rather than the use of ambiguous question stems that are open to interpretation by respondents. For example the question stem of "how do you feel right now?" could elicit responses relevant to the overall emotions of the respondent, but irrelevant to a specific sport competition. The SEQ is based on five key emotions (5-factor model) relevant to sport, with the final inventory containing twenty-two items that have been found to be strongly linked to one of the factors. The following sections provide a brief overview of the five key emotions; namely anger, anxiety, dejection, excitement, happiness (see Jones, et al., 2005).

Anger, anxiety and dejection represent unpleasant experiences that are experienced by sport performers, although the fact that they are categorised as unpleasant does not mean they are always have a negative impact of performance, in fact at certain intensities they may be neutral or even positive. Anger is an emotion associated with arousal that is linked with an impulse to counterattack and engage in aggressive behaviour in sport (Isberg, 2000; Lazarus, 2000). While often associated with frustration and poor performance, anger can also be beneficial to performance when directed at a person or object that has insulted or offended the individual (Beedie, et al., 2005; Lane & Terry, 2000). Anxiety relates to apprehension or uncertainty associated with an experience that is perceived as threatening to an individual (Lazarus, 2000; Raglin & Hanin, 2000). Research on anxiety has dominated the work on emotions in sport when compared with other emotions, and has revealed that anxiety can be both beneficial and detrimental to performance (Hanin, 2010; Jones, 1995). The third unpleasant emotion from the SEQ is dejection, which has strong links with the more clinically orientated term of depression (Jones, et al., 2005). Dejection is associated with feeling of deficiency and sorrow relating to an individual's perception of actual and expected progress for a task (Allen, Jones, & Sheffield, 2009; Frijda, 1994).

Happiness and excitement are the key pleasant emotions included in the design of the SEQ. Happiness is often used interchangeably with the more intense emotion of joy, which is considered to be a core positive emotion (Jackson, 2000; Shaver, Schwartz, Kirson, & O'Connor, 1987). The experience of happiness relates to an individual making reasonable progress towards fulfilling, or having fulfilled a desired goal. Excitement is a pleasant emotional state associated with heightened arousal that is frequently referred to as 'facilitative anxiety', reflecting the characteristics shared with the unpleasant emotion of anxiety (Jones, 1995). The perception of and ability to cope with increased challenges, and meeting or exceeding goals have been shown to be associated with excitement (Burton & Naylor, 1997; Lazarus, 1991).

Whilst Jones and colleagues (2005) suggest that the SEQ can be modified for use with regards to a current or upcoming competition, they do remind us that it is only validated for pre-competition use. While a modified version of the SEQ may provide some insights to emotional experiences during learning in sport, the key limitation is that the items included in this inventory were developed and validated to focus on competition contexts. Previous research has demonstrated key differences between competition and learning contexts in terms of goal orientations, effort, enjoyment, motivation, and performance outcomes (e.g. van de Pol & Kavussanu, 2011; van de Pol, et al., 2012a). However, despite these clear differences, the role of emotions during learning in sport has so far received limited attention (Headrick, et al., 2015). To address this issue there is a need for a measurement tool to be developed that is dedicated and specific to assessing emotions experienced *during* learning in sport. Such a tool would provide valuable information to athletes, coaches, pedagogues, and practitioners by providing increased understanding of emotions experienced alongside physical performance and skill development.

Development of the Sport Learning and Emotions Questionnaire (SLEQ)

The aim of the current study is to develop a field based tool that assesses emotions experienced *during learning events* in sport (i.e. over the time scale of learning). To maintain validity and sensitivity this tool is designed to exclusively measure emotion through the subjective experiences of respondents. Therefore, the SLEQ provides a method for establishing situation specific intensities of emotion, considered to be one of the key dimensions of emotion (Jones, et al., 2005; Parrott, 2001). As such it is envisaged that the SLEQ will be suitable for use as a stand - alone tool alongside reliable and specific measures of actions and cognitions to provide a holistic and intertwined understanding of emergent behaviour.

The process for developing this tool will follow the general framework outlined by Jones et al (2005) in development of the Sports Emotion Questionnaire which was designed for use in relation to *competition*. The development of the emotions tool will be presented in a series of sections representing individual phases of the process. Therefore, each phase includes individual methods, results, and discussion sub-sections. This will be followed by a general discussion section summarising the overall development process and key implications regarding this tool.

Chapter 4: Phase 1 – Identifying emotional items

The aim of the first phase was to collect an inventory of words and phrases that reflected the emotions experienced by individuals learning to perform a skill in sport. The most frequently identified terms would then be compared with the items identified in the SEQ of Jones et al. (2005) to determine whether learning and (pre) competition contexts produce different responses. It was hypothesised that some key items would be shared with the SEQ, but several unique items would also be identified due to the emphasis on learning rather than competition contexts.

Methods

Participants

Participants were 126 male (n=62) and female (n=64) undergraduate students studying exercise science and/or health and physical education at an Australian university (mean age 19.68 ± 2.37 years). All participants reported previous and/or current experiences of learning to perform skills in 25 different sports. Sports participated in were: Football/Soccer (n=24), Netball (n=17), Touch Football (n=13), Australian Rules Football (n=11), Athletics (n=8), Rugby Union (n=8), Volleyball (n=6), Rugby League (n=5), Basketball (n=5), Swimming (n=4), Cricket (n=4), Futsal (n=3), Dance (n=3), and others (n=15). Within these sports the highest levels of representation reported by participants were: school (n=9), club (n=19); district (n=14), regional (n=25), state (n=41), and national (n=19). Therefore this cohort of participants represented a wide range of different sporting backgrounds, and experience levels from which emotion items would be identified.

Procedure

During scheduled class time, potential participants were briefed on the nature of the project by a research team member and provided with ethical and informed consent details. Consenting participants were asked to individually complete a brief written survey comprising two key sections (see Appendix B). The first section recorded anonymous participant information regarding age, gender, primary sport, and highest level of representation (see participant information above). The second section asked participants to identify and list words or phrases that reflected their emotions when learning to perform a skill in sport, including periods of success and failure. Participants were asked to spend at least 5 minutes completing the survey individually. No context or examples were provided to participants in order to remove any experimenter bias in responses.

Analysis

Survey responses were collated to record frequencies for each emotional word or phrase. An exploratory principal component analysis with oblique rotation (direct oblimin) was performed to determine how many of the identified emotion items should be retained going forward. Initial analysis calculated Eigenvalues along with percentages of total variance and cumulative variance for each of the identified items (components). A Scree plot was also created to visually represent the importance of each component. All analysis was performed with IBM SPSS Version 22 (IBM SPSS Statistics for Windows, 2013).

Results & discussion

In response to the second section of the survey, participants recorded a total of 979 words or phrases describing their emotions when learning a skill in sport (Mean responses per participant 7.77 ± 2.89). Within the 979 total responses, 204 unique terms or phrases were reported. Using Kaiser's criterion (extracts components with eigenvalues > 1) 68 components were initially flagged for extraction representing 92.53% of cumulative variance. Visual assessment of the scree plot (see Figure 4.1) was ambiguous for this number of components and therefore Kaiser's criterion was deemed inappropriate due to overestimation. Further inspection of eigenvalues and total variance values revealed that 39 components produced eigenvalues above 2, paired with a variance percentage above 1. More specifically, component 39 represented an eigenvalue of 2.050 compared with 1.998 for component 40, with variance values of 1.01% and 0.98% respectively. The cumulative percentage of variance at component 39 represented 70.85%, with components 40 - 204 each representing less than 1.0% of total variance. The scree plot still remained largely inconclusive at this number of components. Upon reflection of the emotional items corresponding to these components it was deemed appropriate for the purposes of the questionnaire to include components 1 to 39 in an initial list that could be refined further in following phases (see Table 4.1).

In order to make early comparisons with the SEQ, the initial list of 39 items was contrasted at face value with the preliminary 39 item SEQ (see Jones, et al., 2005, p. 420). Comparing these items with the preliminary SEQ was appropriate given that the preliminary SEQ items had not yet been subjected to factor analysis, and subjective trimming to meet the requirements of a short questionnaire (final SEQ includes 22 items only). Furthermore, by coincidence both the preliminary SEQ and the initial list both included 39 items making for simple comparison. Contrasting the two lists revealed that 17 items were common, however a further 22 items were found to be unique to the phase 1 survey results. The clear discrepancy in items identified suggests that there are differences in emotions between pre-competition and learning contexts that warrant further exploration. Upon further consideration of the 22 unique items, seven items were flagged as potentially inappropriate to carry forward to further stages of questionnaire development. Two items (confident, achievement) were identified as potentially representing cognitions rather than emotions. The item ‘confident’ was removed from the list (as with Jones, et al., 2005), however, it was decided to tentatively retain ‘achievement’ given that this item was unique to the initial list and warranted further scrutiny. Three items (exhausted, pain, tired) were removed because they related to physical states and/or could be misinterpreted. A further item was considered too colloquial to be included (stoked: an Australian slang term meaning 'excited' or 'happy'), and another (pride) was combined with the more frequently identified term (proud). Therefore a total of 33 emotional items relating to learning remained to be subjected to further scrutiny in the following phases.

Table 4.1. The list of 39 most identified emotional terms from the phase 1 survey. Items are split into those that are common with the preliminary 39 item SEQ (Jones et al., 2005), and those unique to this study.

Items in common with SEQ (17)				
Angry	Annoyed	Anxious	Content	Disappointed
Energetic	Excited	Frustrated	Fulfilled	Happy
Joy	Motivated	Nervous	Pressured	Sad
Satisfied	Stressed			
Unique items (22)				
Accomplishment	Achievement	Bored	Competitive	Confident*
Confusion	Determined	Eager	Elated	Embarrassed
Enjoyment	Exhausted*	Fear	Fun	Included
Pain*	Pride*	Proud	Relieved	Stoked*
Successful	Tired*			

*Indicates items removed (see text)

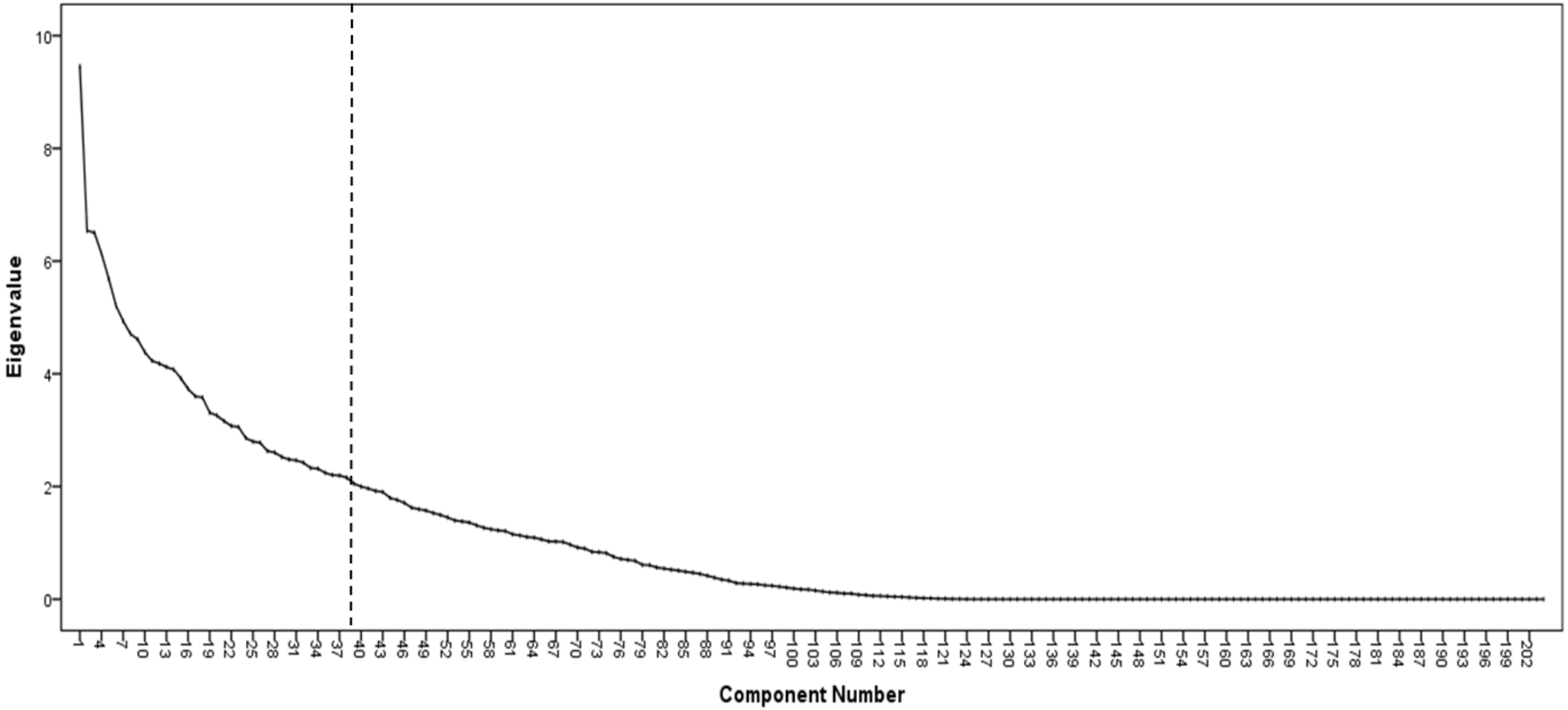


Figure 4.1. Scree plot displaying Eigenvalues for phase 1 items. Components to the left of the dashed vertical line were retained (1-39).

Following the identification and trimming of items, a pilot investigation was completed to provide an initial practical comparison of SEQ and phase 1 items. This pilot was carried out in an attempt to provide preliminary evidence highlighting the irrelevance of some SEQ items to learning contexts. Therefore the purpose of this exploratory study was to provide further (practical) support for the development of a new learning specific questionnaire. Given that this pilot study was not integral to the development of the questionnaire it was included in the appendices for reference (see Appendix C, page 263).

Chapter 4: Phase 2 - Face validation of items

Phase 2 was designed to assess the face validity of the 33 items identified and retained from the initial phase 1 survey. This process involved verifying whether each of the items were considered: (i) relevant to individual's experiences during learning in sport; and (ii) whether the same items related to any of the five key emotions (anxiety, dejection, anger, excitement, happiness) comprising the five-factor model of the SEQ (Jones, et al., 2005). It was anticipated that at least one of the factors (most likely anxiety or dejection) would be found to be irrelevant due the change in context between competition and learning.

Methods

Participants

Participants for this phase were 87 male (n=43) and female (n=44) undergraduate students studying exercise science and/or health and physical education at an Australian university (mean age 20.71 ± 3.85 years). No participants from this phase of the study had previously completed the initial survey from phase 1, or the golf putting pilot. All participants reported previous and/or current experiences of learning to perform skills spread across 23 different sports. These sports included: Netball (n=12), Football/Soccer (n=11), Cricket (n=9), Basketball (n=8), Touch Football (n=6), Rugby Union (n=5), Australian Football (n=4), Swimming (n=4), Gymnastics (n=3), Volleyball (n=3), Tennis (n=3), Athletics (n=3), Powerlifting (n=3), Water Polo (n=2), Rugby League (n=2), Martial Arts (n=2), and other (n=7). While participating in these sports, the highest levels of representation reported were: school (n=4), district (n=15), regional (n=20), state (n=22), and national (n=7).

Procedure

During regular class time (that was not related to the research theme), prospective participants were briefed on the nature and requirements of the project by a research team member and provided with ethical and informed consent details. Consenting participants were asked to individually complete a brief written survey (see Appendix D). As with phase 1 the first section recorded anonymous background information regarding age, gender, primary sport, and highest level of representation. The second section presented participants with a matrix where they were asked to indicate (by ticking a box) whether each of the 33 items from phase 1 were (i) relevant to emotions they had experienced during learning in sport, and (ii) related to any of the five key emotion factors from the SEQ (anxiety, dejection, anger, excitement, happiness). Participants were asked to tick as many boxes as they felt appropriate and leave all other boxes blank. Once again, no context or examples were provided to participants in order to remove any leading bias in responses.

Analysis

Participant responses were collated to produce frequencies for items in terms of overall relevance, and relevance to any of the five key emotions/factors. The percentage of participants identifying each item as relevant was calculated and reported in a summary table (Table 4.2) ranked by overall relevance.

Results & discussion

Results derived from the percentage of participants indicating the relevance of an item to their own experiences and the five key emotions are reported in Table 4.2. These results reveal that all 33 items were considered relevant to some extent, with 26 items reported relevant by at least half of the participants. Seven items (embarrassed, fear, sad, confusion, content, elated, bored) were deemed relevant by less than 50% of participants. Furthermore, none of these seven items were related to any of the five SEQ factors by more than 50% of participants.

Table 4.2 also reports the five items that were most frequently linked with each of the five SEQ emotions/factors. This provided an opportunity to compare the items associated with each emotion factor from the SEQ. The SEQ structure included five items for both anxiety and dejection, along with four items each for anger, excitement, and happiness (see Jones, et al., 2005, p. 431). Results indicate that *anxiety* was most related to the items: anxious; nervous; pressure; stressed; fear. With the exception of fear all of these items were identified by 50% or more participants. *Dejection* was linked to: disappointment; embarrassed; sad; confusion; annoyed. All of these items returned percentages of less than 50% suggesting that participants did not highly relate the emotion of dejection with learning experiences. *Anger* was related most frequently to: angry; frustrated; annoyed; disappointed; stressed. However, only the first three items were identified as relevant to anger by more than 50% of participants. More than 50% of participants linked *excitement* with the items: excited; competitive; motivated; energetic; achievement. *Happiness* was most related with: happy; achievement; enjoyment; accomplishment; fun. Each of these items was identified by over 70% of participants as being related to happiness with several further items considered relevant by over 50% of participants.

Interestingly the item 'achievement' was found to be the most relevant item overall, with 50% of participants linking it to both excitement and happiness. Therefore, despite original doubts surrounding its inclusion, these results make a strong case for retaining this item as part of a provisional 33 item list.

Table 4.2. Percentage of participants reporting items to be relevant to learning a skill in sport, and to any of the five key emotions. Items are presented in descending order of overall relevance.

Emotion	Relev-ance	Anxiety	Dejec-tion	Anger	Excite-ment	Happi-ness
Achievement	95.40	6.90	3.45	3.45	55.17*	78.16*
Successful	91.95	4.60	1.15	2.30	48.28	72.41
Competitive	90.80	26.44	2.30	13.79	68.97*	13.79
Determined	90.80	12.64	2.30	6.90	48.28	31.03
Accomplishment	89.66	8.05	2.30	1.15	48.28	75.86*
Enjoyment	86.21	0	0	0	45.98	78.16*
Fun	85.06	0	0	0	43.68	74.71*
Motivated	85.06	5.75	0	3.45	59.77*	45.98
Happy	83.91	0	0	0	29.89	81.61*
Excited	81.61	2.30	0	0	78.16*	39.08
Energetic	77.01	2.30	0	3.45	57.47*	40.23
Nervous	75.86	65.52*	6.90	2.30	16.09	1.15
Pressure	75.86	58.62*	8.05	6.90	20.69	3.45
Frustrated	73.56	18.39	13.79	60.92*	1.15	1.15
Proud	73.56	3.45	0	0	27.59	64.37
Disappointed	70.11	16.09	35.63*	28.74*	4.60	0
Satisfied	68.97	2.30	2.30	0	26.44	60.92
Annoyed	66.67	10.34	14.94*	51.72*	0	0
Anxious	66.67	82.76*	4.60	1.15	10.34	0
Relieved	62.07	5.75	0	0	18.39	54.02
Eager	60.92	8.05	0	0	49.43	20.69
Included	60.92	4.60	1.15	0	24.14	51.72
Joy	59.77	0	0	0	31.03	56.32
Stressed	54.02	52.87*	4.60	17.24*	5.75	2.30
Fulfilled	52.87	0	0	0	17.24	48.28
Angry	50.57	3.45	8.05	74.71*	1.15	1.15
Embarrassed	44.83	29.89	24.14*	3.45	2.30	1.15
Fear	41.38	35.63*	9.20	4.60	4.60	0
Sad	41.38	17.24	24.14*	12.64	2.30	3.45
Confusion	37.93	17.24	16.09*	8.05	0	0
Content	37.93	1.15	2.30	0	9.20	33.33
Elated	29.89	0	0	0	20.69	29.89
Bored	21.84	2.30	14.94	3.45	0	0

* Indicates items are ranked in the top five for each emotion/factor (from SEQ) by percentage

Taking these results into consideration, it was concluded that the five key emotions used as factors in the design of the SEQ were not appropriate to include on a tool to record and measure emotions during learning in sport. On face value, anxiety, excitement and happiness were found to be relevant with at least four items linked to each by more than half of the participants. Only three items were linked to anger by more than 50% of participants suggesting that this emotion/factor was marginally relevant and potentially not warranting inclusion. No items were found to be related to dejection by more than 50% of participants, with the item 'Disappointed' the highest at only 35.63%. In comparison, during the development of the SEQ a total of 12 items were deemed relevant to dejection by more than 50% of respondents. A further indication that the five-factor model from the SEQ may not be appropriate was that several items (e.g. achievement, successful, motivated, and disappointed) were found to be strongly linked (ranking in the top five by percentage) at face value to two factors. This suggests that in the context of learning, participants found it difficult to distinguish between the designated factors for selected emotion items.

Overall relevance percentages for items that closely matched the five factors also suggested that dejection was not relevant as a key emotion for learning. Results from Table 4.2 reveal that anxiety (anxious – 66.67%); anger (angry – 50.57%); excitement (excited – 81.61%); and happiness (happy – 83.91%) were all considered relevant by more than half the participants. The fifth factor of dejection (or a derivative of) was not listed as one of the 33 items in this phase, or in the initial list of 204 items from phase 1, offering a possible explanation for why so few participants found it relevant to any of the items. In a similar phase of their study Jones et al. (2005) found that dejection and anger were also reported to be less relevant, than anxiety, excitement and happiness. Reasons for this include that dejection and anger are of negative valence, and may be experienced less frequently though at a higher intensity (Diener, et al., 1985; Lane & Terry, 2000; Woodman, et al., 2009). The predominance of items relating to happiness and excitement also supports previous work suggesting that the study of positively valenced emotions is essential for understanding sport contexts, as opposed to the traditional (clinical) focus on negative emotions (Folkman, 2008; McCarthy, 2011; Skinner & Brewer, 2004).

Following the findings from phase 1 (and the golf putting pilot task) it was established that the emotion items from the SEQ of Jones et al. (2005) were not all appropriate for learning contexts. Phase 2 set out to establish the face validity of the items and determine how relevant they are considered to the key factors/emotions from the SEQ. Findings from this phase suggest that the factors from the SEQ were not considered relevant to learning contexts. In particular the factor 'dejection' was not linked closely with any of the items identified in phase 1. Therefore, the case for designing a new tool that measures intensity of emotions during learning is strengthened. This tool will include both emotion items and factors specific to the context of learning in sport.

Chapter 4: Phase 3 – Assessment of item and factor structure

The preceding development phases identified the need for a specific tool relating to emotions experienced during learning. The eventual tool is intended for use during field-based learning / skill acquisition sessions. Therefore, this phase of development is focussed on establishing factors (subscales) for the questionnaire and validating the items with participants across a variety of sports. Based on the responses from participants in this phase, the items will be refined, and factors will be established to determine the design and structure of the final questionnaire. Building on previous phases, it was hypothesised that positively valenced items would be found most relevant to learning contexts. In terms of factor identification, it was expected that four or five factors would emerge representing the key positive and negative emotions reported. In order to develop a succinct, and easy to complete questionnaire for use during applied learning sessions, it was also desirable that approximately 10 items be trimmed from the list of 33 items coming into this phase (SEQ includes 22 items). These factors, and associated loading items, were expected to substantially differ from those developed in the SEQ.

An important decision within this phase of the questionnaire development involved determining the number of factors, and number of individual items to link to each factor. The choice of how many factors would make up the questionnaire was largely dependent on the outcome of the factor analyses described in the following sections. Due to the key similarities with the design of the SEQ it was expected that four or five factors would emerge. At least two of these factors were anticipated to represent positively valenced items, given the dominance of positive items in the previous phases. Despite using the SEQ as a guide, this phase included a key feature of questionnaire development that differed from that of the SEQ. The key difference here is that Jones et al. (2005) designated the five factor model of the SEQ prior to all subsequent phases of questionnaire development. Therefore, items identified and refined through the various phases were modelled in relation to the five targeted factors. The approach adopted for the development of this current questionnaire allowed factors to emerge based on the results of item identification and refinement in preceding phases of inquiry. As a consequence, selected emotion items informed the identification of potential factors, rather than fitting items to predetermined factors as in the SEQ. This process involved various stages of statistical analysis paired with the experiential knowledge and interpretations of the research team.

Following previous investigations and suggestions, the aim was to include approximately four items in each of the identified factors. As mentioned previously, a five factor model was used in the final version of the SEQ. Two of these factors (anxiety, dejection) included 5 items, and the remaining three (excitement, anger, happiness) 4 items (Jones, et al., 2005). In order to maintain internal consistency and reliability of factors in brief questionnaires, it has been suggested that 4 items per factor is ideal (Jackson & Marsh, 1996; Watson & Clark, 1997; Watson, et al., 1988). Along the same lines, Bollen (1989) determined that factors should have at least 3 items or indicators with ‘nonzero loadings’. Based on these guidelines, the following sections set out to detail the process of (i) identifying 4-5 possible factors that represent the majority of responses through exploratory factor analysis (EFA); (ii) refining and trimming the items that load onto these factors to ensure the brief nature of the questionnaire; and (iii) verifying these factors and items that adequately load onto each factor through confirmatory factor analysis (CFA).

Methods

Participants

Individual and groups of participants were recruited from sport academies, institutes, clubs, and university exercise science / physical education courses. In total 342 male (n=180) and female (n=162) participants (mean age= 20.19 ± 3.62 years) completed this phase of the questionnaire development, and were not involved in any other phase. All participations reported involvement in competitive sport including: Football/Soccer (n=50), Australian Football (n=40), Netball (n=28), Water Polo (n=21), Athletics (n=15), Gymnastics (n=13), Touch Football (n=13), Rugby Union (n=12), Rugby League (n=11), Swimming (n=11), Cricket (n=9), Basketball (n=9), Powerlifting (n=6), Field Hockey (n=6), Volleyball (n=5), and others (n=93). Within these sports the highest levels of participation were: school (n=6), club (n=65), district (n=27), regional (n=47), state (n=107), and national (n=90). Length of involvement in these sports was reported to range from 0.5 to 21 years (mean duration= 8.83 ± 4.06 years). Following approval from a university ethics committee, prospective participants were provided with informed consent details prior to agreeing to complete the survey.

Procedure

Participants were asked to complete a two page survey based on their experiences during a learning/skills focussed session. This survey (see Appendix E) comprised of a section asking for anonymous background information including age, gender, and sport background. The second section asked participants to read a list of 33 emotion items and rate them on a scale using the stem: 'how you feel in relation to the session you have just completed'. The 5 option response scale was previously employed on the SEQ (Jones, et al., 2005) and POMS (McNair, et al., 1971). Participants were asked to individually consider each item and then circle a number from 0 – 4 based on how they felt in regards to the item during the session (0 = 'not at all'; 1 = 'a little'; 2 = 'moderately'; 3 = 'quite a bit'; 4 = 'extremely'). In consultation with the coach, manager, or teacher / lecturer a member of the research team attended identified sessions to confirm the focus on learning and/or skill development over fitness, strength, conditioning, or game play. The research team member took on a purely observational role during the session to ensure no disruption was created to the normal training environment.

Analysis

Participant responses were initially collated in order to calculate and visually inspect the basic frequency, rating, and mean values for each of the 33 items. The 33 items were then subjected to an exploratory factor analysis (EFA) using the principal axis factor extraction method with oblique rotation (direct oblim – factors can correlate, see Field, 2013; Williams, Onsman, & Brown, 2010), performed with SPSS (IBM SPSS Statistics for Windows, 2013). The Kaiser-Meyer-Olkin (KMO) measure was used to assess the sampling adequacy of the factor analysis. Following the identification of the emergent factors, the groups of loading items were assessed and interpreted to develop assumptions about what each factor related to. Cronbach's alpha (α) was also calculated for each extracted factor to assess the reliability of the potential subscales when considering items loading above a value of 0.4. Reliability was also assessed following refinement and trimming of items to suit the brief nature of the proposed questionnaire.

Using the identified factors as latent variables, the proposed questionnaire design was subjected to confirmatory factor analysis (CFA) using structural equation modelling (SEM) techniques. Factors were distinguished using the maximum likelihood estimation method and were permitted to intercorrelate freely. To assess the normality (multivariate kurtosis) of data the Critical Ratio (C.R) was inspected (Byrne, 2010). Factor loadings were taken into account to assess model design, following loading values (i.e. factor loadings > 0.6) from the SEQ (Field, 2013; Jones, et al., 2005). Modifications to the model were also identified and subjectively interpreted case-by-case based on the value of Modification Indices (MI), and whether the suggested changes made logical sense (i.e. error covariances between related items) within the model design. In the event of unacceptable model fit, modifications were made one at a time to independently assess the impact of the change on model fit criteria (Byrne, 2010). Goodness-of-fit of the model was evaluated through the overall chi square (χ^2) value (with χ^2/df ratio), along with a two index method comprising the comparative fit index (CFI - Bentler, 1990) and root mean square error approximation (RMSEA - Steiger & Lind, 1980). The use of chi square, CFI and RMSEA (with 90% confidence intervals) values as methods for assessing model fit have been extensively advocated previously (Bentler, 2007; Browne & Cudeck, 1993; Byrne, 2010; Hu & Bentler, 1999; Jackson, Gillaspy, & Purc-Stephenson, 2009). This phase of analysis was performed using SPSS AMOS (IBM SPSS AMOS Statistics for Windows, 2013).

Following the identification of a suitable model correlation analyses were performed on the mean scores for each factor to determine relationships between the proposed subscales. A one-way repeated measures ANOVA with pairwise comparisons, Bonferroni corrections, and Greenhouse-Geisser corrections to sphericity was also performed to assess statistical differences between factor scores.

Results & discussion

Descriptive results

A summary of results for all 33 items is presented in Table 4.3 detailing the overall mean ratings, along with a breakdown of rating frequencies for each item. Interesting to note is the trend of positively valenced items generally rating at higher scores than negatively valances items. This supports the findings from the golf putting pilot investigation where positive items were more predominant overall.

Table 4.3. Summary of survey results presented in descending order of mean rating.

Item	Mean rating ± SD	# 0	# 1	# 2	# 3	# 4	% yes (i.e. 1-4)
Motivated	3.23 ± 0.87	5	8	45	130	154	98.54
Determined	3.20 ± 0.88	5	11	43	136	147	98.54
Enjoyment	3.16 ± 0.95	7	15	44	125	151	97.95
Included	3.07 ± 0.94	6	13	64	126	133	98.25
Fun	3.05 ± 1.01	7	25	48	125	137	97.95
Happy	3.00 ± 0.90	4	15	68	144	111	98.83
Excited	2.91 ± 1.07	10	29	65	116	122	97.08
Competitive	2.86 ± 1.09	15	21	75	116	115	95.61
Accomplishment	2.86 ± 0.82	5	12	75	184	66	98.54
Successful	2.84 ± 0.93	6	18	88	142	88	98.25
Energetic	2.82 ± 0.98	8	23	82	138	91	97.66
Achievement	2.81 ± 0.84	5	13	90	169	65	98.54
Eager	2.79 ± 1.02	9	29	80	132	92	97.37
Joy	2.78 ± 1.02	12	23	82	136	89	96.49
Satisfied	2.58 ± 1.06	15	38	90	131	68	95.61
Fulfilled	2.50 ± 1.03	14	39	106	127	56	95.91
Proud	2.50 ± 1.06	16	45	91	133	57	95.32
Content	2.21 ± 1.08	29	48	124	104	37	91.52
Elated	1.94 ± 1.17	53	54	129	73	33	84.50
Relieved	1.91 ± 1.13	46	69	124	76	27	86.55
Pressure	1.58 ± 1.18	84	73	105	64	16	75.44
Nervous	1.28 ± 1.19	112	99	71	43	17	67.25
Frustrated	1.26 ± 1.16	115	95	73	47	12	66.37
Stressed	1.09 ± 1.10	137	85	81	31	8	59.94
Anxious	1.07 ± 1.11	140	88	72	33	9	59.06
Annoyed	1.00 ± 1.01	135	108	65	31	3	60.53
Disappointed	0.95 ± 1.04	148	103	60	23	8	56.73
Angry	0.93 ± 1.01	148	104	61	24	5	56.73
Fear	0.83 ± 1.02	173	89	50	26	4	49.42
Confusion	0.75 ± 0.88	165	115	45	16	1	51.75
Embarrassed	0.68 ± 0.88	188	94	43	17	0	45.03
Bored	0.62 ± 0.99	217	72	29	15	9	36.55
Sad	0.40 ± 0.73	243	69	25	2	3	28.95

Exploratory factor analysis

Sampling adequacy was found to be highly acceptable (KMO = .90). Furthermore the KMO values for individual items were also highly acceptable with values ranging from .76 to .95 (values over .50 considered acceptable, Field, 2013). The EFA of potential factors and loading items initially extracted six factors with Eigenvalues over Kaiser's criterion (1), representing 63.92% of total variance. However, six factors were not deemed appropriate for the purposes of the eventual questionnaire due to several of these factors having less than 3 items loading above an acceptable value of 0.4 (Field, 2013), and the items loading to each factor not displaying clear trends or themes. Similar issues with loading items arose for the extraction of five factors, along with ambiguous results from the scree plot in both cases. Extracting four factors revealed more promising factor/item groupings, with similar items tending to load on to common factors. These four factors all had eigenvalues above 1 and together represented 56.78% of sample variance. Rotated loadings for each item on the four extracted factors are presented in Table 4.9. Based on the nature of the items strongly loading (i.e. above +/- 0.4) to each of the extracted factors, it was deduced that the factors could tentatively be labelled as 'Enjoyment', 'Nervousness', 'Satisfaction', and 'Annoyance'. The four labels were indicative of the potential subscales and structure of the eventual Sport Learning and Emotions Questionnaire (SLEQ). Reliability of items relating to the proposed subscales was found to be high with each factor returning a Cronbach's α value of at least .85 (see Table 4.4).

Table 4.4. Item factor loadings, eigenvalues, variance %, and Cronbach's α for each of the four extracted factors and/or questionnaire subscales.

Item	Factor 1	Factor 2	Factor 3	Factor 4
Accomplishment	.071	-.037	**.685**	.077
Achievement	.047	-.043	**.674**	.052
Angry	-.011	-.005	-.014	**.795**
Annoyed	.007	-.106	-.103	**.911**
Anxious	-.013	**.562**	-.093	.221
Bored	-.587	.027	.165	.282
Competitive	**.473**	.067	.111	.125
Confusion	-.060	.199	.126	.314
Content	.020	-.052	**.437**	-.088
Determined	**.423**	.020	.282	.086
Disappointed	.013	.256	-.113	**.540**
Eager	**.595**	.070	.018	.031
Elated	.139	-.024	**.419**	.094
Embarrassed	-.054	.275	.077	.399
Energetic	**.565**	-.067	.228	.073
Enjoyment	**.863**	-.014	-.024	.023
Excited	**.782**	.115	.040	.033
Fear	.006	**.692**	-.005	.059
Frustrated	.028	.167	-.087	**.664**
Fulfilled	.214	-.032	**.605**	.001
Fun	**.819**	.028	.041	-.007
Happy	**.779**	-.015	.070	-.041
Included	**.669**	-.079	.015	-.058
Joy	**.782**	-.069	.090	.020
Motivated	**.594**	.059	.185	.024
Nervous	.077	**.970**	-.017	-.153
Pressure	.073	**.737**	-.015	.015
Proud	.174	.059	**.583**	-.035
Relieved	-.060	.188	**.507**	-.097
Sad	-.215	.393	.153	.246
Satisfied	.038	-.055	**.743**	-.062
Stressed	-.006	**.715**	.025	.116
Successful	.022	-.028	**.770**	-.016
Eigenvalues	9.48	6.05	1.77	1.43
Variance %	28.72	18.35	5.37	4.34
Cronbach's α	.93	.87	.86	.85

Note: Cronbach's α calculated using items with factor loadings above 0.4 only (in bold)

Following the initial identification of factors, the items loading onto each were subjected to further scrutiny in order to meet the goal of including at least 4 items per factor while also ensuring a brief (approximately 20 item) questionnaire. Factor 1 (Enjoyment) had 11 items loading at values of 0.4 or higher and therefore substantial refinement was required. Closer examination of factor loadings revealed a substantial drop in values between the fifth (happy .779), and sixth (included .669) items, supporting the retention of the top 5 items. These items all corresponded well with each other in terms of reflecting the inherent happiness and enjoyment involved with learning experiences. The items deemed not suitable on account of factor loadings (included, eager, motivated, energetic, competitive, determined) were also deemed to be not as relevant to the theme of enjoyment. On a side note, the item 'bored' also loaded highly to factor 1, however, as a negative value. The decision was made not to retain this item given it corresponded with a weaker factor loading than the top 5 items and also did not correspond with the theme of enjoyment.

Factor 2 (Nervousness) included 5 items that loaded over the value of 0.4. The fifth item 'anxious' was flagged as a potentially weak item given the decline in factor loading between it and the other four items. Therefore, all five items were retained at this stage, with the possibility of trimming 'anxious' in subsequent analysis. The third factor (Satisfaction) was also tentatively trimmed to five items from the initial nine items loading above 0.4. This decision was based on a combination of factor loadings and results from earlier phases. The items 'elated' and 'content' were removed on account of the comparatively weak factor loadings in relation to the top five items. The item 'relieved' was removed due to the drop in factor loading between it and the top four items in particular. The decision not to retain 'proud' was a difficult one; however, 6 items were not deemed suitable for a single factor

(Jackson & Marsh, 1996; Watson & Clark, 1997; Watson, et al., 1988). Furthermore, results from previous phases indicated that ‘proud’ was not deemed as relevant to learning by participants in comparison to the higher ranking items. The fifth item ‘fulfilled’ was also flagged for potential removal at later stages due the difference in factor loading between it and the top four items. Factor 4 (Annoyance) was a more straightforward decision with only 4 items loading to this factor by more than 0.4. The fifth highest loading item (embarrassed) was considered for retention, however, it also loaded in the top seven items for the second factor. Therefore, it was deemed inappropriate to include ‘embarrassed’ on either factor. Embarrassed was also considered to not fit well with the overriding theme of the four retained items. Furthermore, ‘disappointed’ was flagged as a potentially weak item that might come under further scrutiny.

Reviewing these refinements to the tentative questionnaire design reveals a four factor structure with sets of five items loading on three of the factors, and four items loading on the remaining factor. In comparison, the final 22 item version of the SEQ included five factors, two with five loading items, and three with four loading items. The tentative 19 item design for the SLEQ retains reliability for the four proposed subscales with alpha (α) values of at least .85, as reported in Table 4.5. Item origin results show that the majority of items (13 of 19) were present in both the phase 1 list (Table 4.1) and the preliminary SEQ of Jones et al. (2005). However, five of the items shared with the preliminary SEQ (pressure, stressed, satisfied, fulfilled, frustrated) were not retained in the final version of the SEQ. Factor 3 (Satisfaction) included the highest proportion of items exclusive to the phase 1 list (3 of 5) suggesting that feelings of achievement and success relate highly with participants in learning contexts. Furthermore, neither of the factor 3 items included in both the preliminary SEQ and phase 1 list (satisfied, fulfilled) were retained in the final version of the SEQ. This effectively means that the items that making up factor 3 are unique to this learning focussed emotion questionnaire. These findings once again illustrate the difference between competition and learning contexts in terms of participant experiences.

Table 4. 5. Proposed factor and item structure following EFA. Item origin: *Phase 1*: item originates from phase 1 list only; *Both*: item originates from the preliminary SEQ and Phase 1.

Potential Factors	Items	Factor Loadings	Cronbach's alpha (α)	Item Origin
Factor 1	Enjoyment	.863	.93	Phase 1
	Fun	.819		Phase 1
	Excited	.782		Both
	Joy	.782		Both
	Happy	.779		Both
Factor 2	Nervous	.970	.87	Both
	Pressure	.737		Both*
	Stressed	.715		Both*
	Fear	.692		Phase 1
	Anxious	.562		Both
Factor 3	Successful	.770	.86	Phase 1
	Satisfied	.743		Both*
	Accomplishment	.685		Phase 1
	Achievement	.674		Phase 1
	Fulfilled	.605		Both*
Factor 4	Annoyed	.911	.85	Both
	Angry	.795		Both
	Frustrated	.664		Both*
	Disappointed	.540		Both

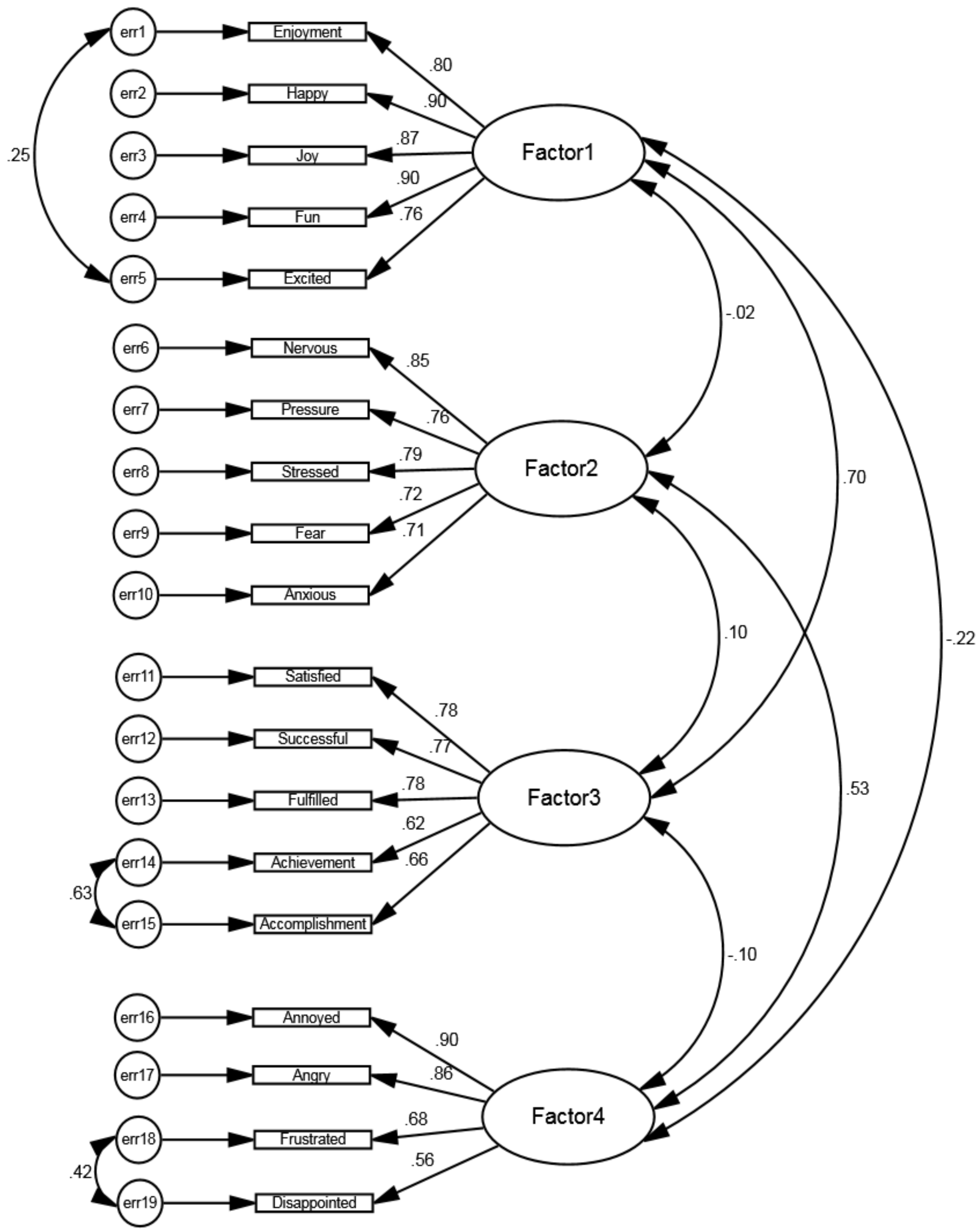
*item not included on the final version of the SEQ

Confirmatory factor analysis

Model 1

Following the development of the tentative four factor, nineteen item model that emerged from the EFA, the next step was to assess the suitability of this model structure through CFA. The proposed model (see Figure 4.2) returned a Chi-square (χ^2) value of 564.915, with 146 degrees of freedom, and a probability level of .000. The χ^2/ *df* ratio (3.87) exceeded the suggested cut-off value of ≤ 3 (Schreiber, Nora, Stage, Barlow, & King, 2006). The relatively high χ^2 value and significant probability value suggest a poor model fit, however, the results also revealed a high critical ratio (C.R.= 24.075) indicating multivariate nonnormality (kurtosis) in the data sample (Byrne, 2010). Chi-square values have been suggested to be highly sensitive to sample size and nonormality of data (high C.R. value), which can produce inflated χ^2 values and misleading significant probability levels (Curran, West, & Finch, 1996; Steiger, 1990). No evidence of multivariate outliers was observed for this model.

Continuing with the analysis of goodness-of-fit, the model initially produced unacceptable CFI (.899), and RMSEA (.092 $^{[.084,\ .100]}$) values. Suggested cut-offs for these goodness-of-fit indicators are CFI ≥.95 and RMSEA <.06 (Hu & Bentler, 1999; Schreiber, et al., 2006). Upon examination of suggested modification indices it was observed that there was some potential to improve model fit by modifying error covariances. Potential modifications were considered suitable if MI values for pairings were substantially higher than other pairings, and were appropriate in terms of the nature of the paired items (i.e. items of similar meaning, see Byrne, 2010). The most obvious pairing of error covariances for modification was those associated with items 14 and 15 from factor 3. By adding this error covariance (MI = 110.339) the modified model showed some evidence of improved fit (χ^2 = 443.033; CFI = .913; RMSEA = .087 $^{[.078, .097]}$). Two further rounds of modifications to error covariances also produced slight improvement to model fit as follows: items 18-19 (MI = 36.589; χ^2 = 400.471; CFI = .925; RMSEA = .066 $^{[.058, .075]}$), and items 1-5 (MI = 11.199; χ^2 = 357.113; CFI = .948; RMSEA = .081 $^{[.072, .092]}$). Despite the addition of these three modifications the originally proposed factor-item structure did not reach an acceptable level of fit. Therefore, it was concluded that this particular model structure was not appropriate.



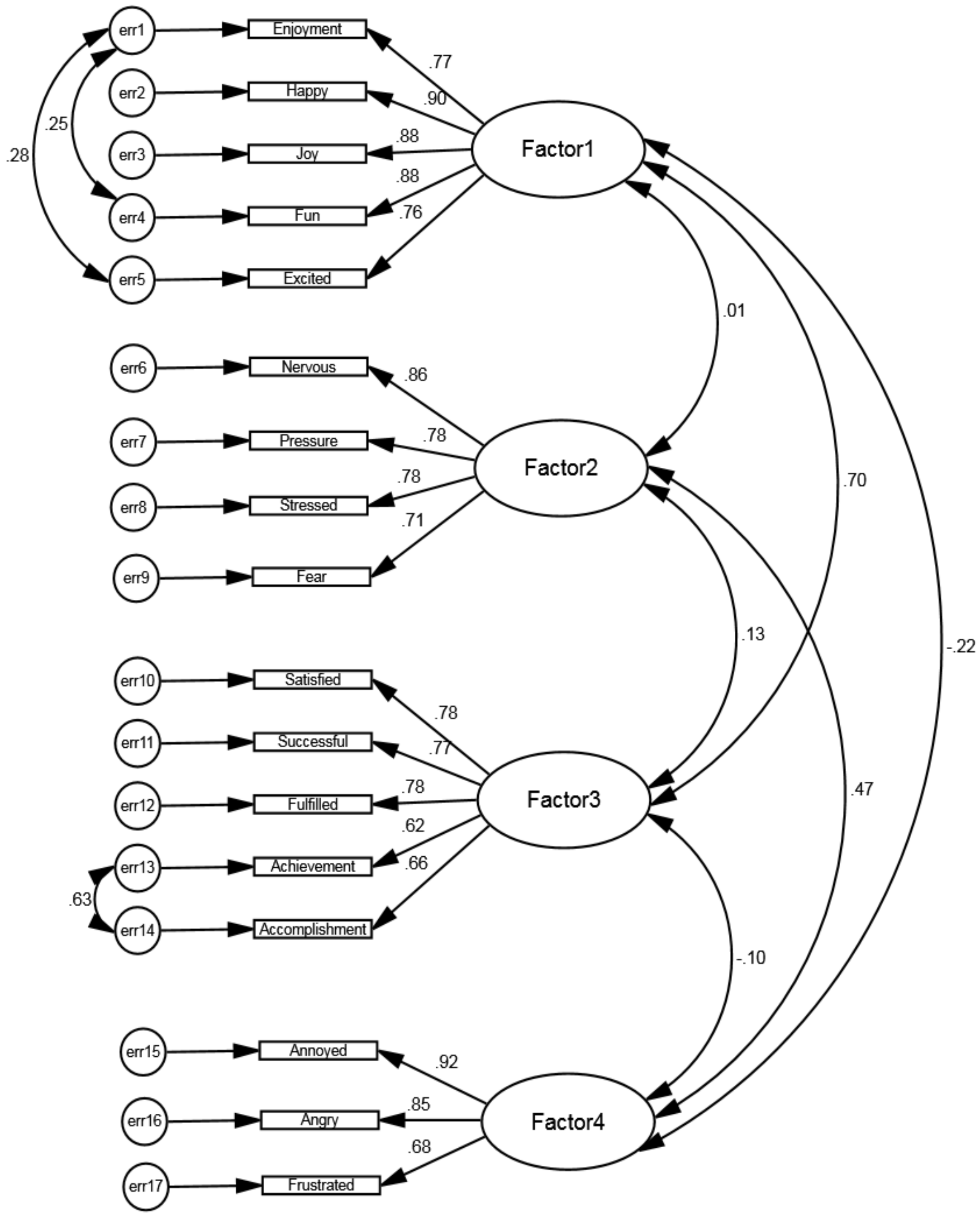
(χ^2 = 357.113; CFI = .948; RMSEA = .081 $^{[.072, .092]}$)

Figure 4.2. Model 1 with modifications. Values on model represent (left-to-right) error covariances, standardised factor loadings, and factor correlations.

Model 2

Based on the factor loadings from the EFA stage and observations from model 1 the next step was to investigate removing the items flagged as potentially weak (i.e. disappointed, anxious, fulfilled). Both 'disappointed' and 'anxious' loaded at values less than 0.6 to their respective factors in the EFA stage. Furthermore, throughout the rounds of modification both these items continued to be the weakest loading items on the relevant factors (particularly disappointed). On the other hand, throughout the rounds of modification 'fulfilled' maintained a factor loading value on par with the other four items loading on factor 3. As a result it was decided that a revised model would be analysed with 'disappointed' and 'anxious' no longer considered as loading items. The final version of the SEQ also included items with factor loadings of at least 0.6, further justifying the removal of these two weaker items. Therefore, model 2 was again based on a four-factor structure with five items loading on factors 1 and 3, four items on factor 2, and three items on factor 4.

Initial inspections of model 2 (Figure 4.3) suggested an enhanced model fit as opposed to model 1 (χ^2 = 407.369; CFI = .920; RMSEA = .087 $^{[.078, .097]}$). Probability remained the same (.000), while both the degrees of freedom (113) and $\chi^2/\ df$ ratio (3.61) decreased as expected with fewer items. The C.R remained high (22.020) and once again no outliers were observed. Modification indices suggested that error covariances for items 13-14 would improve fit (MI = 110.297). This modification substantially improved the model fit (χ^2 = 270.283; CFI = .957; RMSEA = .064 $^{[.055, .074]}$), to a point where CFI was acceptable. Further appropriate modifications to error covariances on items 1-5 (MI = 15.484; χ^2 = 253.532; CFI = .961; RMSEA = .061 $^{[.051, .071]}$), and 1-4 (MI = 11.998; χ^2 = 238.682; CFI = .965; RMSEA = .059 $^{[.048, .069]}$) resulted in more than acceptable values for CFI, RMSEA, and $\chi^2/\ df$ ratio (2.17).



(χ^2 = 238.682; CFI = .965; RMSEA = .059 $^{[.048, .069]}$)

Figure 4.3. Model 2 with modifications. Values represent (left-to-right) error covariances, standardised factor loadings, and factor correlations.

Modification to error covariances were deemed suitable given the MI values of pairings in each round, the similarity of these items, and that both items of each pairing loaded on the same factor. An equivalent process was followed to determine whether also removing 'fulfilled' would produce further enhanced model fit. Following two rounds of suitable modification to error covariances values of cut-off indices were χ^2 (253.450), CFI (.954), and RMSEA (.069 $^{[.059,\ .080]}$) indicating that the removal of this item did not improve model fit. The fit of the model when only removing 'disappointed', the lowest loading item from EFA and model 1 was also investigated. Following three suitable modifications to error covariances this model structure again did not suggest a better fit than that of model 2 (χ^2 = 303.660; CFI = .955; RMSEA = .064 $^{[.055,\ .074]}$).

Results for the unstandardized estimates revealed that all were statistically significant with individual item C.R values meeting the cut-off value of >1.96 (Arbuckle, 2013; Byrne, 2010). Standardised estimates (factor loadings) and error variances are reported on Table 4.6 for the factor-item structure represented by model 2. All items loaded on to the relevant factors with values ranging from .622 - .915 (mean = .787). These values were similar, if not stronger to those observed in the final version of the SEQ which ranged from .603 - .820 (mean = .747). Reliability for the revised model structure was slightly reduced for factors/subscales 2 and 4 (See Table 4.6), however, all values remained strong and comparable with those of the SEQ (Jones, et al., 2005).

Table 4.6. Factor loadings, error variances, and subscale reliability (α) for model 2 following CFA. Item origin: *Phase 1*: item originates from phase 1 list only; *Both*: item originates from the preliminary SEQ and Phase 1.

Factors	**Items**	**Factor Loadings**	**Error Variance**	**Cronbach's Alpha (α)**	**Item Origin**
Factor 1	Happy	.902	.150	.93	Both
	Fun	.884	.222		Phase 1
	Joy	.879	.235		Both
	Enjoyment	.770	.368		Phase 1
	Excited	.765	.474		Both
Factor 2	Nervous	.859	.369	.86	Both
	Stressed	.779	.474		Both*
	Pressure	.776	.554		Both*
	Fear	.714	.506		Phase 1
Factor 3	Satisfied	.784	.434	.86	Both*
	Fulfilled	.781	.411		Both*
	Successful	.766	.354		Phase 1
	Accomplishment	.659	.376		Phase 1
	Achievement	.622	.429		Phase 1
Factor 4	Annoyed	.915	.167	.84	Both
	Angry	.848	.286		Both
	Frustrated	.681	.724		Both*

*item not included on the final version of the SEQ

Table 4.7. Mean score and correlations for each factor / subscale.

Factor / Subscale	Mean score ± SD	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	2.98 ± .87	1			
Factor 2	1.19 ± .94	.02	1		
Factor 3	2.72 ± .75	.62**	.12*	1	
Factor 4	1.06 ± .93	-.17**	.49**	-.06	1
Total SLEQ score	7.95 ± 2.14				

** Significant correlation ($p < .01$), * Significant correlation ($p < .05$)

Sport learning and emotion questionnaire design

On account of the acceptable goodness-of-fit values, and strong (> 0.6) factor loadings it was concluded that removing the items ‘disappointed’ and ‘anxious’ from the model design was correct. Therefore, the design of the SLEQ would be underpinned by the structure of model 2, with four factors comprising of five, four, five, and three items respectively (17 items in total). This factor-item structure met the guidelines discussed earlier in terms of addressing internal consistency and representing a particular factor adequately (Bollen, 1989; Jackson & Marsh, 1996). Factor 4, with three loading items, only just met these suggestions, however, as established earlier, including the fourth item was found to diminish the goodness-of-fit of the overall model.

Turning to the final questionnaire design, each of the four factors represents a subscale for which the questionnaire scoring system would be based. Following the simple scoring system from the SEQ (Jones, et al., 2005), the sum of item ratings (i.e. 0-4) in each subscale is divided by the number items in each subscale to produce a score (mean). As such, the score for each subscale can range from 0 - 4, on the basis of the following calculations: Factor 1 = score / 5 items; Factor 2 = score / 4; Factor 3 = score / 4; and Factor 4 = score / 3. Consequently, the complete questionnaire can in theory return total scores ranging from 0 – 16. Higher scores indicate that a participant is experiencing an increased intensity of emotions at a specific time or in relation to a specific task. Therefore, the task could be considered emotion-laden, suggesting that an individual is engaged or invested in the task. Alternatively, lower scores indicate that a task is not emotionally engaging for an individual, potentially due to a lack of contextual, situational, and affective information or constraints (Headrick, et al., 2015; Kiverstein & Miller, 2015; Lewis, 2005).

Table 4.17 exemplifies the mean scores for each factor, and SLEQ total score from the current sample of 342 respondents. It must be acknowledged that participants also responded to 16 other items as part of the validation process, and therefore these exemplar scores may not be entirely indicative of results for each subscale. Nevertheless, statistical analysis of differences in the mean factor scores revealed a significant main effect ($F_{2.05,\ 698.61} = 4.67$, $p < .05$, $\omega = .78$). Pairwise comparisons returned significant differences ($p < .05$) between all factor combinations except factors 2 and 4 (see Table 4.7 for mean and SD values). The lack of significant difference in scores between factors 2 and 4 reflects the previously discussed trend of negatively valenced items generally being selected less frequently. Factor 2 and 4 scores also returned higher SD values than factors 1 and 3 suggesting there was greater variability in participant ratings for the corresponding items.

Correlations between mean scores for each factor revealed statistically significant and large positive interactions between factors 1-3 and 2-4, and a small interaction for 2-3. Factors 1-4 returned a small negative interaction, and all other combinations were insignificant (Table 4.7). Reflecting on the items loading to each factor these correlational results appear to be quite logical. The large positive correlations correspond with factors representing items of similar type and valence that would generally be expected to fluctuate in unison (Shaver, et al., 1987). Alternatively, the lone significant negative correlation indicates that scores for factors 1 and 4 tend to mirror each other due to the contrasting emphasis on items similar to ‘enjoyment’ and ‘annoyed’ respectively.

The final decision to make regarding the design of the proposed questionnaire was the issue of labels to describe each factor or subscale. These labels would be used to distinguish the four subscales and therefore needed to represent all loading items effectively. It was considered important (where appropriate) to designate labels that were distinctive to the SLEQ and the inherent focus on learning. As mentioned previously the SEQ included the predetermined subscales of anxiety, dejection, anger, excitement, and happiness (Jones, et al., 2005). Interestingly, none of the items directly related to these labels (e.g. anxiety – anxious, dejection - dejected) were the highest loading items in their respective subscales during the SEQ development. Inspecting the factor loadings from Table 4.6 revealed that the highest loading items for each SLEQ subscale were: 1 – 'happy'; 2 – 'nervous'; 3 – 'satisfied'; 4 – 'annoyed'. Despite these items loading highest on they do not necessarily represent the overall theme for each group.

Taking into account the previous information it was decided to label the first subscale as *Enjoyment*. As an item originating exclusively from the phase 1 list, enjoyment had clear relevance to learning contexts. Enjoyment also was interpreted to have stronger links with fun (also phase 1) and excited, when compared to the highest loading item in happy (Jackson, 2000). Happy (or happiness) was also not deemed relevant because it has been considered a lower intensity alternative to another item, joy (Lazarus, 1991). Joy itself (and by association - happy) was found to be unsuitable as it is a wide-ranging term, often referred to as a core 'positive' emotion, that somewhat related to several items from other subscales (Jackson, 2000; Niedenthal, 2008). Both fun and excited were ruled out for the reason that they simply did not represent the other items adequately.

The second subscale was termed *Nervousness* which reflected the predominant factor loading of the item 'nervous' in both the initial and final structural model designs. Regardless of the difference in factor loadings the remaining items were either considered too broad (fear) or too specific (stressed, pressure) to adequately represent the subscale (Öhman, 2008; Shaver, et al., 1987). The labels 'anxiety' or 'anxiousness' were also considered given that the item anxious was included in this subscale in the initial design. However, this notion was rejected as a consequence of anxiety relating to situations that are potentially threatening or dangerous and creating insecurities in individuals (Lazarus, 1991; Raglin & Hanin, 2000), along with the relatively weak observed factor loading.

The third subscale was labelled *Fulfilment*. A derivative of this term (fulfilled) appeared in the happiness subscale in the preliminary SEQ, but was not retained as an item in the final version of the SEQ (Jones, et al., 2005). Satisfied and successful were deemed inappropriate due to links with the core positive concept of 'joy' (Shaver, et al., 1987). Accomplishment and achievement were both interpreted as being unsuitable given the strong error covariance evidenced in model 2. Therefore, designating either item as the subscale label was considered misleading due to their established links.

The fourth and final subscale was designated the label of *Anger* to represent the items 'annoyed', 'angry', and 'frustrated'. These three items were also in the anger subscale of the SEQ, however, frustrated was not retained in the final version (Jones, et al., 2005). Some consideration was given for selecting frustration (frustrated) as the subscale label given that it is a unique item to the SLEQ. However, on account of factor loadings, and previous categorisations (Jones, et al., 2005; Lazarus, 1991;

Shaver, et al., 1987) it was concluded that anger provided a more appropriate representation of the subscale as it included links to both annoyed and frustrated.

Drawing on the three previous phases of inquiry and analysis, the final version of the Sport Learning and Emotions Questionnaire (SLEQ) is presented on page 113. The four-factor design underpins two positive (Enjoyment - Fulfilment) and two negatively (Nervousness – Anger) valenced subscales , which in turn represent 17 emotion items determined to be most relevant to learning contexts. Due to the focus on emotions during learning contexts, and the manner in which items were identified and refined, the SLEQ is suitable for implementation throughout learning sessions in sport. The brevity and accessibility of this new emotions tool also affords the opportunity to administer the SLEQ several times, and under the influence of various constraints throughout a session. Therefore, the SLEQ is designed to facilitate comparisons across various time scales alongside other measures (e.g. movement analysis, performance outcomes, game plans, tactics) of value to athletes, coaches, practitioners, and researchers.

SPORT LEARNING & EMOTIONS QUESTIONNAIRE (SLEQ)

Instructions:

Below is a list of words that represent a range of feelings that might be experienced during learning in sport. Please carefully read each word and indicate on the scale (0-4) how you feel ***right now, at this moment in relation to the current task / session***. There are no right or wrong choices. All selections should be based on your feelings alone.

	Not at all	A little	Moderately	Quite a bit	Extremely
Happy	0	1	2	3	4
Nervous	0	1	2	3	4
Satisfied	0	1	2	3	4
Annoyed	0	1	2	3	4
Fun	0	1	2	3	4
Stressed	0	1	2	3	4
Fulfilled	0	1	2	3	4
Angry	0	1	2	3	4
Joy	0	1	2	3	4
Pressure	0	1	2	3	4
Successful	0	1	2	3	4
Frustrated	0	1	2	3	4
Enjoyment	0	1	2	3	4
Fear	0	1	2	3	4
Accomplishment	0	1	2	3	4
Excited	0	1	2	3	4
Achievement	0	1	2	3	4

	SCORING INSTRUCTIONS (for researcher only)	**Score**
Enjoyment	= (happy + fun + joy + enjoyment + excited) / 5	________
Nervousness	= (nervous + stress + pressure + fear) / 4	________
Fulfilment	= (satisfied + fulfilled + successful + accomplishment + achievement) / 5	________
Anger	= (annoyed + angry + frustrated) / 3	________
	Total SLEQ	________

Participant ID: ____________ Session / Date: ____________ Trial / Condition: ____________

Chapter 5: Implementing the SLEQ during learning in sport: Applied case examples

Overview

Following the design and development of the Sport Learning and Emotions Questionnaire (SLEQ) in Chapter 4, the next stage of inquiry was to apply the tool in applied *learning* contexts in sport. Therefore, Stage 3 of this thesis comprises of two case examples demonstrating the use of the SLEQ in a team passing game ('Endball' – Example A), and a cricket batting task (Example B). These studies had two main goals. Firstly, both of these examples were designed to demonstrate the effectiveness of the SLEQ for measuring emotion intensity, in unison with action (e.g. movement and performance), and cognition variables when key constraints were manipulated. Despite previous investigations also including physiological variables (e.g. heart rate, see Oudejans & Pijpers, 2009; Pijpers, et al., 2005; Pijpers, et al., 2006), in the examples presented in this chapter a deliberate and theoretically based decision not to include physiological variables was made with focus being put on the crucial interaction between actions, emotions, and cognitions. This decision was made on account of physiological responses often being associated exclusively with select emotional terms such as anxiety, rather than more comprehensive indications of emotion intensity incorporating both positive and negatively valenced items (Jones, et al., 2005; Martens, Burton, et al., 1990). Furthermore, such physiological measures are generally only markers of arousal, rather than direct indications of emotion (Jones, 2003; Jones, et al., 2005). Therefore, the approach adopted in these examples provided the opportunity to observe the dynamic between overall emotion intensity, actions, and cognitions.

The second goal of these examples was to highlight the relevance of the two key principles of Affective Learning Design (ALD – see Chapter 3), specifically: (i) the design of emotion-laden learning experiences that effectively simulate the constraints and demands of performance environments in sport; (ii) recognising individualised emotional and behavioural tendencies that are indicative of learning. These principles highlight the importance of considering the influence of affective constraints, and a holistic approach to emergent behaviour including emotion.

Example A involved the systematic manipulation of a task constraint (possession time) during a session where the participants played the small-sided invasion game 'Endball'. Through the manipulation of this targeted constraint it was expected that participants would show fluctuations in emotion intensity and actions as they attempted to adapt to the changing task demands. The final game saw the constraints return to the initial condition, in order to observe whether the preceding manipulations produced any noticeable changes in emergent behaviour. Therefore, the session design was deliberately constructed to facilitate learning over a short time scale representative of experiences during a common physical education class, or practice session. For the purposes of this example, measures of emotion (SLEQ) and actions (game performance characteristics) were investigated to provide initial insights regarding the effectiveness of the SLEQ. Hence, this example study was considered as a critical 'first step' to implementing the SLEQ in applied sport environments, along with demonstrating the second principle of ALD.

Example B provided the opportunity for an in-depth single case investigation using the task vehicle of cricket batting. Space-time constraints were manipulated to simulate increasing delivery (ball) speeds during a representative batter versus bowler practice game scenario. This study design set out to increase the task demands from the perspective of the batter and observe related fluctuations in emotion intensity (SLEQ), actions (kinematics and performance outcomes), along with cognitions (via brief confrontational interviews during natural breaks in the game). Therefore both principles of ALD were incorporated, in terms of including affective constraints, and the recognition of individualised tendencies of actions, emotions, and cognitions. The time scale of this example was again kept to one session encompassing several constraint manipulations, simulating a typical practice environment in sport.

Given the richness and volume of data available in both of these examples the fluctuations between trials and/or conditions were readily able to be observed and analysed. These fluctuations have often been neglected and overlooked in favour of comparing mean values from a set or block of performances, often to the detriment of understanding short term changes in key measures (Newell, et al., 2001). As reported in the following sections, both examples provided evidence of linked changes in actions and emotions (also cognitions in Example B) as constraints were manipulated throughout various periods of the session. Longer term changes that are indicative of learning were also observed across the sessions as a whole, reflecting the notion of interacting time scales of learning (Granott & Parziale, 2002; Lewis, 2002; Newell, et al., 2001).

Despite the brief nature of the two sessions, both examples can be considered representative of learning over short periods of time. This is further supported by the functional adaptability displayed by individual participants and/or teams following the manipulation to constraints discussed throughout the remainder of the chapter. The methodological designs of both applied case examples satisfy the current aim of demonstrating how the SLEQ can be implemented in applied sport learning contexts.

Taking the following results and implications into account these studies form a necessary step towards longitudinal investigations incorporating the SLEQ and principles of ALD.

Chapter 5: Applied case example A

The influence of manipulated task constraints on the interaction between emotions and actions in a small-sided invasion game

Abstract

Through the systematic manipulation of a targeted constraint this study aimed to investigate the effectiveness of the newly developed *Sport Learning and Emotions Questionnaire* (SLEQ) for tracking emotion intensity in an applied sport context. The SLEQ was designed to reflect *Affective Learning Design* (ALD) principles, and was implemented here to record the emotion intensities of individuals during a team passing and possession game. Critically this investigation observed emotion intensity alongside key game events (e.g. passes, touches, errors) under the influence of manipulated constraints. Two teams of eight participants participated in four games of 'Endball' (similar to Netball), with individual possession time restricted in each case (3, 2, 1, and 3 seconds respectively). Manipulations in possession time were found to be linked with emotion and action variable changes, particularly during the transition from one game to the next (i.e. from the 2 second game – to – the 1 second game). Significant correlational interactions were evident between fluctuations in action variables (e.g. incomplete passes), and emotion subscale scores (e.g. Anger) demonstrating the effectiveness of the SLEQ for measuring relevant emotion intensities. These fluctuations were indicative of metastable regions created by the systematic manipulation of constraints, where participants and teams were forced to explore the environment for new functional states of emergent behaviour. Therefore, this investigation demonstrates the value of the SLEQ for measuring emotion intensity throughout an applied learning context, for understanding the interaction between actions and emotions following the systematic manipulation of constraints.

Introduction

The constraints based approach has received considerable attention recently as an approach for understanding how a practitioner, coach, or teacher might manipulate key features of a task to study or shape the behaviour of individuals in sport (Chow et al., 2006; Davids, 2001; Renshaw, Chow, et al., 2010). This approach is based on the three categories of constraints proposed by Newell (1986). Organismic or Individual constraints represent characteristics of an individual in a particular environment or situation. These characteristics include the physical size, physiology, and strength of an individual and are inherently difficult to manipulate as a consequence of such qualities being largely 'internal'. Through previous sections, emotions and cognitions have also been discussed as constraints reflecting an individual's interaction with and perception of environmental information (Headrick, et al., 2015; Lewis, 2004; Pinder, et al., 2014). Environmental constraints can include both physical (e.g. light, temperature, weather conditions) and social (culture, peers, spectators) influences on learning or performance (Araújo, Davids, Bennett, Button, & Chapman, 2004; Renshaw, Chow, et al., 2010). Environmental constraints are often difficult to distinguish from the third category – task constraints (see, Renshaw & Davids, 2014). Task constraints are generally more specific to a particular situation and often relate to manipulations to rules, equipment, instructions, and playing surface/area (Chow, et al., 2006; Hristovski, et al., 2006; Newell & Ranganathan, 2010).

Task constraints are the most accessible form of constraints available to be manipulated in sporting contexts. Examples include the manipulation of proximity-to-goal and the presence of defending players in football interpersonal interactions (Headrick, Davids, et al., 2012; Orth, Davids, Araújo, Renshaw, & Passos, 2014), the impact on interceptive actions when implement characteristics are changed in tennis and cricket (Buszard, Farrow, Reid, & Masters, 2014; Headrick, Renshaw, Pinder, & Davids, 2012), and situation specific instructions in basketball (Cordovil, et al., 2009). Studies such as these have provided valuable insights for how the physical behaviours (including feelings, perception, decision making, and actions) of individuals can be shaped through the systematic manipulation of key constraints. The current project aims to build on previous constraints-led approaches by considering how manipulations to key constraints might influence actions, in conjunction with emotions, which have often been neglected (see Chapters 1-3).

The Sport Learning and Emotions Questionnaire (SLEQ), was specifically designed for use during learning tasks in sport, and to address the need to better understand the impact of manipulating specific learning tasks. Throughout the previous chapters the theoretical underpinnings and structural design of the SLEQ have been extensively discussed. This sport orientated tool is designed to be used at several occasions throughout a session to document the intensity of select items grouped to four distinct subscales (see chapter 4 – phase 2 and 3). The SLEQ scoring system does not stipulate the type or valence of emotions experienced, rather the overall intensity or 'emotional engagement' of an individual during a specified time period.

The task constraint manipulated during this study was the maximum time a participant could maintain possession of the ball during a common invasion game. This constraint was chosen as it was a relatively simple variable to manipulate and exemplified a manipulation that could readily be implemented by a coach or teacher in a wide variety of sports and games (Moy, Renshaw, & Davids, 2014; Renshaw, Chow, et al., 2010). Through systematic manipulation of this task constraint it was anticipated that the performance of participants would initially be destabilised leading to metastable periods (see, Chow, et al., 2011; Headrick, et al., 2015; Pinder, et al., 2012). Therefore, participants would be forced to adapt to the change in constraints and learn how best to satisfy their performance objectives within the new task demands of the game. Observable changes in both actions (game events e.g., touches, errors, complete passes) and emotion intensity were expected to take place during these metastable periods as participants actively searched for new or different functional states (Hristovski, Davids, & Araújo, 2009; Pinder, et al., 2012). Further, it was expected that SLEQ scores and performance variables would show evidence of complimentary changes at key times (i.e. immediately following manipulation of the constraint), supporting the previous theoretical arguments surrounding the intertwined relationship between action and emotion. Taking into account the design of the session (possession time systematically reduced before returning to the original value – see methods) changes in emotion and game characteristics were anticipated from the start to the end of game play. More specifically, it was anticipated that the first and final games (identical possession times) would exhibit different observable characteristics following the two manipulations in constraints during the session. Essentially it was expected that changes in emotions and performance would be shaped by previous experiences even though the task constraints were the same for games 1 and 4. Potential improvements in performance could be inferred through variables such as goals scored, errors, and completed passes.

Methods

Participants

Eight male (n=5) and female (n=3) university students (mean age = 19.63 ± .74 years) voluntarily participated in the project as part of scheduled class activity relating to an assessment project. Each prospective participant was briefed on the nature of their involvement and asked to provide written informed consent prior to commencing. The eight participants were provided with sufficient detail regarding the study, but were not explicitly aware of the specific measures collected until data collection commenced. Participants indicated current and/or previous experience in the following sports: Football (soccer, n=3); Touch Football (n=2); Rugby League (n=1); Boxing (n=1); and Athletics (n=1). Highest levels of representation in these sports were: State (n=3); Regional (n=2); Club (n=3) and length of participation was reported to be 6.63 ± 3.20 years. Therefore, none of the participants were experienced in Netball or Basketball which share key characteristics with the Endball game in this study. The participants were asked to self-select evenly matched teams. This was deemed the best approach as the individuals were very familiar with each other as they were in the latter years of their university course and were part of the same cohort.

Procedure

Task design

Participants were required to play four short games of 'Endball' on an outdoor grass surface. Endball is an invasion game where teams attempt to score goals by having a team member take possession of the ball while he/she is standing within a designated goal area at the respective 'end' of the playing area. This game was chosen as it included many coordination modes for passing, catching, interpersonal interactions, and important principles of play (e.g. time-space characteristics) also exhibited in popular invasion game sports such as Netball, Basketball, Football/Soccer and Hockey. Similarities in task constraints with Netball are perhaps most prevalent, whereby: possession alternates from team-to-team freely (i.e. following a goal or rule breach); a time limit is imposed for the duration each individual possession by a player (3 seconds in Netball); and players cannot move/run/dribble while in possession of the ball. As a result of these constraints players/teams can only promote the ball towards the endzone through one or a series of successful passes, each completed within the specified possession time limit. The manipulated independent variable, in the form of a task constraint (or in ecological dynamics terms a *candidate control parameter*[2]), throughout the four games in the current investigation was the *maximum time a participant could maintain possession of the ball*. Specifically, each individual possession time was initially constrained to 3 seconds, before systematically being reduced to 2 and then 1 second. For the final game of the session, possession time returned to the original limit of 3 seconds. The session design, task/possession time constraints for each game and response collection occasions are presented in Figure 5.1 below.

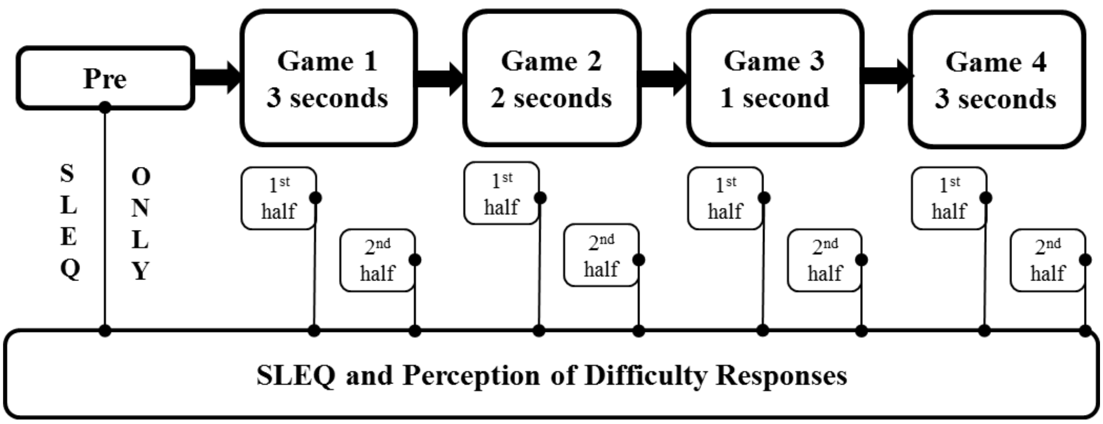


Figure 5.1. Representation of session design with SLEQ and perception of difficulty (PoD) collection occasions.

[2] Informational variables that when manipulated have the potential to destabilise system organisation

Each of the four games took place on a playing area 20m in length and 12m in width, with 2m deep ‘endzones’ used for scoring at each end. Two teams of 4 players participated and were identified by contrasting coloured bibs. Employing the Game Intensity Index calculation (GII, see Chow, et al., 2013) the Endball game equated to an index of 30 (GII = playing area (m^2) / number of players), very similar to that of Netball (GII = 33.2). Therefore, the intensity of the four games in terms of players and space was considered appropriate for the purpose of the investigation. Games consisted of two, three minute halves with two minutes rest between each half, and five minutes between each game. A regulation (size 5) Netball was used in all games, and a neutral referee enforced the relevant game rules with assistance in terms of timing provided by members of the research team. Participants were asked to play a warm up game for the purposes of familiarising themselves with the generic game rules (no possession time restriction). This warm up also provided the recorders (see later in this section) with a chance to familiarise themselves with the key game characteristics that were to be observed.

Emotion and perception of difficulty

In order to observe how the manipulation of task constraints might influence emotion throughout the session, the SLEQ was administered prior to the first game (following warm up) and then following both half and full time for each game. On each occasion participants were presented with a paper copy of the SLEQ and made aware of the instructions and response scale. Participants were at no stage permitted to review their responses from previous occasions, or communicate with other players whilst completing the questionnaire. Following completion of the SLEQ (30-60 seconds completion time), participants were also asked to indicate their ‘perception of difficulty’ in relation to playing in the respective half of each game.

This was recorded on a scale of 1 (very easy) to 10 (impossible) where difficulty could relate to all aspects of the game (e.g. physical, skill, strategic demands). Alongside the SLEQ, this simple measure was incorporated to provide individualised and alternate perspectives on the influence of manipulations to the selected task constraint.

Game analysis

The actions of each participant and team were recorded to establish if the manipulated task constraint influenced specific game characteristics or events. Key events were recorded for each team possession and included counts of: touches; complete/incomplete passes; goals; dropped balls resulting in a turnover; time violations; moving with the ball fouls; and out of bounds. Equivalent events were recorded for individual participants within these team possessions, each by separate pairs of recorders in the form of other students from the class. Pairs of recorders independently observed and recorded the actions of their respective player/team before coming together to cross check the events at the end of each half to ensure the consistency and reliability of results. Inter-observer reliability returned mean correlations of .88 ± .08 for the actions of the eight players, and .95 ± .02 for the actions of the two teams. These reliability results met the required level, and in fact were quite strong, given that events were recorded in real time (Van der Mars, 1989). As mentioned previously, the recorders were given the opportunity to familiarise themselves with key events during the warm up. In terms of the 'result', each game was treated independently. That is, each game started with a score of 0-0.

Analysis

All results were collated by the research team and entered into spreadsheets for initial analysis and inspection of possible patterns or trends in data. One-way

ANOVA tests were then performed to identify statistically significant differences between teams throughout the session for goals scored, touches, passes (complete and incomplete), combined errors, and perception of difficulty. Given that the overarching aim of this study was to establish how emotion (SLEQ responses) might link with actions during a learning session/lesson, the respective SLEQ and subscale scores were the primary focus of the analysis. A series of one-way ANOVA tests were performed to identify any differences between the two teams for overall SLEQ and subscale scores at each measurement occasion. Effect sizes were also calculated to accompany all ANOVAs using omega (ω), with the following classifications: small = 0.10; medium = 0.30; large = 0.50) (Field, 2013). As a measure for determining the change in SLEQ scores and game events between each half, z scores were calculated. The z scores provided data specifying the change in SLEQ (and subscales ENJ, NERV, FUL, and ANG) alongside the change in number of key events (e.g. touches, goals), and perception of difficulty ratings during the respective periods of play. Change in z scores were then subjected to a correlation (Pearson's correlation coefficient, *r*) analysis to determine any relationship between SLEQ score and occurrence of game events following the previously mentioned manipulations to task constraints (alpha < .05, 95% confidence intervals).

Results

Table 5.1 displays a summary of the observed game events, mean perception of difficulty ratings (PoD), and mean SLEQ scores for both teams. Face value inspection of these results shows that team number 2 were more dominant in terms of game performance, outscoring team 1 in each of the eight halves of play, and also accruing less errors (i.e. turnovers, time violations, moving with the ball fouls, out of bounds). Mean SLEQ scores for each team are plotted alongside the frequency of three game events (goals, touches, errors) in Figure 5.2. Following statistical analyses, no significant differences were found between teams for mean goals scored, or incomplete passes. Significant differences were found for the number of touches in the first half of game 4 ($F_{1, 6} = 31.57$, $p < .05$, ω =.89), in favour of team 1 (see Table 5.1 for mean ± SD values). In the same period team 1 also completed significantly more passes ($F_{1, 6} = 6.40$, $p < .05$, ω =.63). Team 1 was also found to produce significantly more errors during the first half of game 1 ($F_{1, 6} = 10.71$, $p < .05$, ω =.74). Moving to PoD ratings, the only statistically significant difference between teams was found during the second half of game 1, with team 1 players reporting increased difficulty levels compared with team 2 players ($F_{1, 6} = 31.57$, $p < .05$, ω =.90). Responses to the SLEQ revealed significant differences in total SLEQ score and Fulfilment (FUL) score during several periods of play, with the better performing team (2) reporting higher scores on each occasion. Significant differences in SLEQ scores were observed during: game 1 – 1st half ($F_{1, 6} = 12.04$, $p < .05$, ω =.76); game 2 – 2nd half ($F_{1, 6} = 9.37$, $p < .05$, ω =.72); game 3 – 1st half ($F_{1, 6} = 7.86$, $p < .05$, ω =.68); game 3 – 2nd half ($F_{1, 6} = 10.91$, $p < .05$, ω =.74); and game 4 – 1st half ($F_{1, 6} = 8.05$, $p < .05$, ω =.68). Fulfilment scores were significantly different between teams during: game 1 – 1st half ($F_{1, 6} = 60.50$, $p < .05$, ω =.94); game 1 – 2nd half ($F_{1, 6} = 45.18$, $p < .05$, ω =.92); game 2 – 1st half ($F_{1, 6} = 10.24$, $p < .05$, ω =.73); and game 4 – 1st half ($F_{1, 6} = 15.78$, $p < .05$, ω =.81).

Table 5.1. Summary of game events, mean perception of difficulty (PoD) ratings, and mean SLEQ scores for each of the two teams.

	PRE	Game 1		Game 2		Game 3		Game 4	
		1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
TEAM 1									
Possessions	-	9	9	11	8	9	7	9	9
Goals	-	1	0	4	2	2	1	3	3
Touches	-	28	34	59	42	46	26	44	38
Complete Passes	-	19	25	48	34	36	20	35	29
Incomplete Passes	-	0	0	7	3	6	2	3	1
Errors	-	7	8	7	6	8	5	6	6
PoD	-	5.25 ± 1.71	5.50 ± 0.58	5.50 ± 1.00	4.50 ± 1.29	4.75 ± 1.71	5.50 ± 2.38	4.75 ± 0.50	3.50 ± 0.58
SLEQ	6.16 ± 1.39	5.96 ± 1.54	5.67 ± 2.15	6.43 ±1.41	7.16 ± 0.58	7.38 ± 0.44	6.81 ± 0.71	5.83 ± 1.14	7.20 ± 0.68
ENJ	3.40 ± 0.40	2.60 ± 0.40	2.35 ± 1.15	2.90 ± 0.81	3.00 ± 0.75	3.30 ± 0.70	3.10 ± 0.68	2.90 ± 0.77	3.35 ± 0.50
NERV	0.56 ± 0.43	0.88 ± 0.63	1.00 ± 0.54	0.63 ± 0.32	0.63 ± 0.43	0.81 ± 0.83	1.06 ± 0.83	0.31 ± 0.24	0.25 ± 0.20
FUL	1.95 ± 0.84	1.40 ± 0.54	1.15 ± 0.66	2.15 ± 0.68	2.70 ± 0.50	2.85 ± 0.19	2.15 ± 0.93	2.20 ± 0.16	3.35 ± 0.41
ANG	0.25 ± 0.32	1.08 ± 1.20	1.17 ± 1.29	0.75 ± 0.50	0.83 ± 0.58	0.42 ± 0.42	0.50 ± 0.43	0.42 ± 0.50	0.25 ± 0.32
TEAM 2									
Possessions	-	9	7	11	8	8	8	10	7
Goals	-	5	4	5	4	5	3	6	4
Touches	-	28	25	36	29	34	33	29	32
Complete Passes	-	19	18	25	21	26	25	19	25
Incomplete Passes	-	2	1	2	1	1	3	2	1
Errors	-	4	3	5	4	3	5	4	3
PoD	-	3.50 ± 1.0	3.25 ± 0.50	5.00 ± 0.0	5.25 ± 0.50	6.25 ± 1.89	6.75 ± 1.50	4.00 ± 1.63	3.75 ± 1.26
SLEQ	8.52 ± 2.10	9.15 ± 1.00	8.16 ± 0.31	8.25 ± 0.80	8.89 ± 0.97	8.90 ± 1.00	8.93 ± 1.06	7.73 ± 0.71	8.44 ± 1.29
ENJ	3.50 ± 0.20	3.40 ± 0.57	3.70 ± 0.26	3.20 ± 0.67	3.10 ± 0.66	2.75 ± 0.93	3.15 ± 0.70	3.35 ± 0.47	3.55 ± 0.34
NERV	1.44 ± 0.83	1.06 ± 0.77	0.56 ± 0.31	0.69 ± 0.24	0.69 ± 0.24	0.94 ± 0.83	0.88 ± 0.72	0.25 ± 0.35	0.13 ± 0.25
FUL	2.50 ± 0.53	3.60 ± 0.16	3.65 ± 0.34	3.45 ± 0.44	3.10 ± 0.66	2.80 ± 0.85	3.40 ± 0.43	3.30 ± 0.53	3.85 ± 0.10
ANG	1.08 ± 1.10	1.08 ± 0.74	0.25 ± 0.50	0.92 ± 1.00	2.00 ± 1.41	2.42 ± 1.66	1.50 ± 1.73	0.83 ± 1.11	0.92 ± 1.62

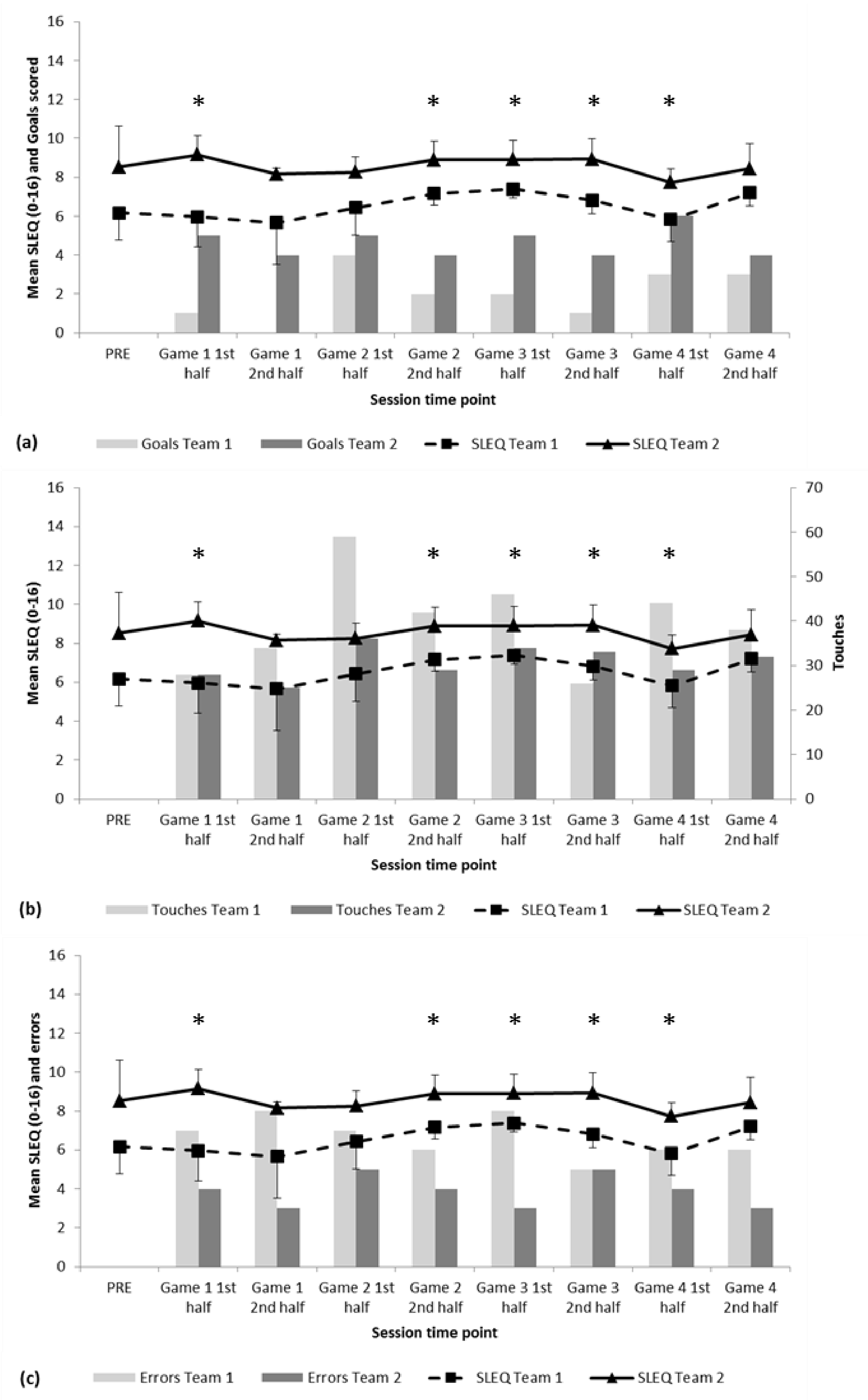


Figure 5.2. Mean team SLEQ scores plotted with: (a) goals scored; (b) touches; and (c) errors across the session. *Significant differences in SLEQ scores between teams (p < .05)

Change in z score results are presented below in a collection of correlation tables displaying the relationship between each observed variable (where appropriate) throughout the 4 games. Table 5.2 and 5.3 present the correlation in change of z scores for SLEQ and each of the subscales comparing Pre session responses with those of game 1 – 1st half, and game 4 – 2nd half (whole session) respectively.

Table 5.2. Change in z score correlations between observed variables from Pre to Game 1 – 1st half (SLEQ only).

	ENJ	**NERV**	**FUL**	**ANG**	**SLEQ**
ENJ	1				
NERV	-.633	1			
FUL	.752* [.204, .976]	-.493	1		
ANG	-.701	.851* [.657, .991]	-.620	1	
SLEQ	.259	.395	.384	.315	1

* Significant correlation (p < .05)

Table 5.3. Change in z score correlations between observed variables from Pre to Game 4 – 2nd half (SLEQ only).

	ENJ	**NERV**	**FUL**	**ANG**	**SLEQ**
ENJ	1				
NERV	-.820* [-.991,-.213]	1			
FUL	.826* [-.420,.987]	-.701	1		
ANG	-.484	.369	-.305	1	
SLEQ	-.039	.203	.101	.791* [-.826,.991]	1

* Significant correlation (p < .05)

Tables 5.4 – 5.10 present correlations of change in SLEQ z scores along with the range of game events recorded throughout each period of play. Table 5.11 reports the same correlation relationships for the entire session.

Table 5.4. Change in z score correlations between observed variables from Game 1 – 1st half to Game 1 – 2nd half (3 second game).

	ENJ	NERV	FUL	ANG	SLEQ	PoD	Touches	Goals	Comp passes	Incomp passes	Errors
ENJ	1										
NERV	.074	1									
FUL	.651	-.402	1								
ANG	-.859* [-.975,-.667]	-.316	-.276	1							
SLEQ	.384	.821* [.221,.986]	.017	-.363	1						
PoD	.186	.666	-.515	-.541	.385	1					
Touches	-.324	.041	-.507	.203	.055	.047	1				
Goals	-.439	.556	-.710* [-.970,-.093]	.186	.143	.392	-.100	1			
Comp passes	-.539	.625	-.618	.386	.284	.315	-.112	.897* [-.276,1.000]	1		
Incomp passes	-.048	-.373	.009	-.062	-.374	-.123	.629	-.588	-.612	1	
Errors	.647	.028	.624	-.517	.413	-.100	.136	-.785* [-.996,-.403]	-.689	.433	1

* Significant correlation ($p < .05$)

Table 5.5. Change in z score correlations between observed variables from Game 1 – 2nd half to Game 2 – 1st half (3 second game – 2 second game).

	ENJ	NERV	FUL	ANG	SLEQ	PoD	Touches	Goals	Comp passes	Incomp passes	Errors
ENJ	1										
NERV	-.367	1									
FUL	.901* [.690,.979]	-.540	1								
ANG	-.817* [-.985,-.313]	.262	-.734* [-.962,.098]	1							
SLEQ	.325	.540	.268	-.060	1						
PoD	-.572	.658	-.692	.542	-.007	1					
Touches	.041	-.204	.071	.502	.195	.166	1				
Goals	.734* [.111,.979]	-.302	.839* [.278,.976]	-.823* [-.987,-.410]	.205	-.621	-.314	1			
Comp passes	-.061	.221	-.032	.479	.666	-.098	.486	-.281	1		
Incomp passes	.221	-.614	.463	.019	-.056	-.296	.410	.026	.191	1	
Errors	-.152	.417	-.391	.080	-.160	.742* [.523,.992]	.093	-.220	-.483	-.556	1

* Significant correlation (*p* < .05)

Table 5.6. Change in z score correlations between observed variables from Game 2 – 1st half to Game 2 – 2nd half (2 second game)

	ENJ	NERV	FUL	ANG	SLEQ	PoD	Touches	Goals	Comp passes	Incomp passes	Errors
ENJ	1										
NERV	.055	1									
FUL	.728* [.244,.943]	.057	1								
ANG	-.729* [-.968,-.030]	.077	-.495	1							
SLEQ	.003	.345	.420	.483	1						
PoD	-.463	.052	-.654	.379	-.299	1					
Touches	-.481	-.051	-.101	.394	.224	.577	1				
Goals	.249	.600	.163	-.086	-.015	.441	.190	1			
Comp passes	-.574	-.030	-.070	.417	.513	-.208	.341	-.580	1		
Incomp passes	-.237	-.472	.011	.298	.096	.531	.817* [.641,.974]	.120	.074	1	
Errors	.207	-.368	.385	-.337	-.187	-.166	.320	-.035	-.200	.350	1

* Significant correlation (p < .05)

Table 5.7. Change in z score correlations between observed variables from Game 2 – 2nd half to Game 3 – 1st half (2 second game – 1 second game)

	ENJ	NERV	FUL	ANG	SLEQ	PoD	Touches	Goals	Comp passes	Incomp passes	Errors
ENJ	1										
NERV	-.429	1									
FUL	.745* [-.008,.980]	-.616	1								
ANG	-.741* [-.922,-.351]	.177	-.787* [-.976,.303]	1							
SLEQ	.242	.564	-.102	-.087	1						
PoD	-.235	.525	-.454	.089	.541	1					
Touches	-.236	-.443	.265	.215	-.572	-.635	1				
Goals	-.445	.198	.045	.202	-.125	-.401	.734* [.432,.966]	1			
Comp passes	.476	-.431	.026	-.030	-.235	-.197	-.149	-.653	1		
Incomp passes	-.159	-.142	.329	.044	-.169	-.521	.811* [.455,.967]	.886* [.790,.999]	-.540	1	
Errors	-.456	.130	.103	.068	-.250	-.373	.453	.756* [-.194,.983]	-.707* [-.920,-.088]	.554	1

* Significant correlation ($p < .05$)

Table 5.8. Change in z score correlations between observed variables from Game 3 – 1st half to Game 3 – 2nd half (1 second game)

	ENJ	NERV	FUL	ANG	SLEQ	PoD	Touches	Goals	Comp passes	Incomp passes	Errors
ENJ	1										
NERV	-.793* [-.970,.335]	1									
FUL	.821* [.429,.974]	-.750* [-.982,-.014]	1								
ANG	-.826* [-.995,-.477]	.564	-.806* [-.965,-.241]	1							
SLEQ	.736* [.454,.980]	-.414	.716* [.186,.950]	-.540	1						
PoD	-.181	-.037	-.318	.141	-.741* [-.972,.034]	1					
Touches	-.162	.029	.216	.183	.322	-.677	1				
Goals	-.397	.460	.071	.171	.111	-.404	.446	1			
Comp passes	.376	-.136	.096	-.129	.324	-.136	.163	-.516	1		
Incomp passes	.306	-.258	.463	-.160	.654	-.764* [-.998,-.066]	.850* [.577,.977]	.098	.533	1	
Errors	.024	-.223	-.021	-.021	-.289	.597	-.603	-.094	-.635	-.724* [-.956,-.121]	1

* Significant correlation ($p < .05$)

Table 5.9. Change in z score correlations between observed variables from Game 3 – 2nd half to Game 4 – 1st half (1 second game – 3 second game)

	ENJ	NERV	FUL	ANG	SLEQ	PoD	Touches	Goals	Comp passes	Incomp passes	Errors
ENJ	1										
NERV	.060	1									
FUL	.432	-.380	1								
ANG	-.564	.671	-.482	1							
SLEQ	.440	.562	.511	.164	1						
PoD	-.648	.407	-.820* [-.967,-.457]	.504	-.359	1					
Touches	-.384	-.066	-.145	.056	-.241	.399	1				
Goals	.512	.572	-.074	-.066	.558	.135	.016	1			
Comp passes	-.730* [-.992,-.081]	-.073	-.065	.585	-.095	.179	.459	-.410	1		
Incomp passes	-.371	.708* [.034,.941]	-.103	.847* [.475,.975]	.475	.319	.275	.076	.534	1	
Errors	-.086	-.447	-.090	-.515	-.579	.121	.343	-.364	-.297	-.458	1

* Significant correlation ($p < .05$)

Table 5.10. Change in z score correlations between observed variables from Game 4 – 1st half to Game 4 – 2nd half (3 second game)

	ENJ	NERV	FUL	ANG	SLEQ	PoD	Touches	Goals	Comp passes	Incomp passes	Errors
ENJ	1										
NERV	.452	1									
FUL	.121	-.155	1								
ANG	-.217	.151	.245	1							
SLEQ	.435	.295	.738* [-.106,.960]	.295	1						
PoD	.103	-.072	-.739* [-.972,-.477]	-.315	-.641	1					
Touches	-.058	.113	-.559	-.281	-.548	.745* [.345,.982]	1				
Goals	-.221	.131	-.679	-.452	-.709* [-.942,-.043]	.230	.389	1			
Comp passes	.677	.179	.075	-.249	.125	.518	.373	-.391	1		
Incomp passes	.144	.201	.526	.388	.369	-.210	.281	-.367	.319	1	
Errors	-.867* [-.997,-.650]	-.257	-.166	.363	-.157	-.202	-.039	.135	-.794* [-.967,-.486]	-.171	1

* Significant correlation ($p < .05$)

Table 5.11. Change in z score correlations between observed variables from Game 1 – 1st half to Game 4 – 2nd half (whole session)

	ENJ	NERV	FUL	ANG	SLEQ	PoD	Touches	Goals	Comp passes	Incomp passes	Errors
ENJ	1										
NERV	-.278	1									
FUL	.718* [-.055,.980]	-.137	1								
ANG	-.484	-.191	-.353	1							
SLEQ	.166	.213	.579	.323	1						
PoD	-.793* [-.995,-.032]	.444	-.860* [-.976,-.613]	.501	-.155	1					
Touches	-.056	.310	-.292	-.528	-.588	.058	1				
Goals	.190	.461	.194	-.276	.170	.052	-.355	1			
Comp passes	-.041	-.215	.158	-.301	-.199	-.324	.573	-.708* [-.947,-.178]	1		
Incomp passes	-.187	.096	.314	.163	.627	-.148	-.102	-.424	.397	1	
Errors	.302	.292	-.105	-.422	-.245	-.100	.454	.080	-.217	-.087	1

* Significant correlation (p < .05)

Discussion

Previous work in applied sport contexts has demonstrated how the manipulation of key constraints can influence the actions and performance outcomes of individuals. This current study aimed to investigate the influence of manipulated constraints on actions, in unison with emotion intensity. Results revealed a range of differences highlighting the effectiveness of manipulating constraints across the session for both action and emotion variables.

Between team findings

Despite no statistical difference between teams in terms of goals scored, team 2 clearly won each game. Interestingly, in general, team 1 were found to complete more passes and thereby more touches (significantly in game 4 – 1^{st} half), while also committing more errors (significantly in game 1 – 1^{st} half). These findings highlight the different style of play adopted by each team, with team 2 completing less passes, but scoring more goals and recording fewer errors across most if not all periods of play (see Table 5.1 and Figure 5.2). Perception of difficulty (PoD) results revealed a significant difference following the 2^{nd} half of game 1 where team 1 again produced higher mean ratings of difficulty. This observation reflects the event of team 1 being outscored by 9 goals to 1 during this game.

SLEQ and Fulfilment subscale results between teams also revealed a number of statistically significant differences across various periods of game play. Team 2 participants were found to report higher scores for both total SLEQ and Fulfilment responses, suggesting that the dominance in goals scored was associated with enhanced intensity of emotions relating to fulfilment or achievement, given that this was the objective of the game. Therefore, it is important to note that despite no evidence of significant differences in goals scored, the overall SLEQ and Fulfilment subscale scores were able to distinguish between teams. Interestingly, team 2 reported higher (although not significantly) Pre session SLEQ and Fulfilment scores, and maintained higher relative scores throughout all periods of play. This is with the exception of a very slight mean deficit (Team 1= 2.85 ± 0.19: Team 2= 2.80 ± 0.85) in Fulfilment score following the 1st half of game 3 (1 second game). The initial difference in SLEQ score highlights individual differences in emotions experienced by members of the two teams. Perhaps the difference may have been less pronounced over the session if team 1 were more competitive in terms of goals scored in one or several halves of play. These findings have some important implications for practitioners such as teachers and coaches, and suggest that the traditional ways of selecting teams based on perceived performance ability alone may not be sufficient. As evidenced in this sample of participants, pre session emotion intensities suggested that one team were more emotionally engaged than the other. This information could be useful to a coach for the planning and design of future sessions as a means of manipulating balance (or imbalance) between teams.

Overall correlation findings

Pre-Game – Game 1 (1st half) SLEQ

Overall (i.e. both teams) correlation results for changes in z scores revealed a range of expected and unexpected findings. Contrasting changes in z scores from pre-game observations with those following the first half of game 1 reveals significant positive correlations between Fulfilment – Enjoyment, and Anger – Nervousness (Table 5.2). These results were largely expected given that these subscales broadly represent positive and negative items respectively, and would be anticipated to fluctuate in unison (Diener, et al., 1985). Interpreting these findings in relation to the session indicates that participants who experienced increased fulfilment also experienced a higher intensity of enjoyment. Conversely participants experiencing elevated intensities of anger also reported increased nervousness intensities. These correlational results provide implications for practitioners in terms of ensuring that individuals experience some success (i.e. Fulfilment subscale) during a session, as it appears to be strongly related to enjoyment. To meet the challenge of ensuring individuals experience some level of success, individualised goals and objectives should be established providing the opportunity for competence to be displayed across various tasks and skill levels within the same activity or session (Chow, Davids, Button, & Renshaw, 2015; Renshaw, et al., 2012). Finally, at this stage of the session, none of the SLEQ subscales were strongly correlated with total SLEQ score.

Pre-Game – Game 4 (2nd half) SLEQ

Results presented in Table 5.3 compare correlations in the same variables (SLEQ scores) across the whole session, from pre-game to the 2^{nd} half of game 4. Once again a significant positive correlation between Enjoyment – Fulfilment is evident. Taking into account emotion intensities spanning the session, a significant negative correlation in z scores for Nervousness and Enjoyment is also present. This relationship would generally be expected given that the individual items comprising these two subscales on the whole represent contrasting experiences. For this set of results another significant positive correlation was observed between total SLEQ score and Anger, indicating that emotion items from this subscale (angry, frustrated, annoyed) were strongly linked with the overall emotional intensity of the session. Given the manipulation of constraints through this learning or training session was intended to challenge and perturb the action and emotion states of participants, the link between the Anger subscale and overall SLEQ score makes logical sense. These findings again provide key practical implications for practitioners in terms of recognising the increase in emotional intensity, and the primary subscale(s) attributing to this increase in intensity across the session. Therefore, a teacher or coach should take into account the possible changes in emotion intensities that may emerge as a result of changes in constraints, and how such emotion intensities may influence the actions of each individual.

Game 1 (1st half) – Game 1 (2nd half)

Table 5.4 reports correlation results comparing changes in z scores from the two halves of game 1, the original 3 second possession game. From this point on, the results also include changes in z scores for game events along with PoD and SLEQ results. For this comparison it can be seen that Anger – Enjoyment are again negatively correlated, while Nervousness is positively correlated with overall SLEQ score. This indicates that teams 1 and 2 might be experiencing higher intensities of items from the Nervousness subscale due to the pressure or stress of feeling the need to improve game performance (team 1) or maintain performance (team 2). At this stage of the session changes in Fulfilment were found to be negatively correlated with goals suggesting that participants in general did not solely base their perception of fulfilment (success, achievement etc.) on scoring goals. This may have been due to a mismatch in teams, resulting in a game that was not particularly engaging or fulfilling (i.e. goals scored became inconsequential). These findings relate to the *challenge point framework* where effective learning environments are considered to include ‘optimal’ amounts of information to both challenge and engage individuals in the learning process (Guadagnoli & Lee, 2004). In relation to goals, these results also reveal that complete passes (positively) and errors (negatively) were significantly correlated with changes in scoring. Overall these links seemed to have face validity, however, as discussed earlier team 1 tended to complete more passes and score fewer goals than team 2.

Game 1 (2nd half) – Game 2 (1st half)

Correlations for changes to z scores from the second half of game 1 and the first half of game 2 (2 second game) are presented in Table 5.5. Significant correlations were observed for Fulfilment - Enjoyment (positive), Anger – Enjoyment (negative), and Anger – Fulfilment (negative). Of note for this comparison is the finding that the change in z score for goals was significantly correlated with Enjoyment, Fulfilment (both positively), and Anger (negatively) providing evidence to suggest that goals were strongly linked with the emotions experienced by participants. As a possible consequence of the manipulation to task constraints within this comparison (3 second – to – 2 second) errors and PoD were also found to correlate positively at a statistically significant level.

Game 2 (1st half) – Game 2 (2nd half)

Comparisons between the two halves of game 2 (2 second game – Table 5.6) once again reveal significant correlations between Fulfilment – Enjoyment (positive), and Anger – Enjoyment (negative). Changes in z scores for incomplete passes and touches were also found to correlate significantly and positively between the two halves. This observation corresponds with both teams reducing the number of touches and by association incomplete passes from the first to second half, implying that the participants may have become more accustomed to the change in constraints during the second half.

Game 2 (2nd half) – Game 3 (1st half)

Similar correlations between Fulfilment – Enjoyment, and Anger – Enjoyment were observed during the next comparison involving the second half of game 2 and the first half of game 3 (1 second game). As with previous results during the change from game 1 – to – game 2, a significant negative correlation between Anger – Fulfilment is again reported (Table 5.7). This finding indicates that the change in the temporal constraint resulted in increased intensities of anger and frustration along with decreased fulfilment for some participants, in this case team 2. Team 1 represented the opposite trend with increased intensities of items on the Fulfilment subscale and decreases for items on the Anger subscale. As anticipated, the change to the 1 second game brought about several other linked changes in game events. Changes in z scores for goals scored correlated positively with touches, incomplete passes, and errors suggesting that participants were forced to change their style of play in order to maintain or increase their goal scoring frequency. Positive relationships with incomplete passes and errors in particular indicate that participants were willing to make more mistakes for each goal scored. This is further supported by the significant positive correlation between incomplete passes and touches. Finally, the change in errors and complete passes were negatively correlated which is no surprise given the change in constraints and the requirement to complete passes in order to score a goal.

Game 3 (1st half) – Game 3 (2nd half)

Changes in z scores following each of the halves during game 3 revealed both Enjoyment and Fulfilment subscales to be significantly correlated to the three other subscales and total SLEQ score (Table 5.8). As observed on previous occasions Enjoyment correlated with Anger and Nervousness negatively, and Fulfilment positively. The same trends were observed for Fulfilment between the respective subscales. Total SLEQ score was positively correlated with both Enjoyment and Fulfilment subscales providing evidence to suggest that the constraint of 1 second possession time influenced overall emotional engagement by means of how intensely participants experienced items relating to enjoyment and fulfilment. Perception of difficulty ratings were observed to negatively correlate with both total SLEQ score and incomplete passes again reflecting the influence of the 1 second task constraint. Overall changes in the frequency of incomplete passes were also significantly correlated with touches (positively) and errors (negatively).

Game 3 (2^{nd} half) – Game 4 (1^{st} half)

Transitioning from the 1 second game (game 3 – 2^{nd} half) back to the 3 second game (game 4) corresponded with a negative correlation between PoD and Fulfilment (Table 5.9). This can be interpreted as reflecting the perceived decrease in difficulty as a result of the longer time permitted for possession of the ball. As discussed earlier, the first half of game 4 saw significant differences between teams in terms of more touches and completed passes for team 1, while team 2 recorded higher scores for Fulfilment and total SLEQ. These results suggest that returning to the original constraints of the 3 second game produced a range of team and individual specific changes, including an immediate increase (though not statistically significant) in goals scored for both teams. During this period of the session several significant interactions were also observed between SLEQ subscales and game events. Enjoyment negatively correlated with complete passes suggesting that an increased number of passes does not necessarily relate to increased intensities of items such as happy and excited. Changes in z scores for incomplete passes were also found to correlate positively with both Nervousness and Anger. This finding suggests that incomplete passes were potentially considered more influential than errors (drops, rule violations) in terms of elevated intensities of items such as frustrated, pressure, annoyed and stressed.

Game 4 (1st half) – Game 4 (2nd half)

Interpreting results between the two halves of game 4 reveals that errors were negatively correlated with Enjoyment and complete passes which was to be expected (Table 5.10). Fulfilment was found to be positively linked with total SLEQ score and negatively correlated with PoD. These findings suggest that returning to the 3 second constraint in game 4 led to many participants experiencing increased intensities of items relating to Fulfilment as a consequence of decreases in perceived difficulty. Changes in the number of touches were also linked to PoD positively indicating that participants may have considered an increased number of passes to elevate difficulty perceptions. Finally, goals and SLEQ were found to be negatively correlated, again indicating that an increased number of goals scored did not necessarily reflect the emotional engagement of participants, whether positively or negatively valenced as discussed previously.

Game 1 (1st half) – Game 4 (2nd half)

The final set of correlation results presented in Table 5.11 concerns the change in observed variables from the first half of game 1 through to the second half of game 4. Therefore, these results reflect change in z scores across the session encompassing the manipulation of the identified task constraint. For this comparison Fulfilment – Enjoyment were again positively correlated, while PoD was negatively correlated with both of these SLEQ subscales. These findings appear quite intuitive and indicate that the manipulation of constraints during the session may have led to participants reporting higher intensities of Enjoyment and Fulfilment in unison.

Contrasting decreases to PoD ratings also suggest that the constraint of 3 seconds possession time was less challenging or demanding for participants after experiencing both 2 and 1 second manipulations. As noted during previous comparisons the change in complete passes was found to negatively correlate with goals scored. This implies that an increased number of complete passes was not imperative for goal scoring, hinting at the notion of quality passes over pure quantity.

Implications

From a theoretical perspective these findings support the intertwined relationship between emotions, and action as modelled and conceptualised earlier (Headrick, et al., 2015; Lewis, 2004; Lewis & Todd, 2005). Following systematic manipulations of constraints across the four games, changes in emotion and action measures were observed, indicating that the participants were forced into periods of metastability (Hristovski, et al., 2009; Kelso, 2012; Pinder, et al., 2012). During these periods (e.g. the transition from the 3-to-2 second game) the players could be considered to have self-organised their actions and emotions in an attempt to be functional in relation to the new task demands (Hristovski, Davids, Passos, & Araújo, 2012).

This preliminary investigation of emotion and action relationships in sport has exemplified the effectiveness of the SLEQ as a tool for recording emotion intensity at various time points. The design of the SLEQ provided the opportunity to gauge the response of players following each half of play, all of which had the potential to correspond with changes in emotion. In tandem with notational analysis of key game events the SLEQ provided rich information that a coach, teacher, or sport practitioner could use in evaluating the effectiveness of skill development or game play interventions on account of emotional engagement and physical performance characteristics.

Limitations and future research

An acknowledgeable limitation of this investigation was the small sample of participants and the data collection period being limited to one class. However, when reflecting on the findings of this investigation of eight participants, the richness of the data provides justification for further research to focus on in-depth analyses of small groups rather than striving for 'statistical power' in the form of mass cohorts of participants. This approach would be particularly beneficial for intervention studies with elite sporting populations where by definition, large samples sizes are not attainable (Pinder, Headrick, & Oudejans, 2015). A single lesson could be considered representative of short time scales of learning, however, in order to strengthen the findings a longer time scale project would be required, tracking the key emotion and action variables through several consecutive classes or sessions typical of school physical education programmes. The method of collecting game event data also had its limitations (particularly for individual participant results) given that all recording was completed 'live' as part of the class project. Subsequent investigations would benefit from the use of video footage documenting each constraints manipulation for later analysis. This would allow a more in-depth analysis of performance, for example, by affording analysis of passing strategies or patterns changed within and between games. The imbalance in Pre session SLEQ scores in favour of team 2 also provides some scope for future work in terms of attempting to pick or select teams that are closely matched in emotion intensity, rather than on perceived performance capabilities alone. Furthermore, due to the aim of evaluating the usefulness of the SLEQ in this study, the findings focussed on the

SLEQ and subscale scores along with game performances, and largely neglected the role of cognitions. Future studies should incorporate cognitions to examine the intertwined relationship between all three concepts to adopt a more holistic approach (see Applied case example B). Finally, despite the short time length of the games, the influence of fatigue must be recognised as a potentially confounding factor on game events and SLEQ scores.

Conclusion

In summary this preliminary study has demonstrated the practicality and effectiveness of the SLEQ for tracking emotion intensity over a select period of time. Interpreting SLEQ results with key game events provided initial, yet strong support for the principles of ALD in practice while also supporting the theoretical approach developed throughout the thesis.

Chapter 5: Applied case example B

Action, emotion, and cognition interactions during a cricket batting practice task

Abstract

This study adopts a single case design to investigate actions, emotions, and cognitions using the task vehicle of cricket batting. To effectively incorporate and observe the interaction between these variables an Affective Learning Design (ALD) approach was implemented. During a simulated game scenario, ball delivery speed was manipulated by systematically reducing the distance from which the bowler released the ball. Throughout the five manipulations in speed, a battery of measures were collected to observe interactions between actions (e.g. movement characteristics, performance outcomes), emotions (intensity using the SLEQ), and cognitions (confrontational interviews to establish intentions and goals). Findings revealed a range of interlinked relationships between variables, particularly when transitioning between delivery speeds (metastable regions). In particular, foot movement distances, Enjoyment subscale scores, perception of achievement ratings, and runs scored measures revealed interlinked tendencies. Therefore, this in-depth individualised investigation provides valuable implications for practitioners regarding the design and study of emergent behaviour during learning events in sport.

Introduction

The concept of Affective Learning Design (ALD), discussed extensively in the previous chapters, advocates for: (i) the design of emotion-laden learning experiences that effectively simulate the constraints of performance environments in sport; and (ii) recognising individualised emotional and coordination tendencies that are associated with different periods of learning (Headrick, et al., 2015; Pinder, et al., 2014; Renshaw, et al., 2014). The investigation discussed during this section incorporates both of these principles using a cricket batting task as vehicle to observe how the manipulation of task constraints influences actions, emotions, and cognitions throughout a targeted skill development task which was representative of a game situation.

In terms of creating emotion-laden learning experiences, previous work has largely focussed on the advantages to learning outcomes when training under pressure and the constraints of induced performance anxiety in a range of tasks (Oudejans, 2008; Oudejans & Nieuwenhuys, 2009; Oudejans & Pijpers, 2009, 2010). In several related investigations by these authors, participants training under the task constraint of induced anxiety were found to more successfully maintain their performance levels in high anxiety performance conditions, compared with those who trained in low anxiety conditions. These tasks included throwing darts when positioned at different heights from the ground (Oudejans & Pijpers, 2009, 2010), handgun shooting at cardboard targets versus live opponents with marking cartridges (Oudejans, 2008), and Basketball shooting with/without being watched and evaluated during practice sessions (Oudejans & Pijpers, 2009). Such findings have clear implications for how affective task constraints can be manipulated during learning or skill development tasks, reinforcing the importance of considering how behaviour and performance outcomes can be constrained by emotional and cognitive information.

A limitation of this previous body of work (and others) is that induced anxiety is the clear focus rather than affect or emotion overall. In order to monitor individualised emotion and cognition tendencies across various periods of learning, in unison with actions or performance outcomes, a more holistic approach is required. The previous chapters have detailed the targeted development and utility of the Sport Learning and Emotions Questionnaire (SLEQ) for tracking the emotional intensity or engagement of individuals over several time points. This tool provides an overall score for emotional intensity along with four distinct subscale scores for Enjoyment, Nervousness, Fulfilment, and Anger. The SLEQ has also been developed *within* sport contexts, for use *within* sport contexts, as opposed to many currently used tools that have been adapted from clinical based instruments. A suitable method for identifying cognitions alongside emotions is the use of confrontational interviewing techniques. This approach is based on an individual reviewing their own performance (often with guidance) to continuously identify key cognitive aspects relating to the situation (Gernigon, et al., 2004; von Cranach & Kalbermatten, 1982). Therefore, the use of targeted questioning can establish the thoughts, intentions, goals, and tactics of individuals to track how manipulations in constraints might alter responses over time (McPherson, 2008).

The task vehicle of batting in cricket has been studied previously from a variety of perspectives relating to the manipulation of constraints and information available to performers (for reviews see, Portus & Farrow, 2011; Stretch, Bartlett, & Davids, 2000). Examples include the manipulation of visual information through occlusion techniques (Müller & Abernethy, 2006), comparing the use of ball projection machines with live bowlers on batting actions (Pinder, Davids, et al., 2011a; Pinder, Renshaw, & Davids, 2009), and attunement to and the influence of using bats with different weight characteristics (Headrick, Renshaw, et al., 2012), to mention a few. Typically these studies have been conducted in situations not particularly representative of the demands and characteristics of match conditions at times due to the constraints imposed by data collection equipment / techniques and the need to 'control' the environment. This is reflective of many cricket batting sessions which are commonly carried out in practice nets with limited simulation or representation of situation specific information present in match conditions, such as score, field placements, and interaction with direct opponents (Pinder, Davids, et al., 2011b; Pinder, Renshaw, et al., 2011; Renshaw, Chow, et al., 2010).

This current investigation adopted a task design that sampled and selected many informational variables that would normally be present in a match situation. Key to the session design was the implementation of a game scenario generating dynamic contextual information that aimed to emotionally engage both the bowler and batter in an interpersonal contest, while also providing the opportunity to observe and collect various variables pertaining to actions, emotions, and cognitions. These characteristics reflect key principles and recommendations of ALD in applied sport settings in terms of incorporating and recognising the influence of affective constraints (Headrick, et al., 2015). Related conceptualisations in cricket have led to the development of coaching tools such as the 'battle zone', effectively a small-sided training game specific to cricket which represents key aspects of a game within a confined playing area (Renshaw, Chappell, et al., 2010; Vickery, Dascombe, Duffield, Kellet, & Portus, 2013).

The distinguishing feature of this current study is the systematic manipulation of simulated delivery speeds to examine any intertwined changes in actions (movements and performance outcomes), emotions (SLEQ scores), and cognitions (confrontational interview responses, and rating scales). Following previous findings it was expected that increased delivery speeds would result in adapted movement patterns, such as shorter front foot step lengths (Pinder, Davids, et al., 2011a; Renshaw, et al., 2007; Stretch, Buys, Du Toit, & Viljoen, 1998). Emotion scores were expected to increase in intensity as the session progressed reflecting the implementation of more challenging task demands. Cognitions were hypothesised to be related to ongoing perceptions of success or failure during the session as the situation of the game-like task changed. It was also envisaged that key variables representing each of actions, emotions, and cognitions would show interrelated tendencies at pivotal times during the session. This characteristic would indicate periods of metastability (see Chapters 2 and 3) where actions, emotions, and cognitions of the participant had been perturbed by the manipulation of task constraints.

Methods

Participant

The participant for this exploratory study was a 19 year old, male, cricket batter. In terms of ability, the participant was a top order batter who had represented Australia at U-19 level and was a junior-professional with an Australian State. Prior to data collection commencing the participant was provided with informed consent information, and written consent was obtained.

Procedure

Task design

The cricket batting task for this investigation required the participant (batter) to face 10 overs (6 deliveries each) from a known bowler of slightly lower playing standard (Club premier / 1st grade standard) with space-time incrementally manipulated to simulate faster deliveries (distance between batter and bowler manipulated). The bowler was selected on account of being familiar to the batter, which provided the opportunity to observe how manipulating space-time demands of deliveries might simulate a faster bowler, while retaining similar bowling action characteristics. This is typical of match and practice situations where a batter will be familiar with the bowler, the characteristics of their deliveries, and tactics. A known bowler of slightly lower standard to the batter was also preferred to address safety concerns given the manipulation in simulated delivery speeds. To further maximise safety the batter was required to wear full personal protective equipment at all times, and the bowler was specifically instructed not to bowl deliveries bouncing above chest height. However, the batter was not made aware of this instruction to ensure that the types of deliveries were not easily predictable.

Data collection was carried out at an indoor cricket net practice facility familiar to both the batter and bowler (synthetic grass). The design of the facility allowed the task to take place in a relatively open space (50m x 20m) when compared with traditional cricket nets. Both the bowler and batsman were instructed to perform in the context of the opening 10 overs of a one-day match (50 overs a side), assuming the roles of an opening bowler and batsman respectively (also their current team roles). Therefore, the batter aimed to score as quickly as possible without being dismissed, and the bowler aimed to restrict runs and ultimately get the batter out. To simulate match conditions an umpire was in position and the bowler had the opportunity to place fielders (in the form of small nets) in positions permitted during the opening 10 overs of a game (Renshaw & Davids, 2004). A regulation four-piece, white leather cricket ball was used throughout the session.

Task manipulation

In order to manipulate the space-time characteristics of deliveries, the length of the pitch was modified following every second over (5 sets of 2 overs). This involved systematically moving the popping crease line markings, stumps, and umpire closer to the batter according to predetermined distances equating to 5 km/h increments in delivery speed (Table 5.11). To determine the range of adjustments the normal delivery speed of the bowler was initially assessed with a sports radar gun (Stalker Radar, Texas) positioned on a tripod between the umpire and stumps. In this case the delivery speed of the bowler across 6 practice deliveries was found to be approximately 115 km/h (Mean = 115.5 ± .33 km/h). Therefore, the initial condition was set at ~115km/h off the full length pitch distance (popping crease – to – popping crease = 17.68 m). This base speed and distance was subsequently used to calculate the remaining task manipulations presented in Table 5.11, by matching the time available.

Table 5.11. Delivery speed calculations

		Delivery speed				
	km/h	**115**	**120**	**125**	**130**	**135**
	m/s	**31.94**	**33.33**	**34.72**	**36.11**	**37.50**
Full Pitch (0m)	Distance	17.68[a]	17.68	17.68	17.68	17.68
	Time	0.55[a]	0.53	0.51	0.49	0.47
0.25m	Distance	17.43	17.43	17.43	17.43	17.43
	Time	0.55	0.52	0.50	0.48	0.46
0.5m	Distance	17.18	17.18	17.18	17.18	17.18
	Time	0.54	0.52	0.49	0.48	0.46
0.75m	Distance	16.93[b]	16.93	16.93	16.93	16.93
	Time	0.53[b]	0.51	0.49	0.47	0.45
1m	Distance	16.68	16.68	16.68	16.68	16.68
	Time	0.52	0.50	0.48	0.46	0.44
1.25m	Distance	16.43[c]	16.43	16.43	16.43	16.43
	Time	0.51[c]	0.49	0.47	0.45	0.44
1.5m	Distance	16.18	16.18	16.18	16.18	16.18
	Time	0.51	0.49	0.47	0.45	0.43
1.75m	Distance	15.93	15.93	15.93	15.93	15.93
	Time	0.50	0.48	0.46	0.44	0.42
2m	Distance	15.68[d]	15.68[e]	15.68	15.68	15.68
	Time	0.49[d]	0.47[e]	0.45	0.43	0.42

Using the bowler's standard speed of 115 km/h the pitch length was manipulated by matching distance and time relationships to create the following conditions:

a) Set 1 (overs 1-2) Full pitch = simulated speed ~**115km/h**

b) Set 2 (overs 3-4) Pitch shortened by 0.75m = simulated speed **~120km/h**

c) Set 3 (overs 5-6) Pitch shortened by 1.25m = simulated speed **~125km/h**

d) Set 4 (overs 7-8) Pitch shortened by 2m = simulated speed **~130km/h**

e) Set 5 (over 9-10) Bowler asked to increase speed to ~ 120km/h - Pitch shortened by 2m = simulated speed **~135km/h**

The decision to cease shortening the pitch at 2m was made for safety reasons and the potential that ball bounce characteristics may become unrepresentative at closer distances. For each condition, the position of the popping crease was re-marked using tape and the stumps maintained at the regulation distance of 1.22m behind. The popping crease is a line marked at both ends of the pitch and some part of the bowler's front foot must land behind this line to constitute a legal (fair) delivery. The umpire and radar were also kept consistent and repositioned proportional to the change in pitch distance. Indicated speed from the radar gun was recorded for each delivery to determine how consistently the bowler was meeting the designated speed. Before each set (2 overs of 6 balls) the batter was made aware of any changes to pitch length, however, he was not explicitly made aware of the delivery speed being simulated.

Actions and performance outcomes

To capture the batter's physical actions in terms of movement characteristics and cricket specific outcomes a range of measures were collected. Two-dimensional kinematic movement data was recorded in order to obtain front-foot movement distances (toward or away from the bowler), and maximum bat lift heights following previous work (Headrick, Renshaw, et al., 2012; Pinder, et al., 2012). To capture these events a high speed camera (Casio EXILIM Pro EX-F1: 300 FPS) was positioned 11m perpendicular to the plane of action in line with the popping crease at the batter's end following previous procedures and recommendations (Bartlett, 2007; Headrick, Renshaw, et al., 2012; Pinder, Davids, et al., 2011a). Key events were analysed using Kinovea 2D motion analysis software (version 8.15). A second camera (Basler Ace: 300FPS) was positioned to capture the batter front on, looking over the top of the bowler and umpire. This camera was elevated 4.33m above the ground and 47.2m from the popping crease at the batter's end. Footage from this camera was used to review ball bounce (line/length), shot type and ball direction in unison with the side-on footage.

A validated measure of bat-ball contact, Quality of contact (QoC, Müller & Abernethy, 2008), was completed post session by three members of the research team (Australian level 1-3 accredited coaches) to determine whether contact was considered: 2 = Good; 1 = Poor; or 0 = no contact. A subjective measure of Forcefulness of Bat-swing (FoBS, Mann, Abernethy, & Farrow, 2010) was also completed to give an indication of the intent involved in each shot (Pinder, et al., 2012). This measure (originally: 2 = high; 1 = moderate; and 0 = low forcefulness) was somewhat modified to better account for different types of bat swing characteristics and was scored on a scale of 0 - 4: 0 = leave/no bat swing; 1 = defensive shot; 2 = 'checked' shot; 3 = incomplete swing; 4 = full swing. Both of these subjective measures provided some description of the shots performed, but were not considered primary variables for analysis. Inter-observer reliability was performed on all 60 trials for both QoC and FoBS. Correlations were strong between all three observers for both QoC (Observer 1-2, r = .82; 1-3, r = .81; 2-3, r = .88), and FoBS (Observer 1-2, r = .88; 1-3, r = .90; 2-3, r = .96). Runs (0s, 1s, 2s, 3s or 4s) were recorded live by the research team with input from the batter and bowler. Where disagreements between the batter and bowler could not be resolved, the research team made the ultimate decision. This occurred on only two occasions during the session. Observations of shot type and direction were recorded live during the session and later confirmed via reviews of the footage.

Emotions

In order to determine any emotional changes resulting from the manipulation in delivery speeds the Sport Learning and Emotions Questionnaire (SLEQ) was employed. The SLEQ was completed prior to the session and following each of the ten overs bowled. The Positive and Negative Affective Schedule (Watson, et al., 1988) was also completed prior to and following the session as a comparative measure of emotions. Both of these tools were implemented by the same member of the research team.

Cognitions

As a simple measure of how fast the batter considered deliveries in an over a 'Perception of Speed scale' was presented. This scale ranged from 0 – 10 and included labels commonly associated with cricket delivery speeds to accompany the batter's rating (see Appendix F). Following each of the 10 overs, the batter was also asked a set of targeted questions inquiring into his thoughts regarding the previous and upcoming overs where relevant (Gernigon, et al., 2004; McPherson & MacMahon, 2008). Further questioning about the session overall took place following the completion of the 10 overs. The audio of these questions and answers was recorded and transcribed for later reference (see Appendix G). Following initial inspection of these responses a 'Perception of Achievement' scale was devised based on responses to the first question "Who do you think won that over, yourself or the bowler?" Responses to this question were found to lend themselves to 5 point scale as follows: 1 – Him (i.e. bowler); 2 – Probably him; 3 – Even; 4 – Probably me; 5 – Me (i.e. batter).

Analysis

Actual delivery speed (regardless of pitch length manipulation) was monitored throughout the session to determine how consistent the bowler was in meeting the designated speeds. All emotion and action results were collated by the research team and entered into spreadsheets for initial analysis and inspection of possible patterns or trends in data. One-way ANOVA tests were then performed to identify statistically significant differences for action variables across the 10 overs. The same method was used to compare values for these variables across the six balls of each over (i.e. ball 1 versus ball 5). Brown-Forsythe statistics were reported if homogeneity of variance was violated. Effect sizes were also calculated to accompany all ANOVAs using omega (ω), with the following classifications: small = 0.10; medium = 0.30; large = 0.50) (Field, 2013). Key action variables are as follows:

- 1st foot movement: Two-dimensional distance of the first front foot movement towards or away from the direction of the bowler relative to the batter's stance/ready position. This movement was found to be an individualised tendency of the batter.
- 2nd foot movement: Distance from the position of the 1st foot movement to the position when the shot was completed.
- Total foot movement: Absolute movement distance of the front foot (1st and 2nd combined) during the shot.
- Bat lift height: Maximum height reached by the toe end of the bat during the back lift/swing measured from the ground.
- Runs: Runs scored per over or ball number as judged by the research team in consultation with both batter and bowler.

Perception of speed, emotion (SLEQ and subscales), foot movements, bat lift height, runs scored, and perception of achievement for each over were all transformed to z scores as a method for determining any linked changes between variables across the session. Change in z scores were then subjected to a correlation (Pearson's correlation coefficient, *r*) analysis to determine any relationship between SLEQ scores and movement/performance variables following the manipulations to task constraints (alpha < .05, 95% confidence intervals).

Cognition results from the brief confrontational questions were transcribed and tabulated for each respective over. Given the exploratory nature of this single case study, the question and answer responses were not subjected to full qualitative analysis. Key aspects of these short responses were, however, included with other results (including QoC, FoBS, shot type, and direction) to create an over-by-over summary of how the innings progressed to provide an overview of how emotions, cognitions and actions interacted.

Results

During the first four sets (8 overs) the bowler was found to be very consistent in meeting the target speed of ~ 115km/h: Set 1 (115.08 ± 1.08 km/h); Set 2 (114.5 ± 1.24 km/h); Set 3 (113.33 ± 2.64 km/h); Set 4 (114.58 ± 1.88 km/h). However, the target of ~ 120km/h in Set 5 proved to be a challenge (112.92 ± 1.88 km/h) with deliveries ranging from 110 – 116km/h. Despite the target speed not being met this set remained part of the study given the richness of action, emotion and cognition findings reported in following sections in relation to the simulated contest between batter and bowler.

Over comparisons

Comparisons of action and movement results between the 10 overs revealed statistically different findings for both 2nd foot movement ($F_{9, 35} = 2.71$, $p < .05$, $\omega = .42$) and total foot movement ($F_{9, 21.68} = 2.55$, $p < .05$, $\omega = .40$). Post Hoc

Bonferroni comparisons revealed overs 7 and 9 to be significantly different for both variables: 2nd foot movement (over 7 = 7.71 ± 6.03 cm; over 9 = 66.54 ± 35.05 cm, $p < .05$), total foot movement (over 7 = 20.78 ± 12.60 cm; over 9 = 75.04 ± 47.03 cm, $p < .05$). Figure 5.4 presents total foot movement for each over alongside SLEQ, and total runs scored. The three remaining variables: 1st foot movement ($F_{9, 16.73} = .625$, $p > .05$, ω =.22); bat lift height ($F_{9, 24.79} = .581$, $p > .05$, ω =.24); and runs ($F_{9, 32.16} = 1.93$, $p > .05$, ω =.32) revealed no significant differences.

Ball number comparisons

Comparison for balls 1 – 6 revealed no significant differences in any of the specified variables: 1st foot movement ($F_{5, 26.09} = 1.70$, $p > .05$, ω =.28); 2nd foot movement ($F_{5, 36.66} = 1.35$, $p > .05$, ω =.20); total foot movement ($F_{5, 54} = .45$, $p > .05$, ω =.27); bat lift height ($F_{5, 12.69} = .35$, $p > .05$, ω =.30); and runs ($F_{5, 54} = .67$, $p > .05$, ω =.21). Figure 5.6 displays the ball-by-ball results for runs scored and SLEQ scores prior to the session and following each over to visually illustrate run scoring patterns throughout the session.

Change in z score correlations

Change in z score correlation results for the session are presented in Table 5.12. Variables compared are the SLEQ and subscale scores (Enjoyment, Nervousness, Fulfilment, and Anger), perception of speed (PoS), perception of achievement (PoA), foot movement distances, bat lift height and runs scored per over. From these results it can again be observed that total foot movement and to a lesser extent 2nd foot movement distances correlated strongly with other variables from both action and emotion categories. Figure 5.5 visually represents trends between SLEQ subscale scores throughout the course of the session. PANAS scores/scales for positive and negative affect are also presented highlighting the increase in both scales across the duration of the session. Positive (26 – 31 = 16.13%) and negative (18 – 20 = 10.0%) affect increased between these two time points compared with total SLEQ (4.3 – 9.42 = 54.34%), Enjoyment (1.4 – 3 = 53.33%), Nervousness (1.5 – 2.75 = 45.45%), Fulfilment (1.4 – 3 = 53.33%), and Anger (0 – 0.67 = 100.0%).

Question and answer responses

Responses to the brief confrontational interviews following each over and the session overall are presented in full in Appendix G (p. 295), with selected key responses included in the set and over summary figures that follow.

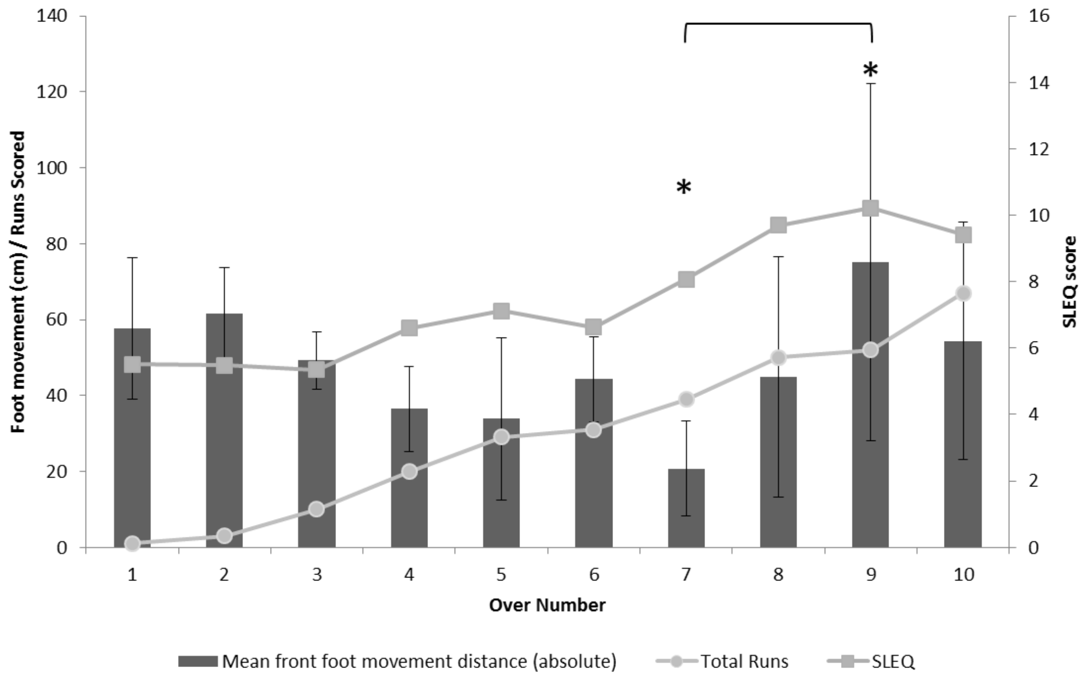


Figure 5.4. Mean (combined 1st and 2nd) foot movement, total runs, and SLEQ score throughout the 10 over session. * significant difference in foot movement (*p* <.05)

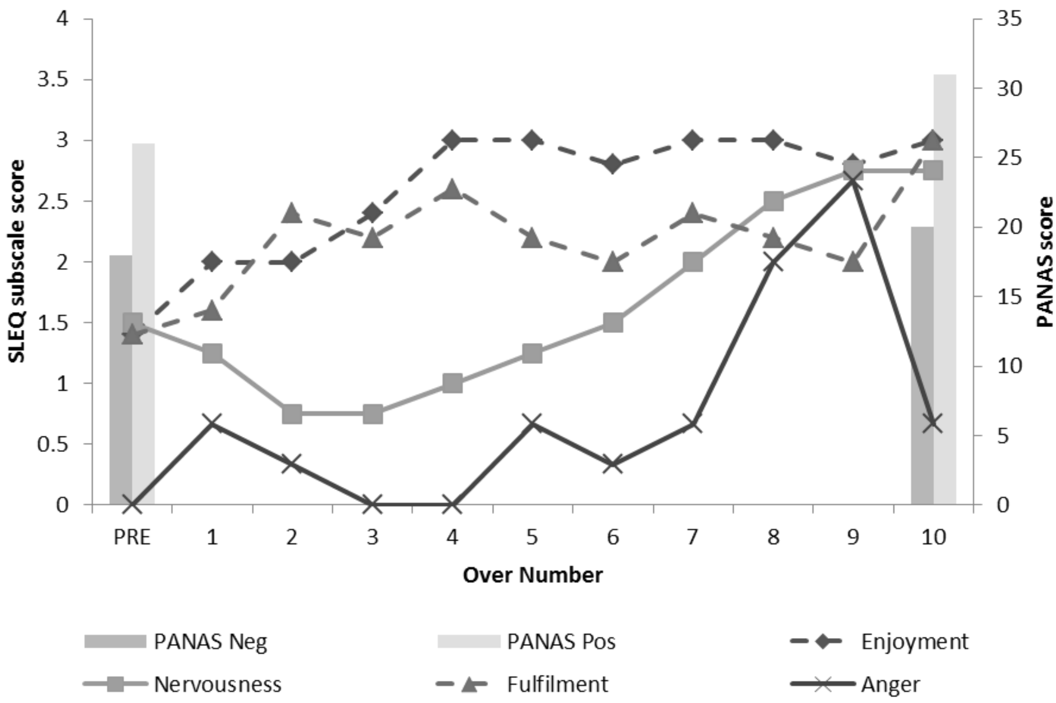


Figure 5.5. SLEQ subscale scores during the session and PANAS scores Pre and post (over 10) session.

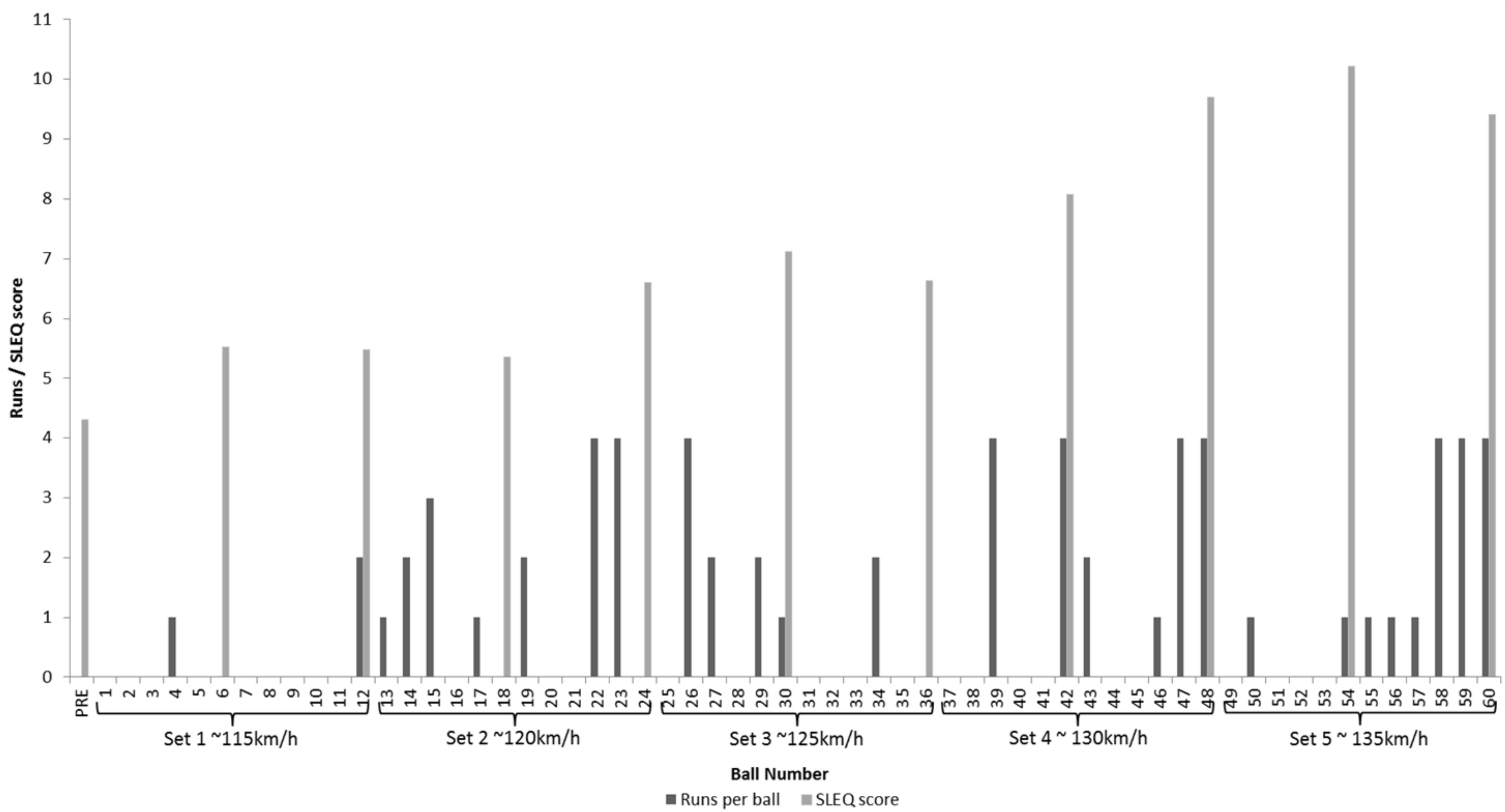


Figure 5.6. Ball-by-ball runs scored and SLEQ score at the end of each over

Table 5.12. Change in z score correlations for the session. * Significant correlation (*p* < .05)

	ENJ	NERV	FUL	ANG	SLEQ	PoS	PoA	1st foot move	2nd foot move	Total foot move	Bat lift height	Runs
ENJ	1											
NERV	-.026	1										
FUL	.336	-.509	1									
ANG	-.265	.541	-.696* [-.917,-.054]	1								
SLEQ	.207	.635	-.248	.789* [.386,.956]	1							
PoS	-.307	.231	-.471	.334	.074	1						
PoA	.365	-.341	.630	-.534	-.220	.158	1					
1st foot move	-.290	.175	.085	.385	.441	-.549	-.534	1				
2nd foot move	-.732* [-.934,-.430]	.056	-.644	.538	.003	.305	-.657	.273	1			
Tot foot move	-.718* [-.942,-.459]	.109	-.527	.578	.137	.025	-.722* [-.945,-.193]	.588	.928* [.762,.984]	1		
Bat lift height	-.130	-.069	-.064	-.106	-.217	-.216	-.616	.176	.276	.207	1	
Runs	.648	-.112	.634	-.522	-.037	-.019	.875* [.453,.979]	-.424	-.739* [-.931,-.300]	-.755* [-.969,-.292]	-.523	1

Over by over summary

The following pages (Figure 5.7 – 5.11) present a timeline of the session to illustrate how the contest between batter and bowler emerged over the course of the 10 manipulated overs. Each figure presents ball-by-ball and over summaries of the respective sets/pairs of overs. The specific type of cricket shots (e.g. BF – back foot; BFD – back foot defence; FFD – front foot defence) are listed alongside runs scored, QoC, and FoBS to provide a detailed description of each action. Visual representations (wagon wheel) of where each delivery was hit in relation to the batter's position, and how many runs were scored are also presented. Deliveries that were not played at, or missed by the batter were not included on the wagon wheels (Note: batter was left-handed – off-side = left of page; on / leg-side = right of page). Solid lines represent shots played with the batter's weight primarily on the front foot (moving towards the bowler - FF), and dashed lines represent back foot shots (away from the bowler - BF) (Stretch, et al., 2000; Woolmer, Noakes, & Moffett, 2008). In terms of the batter's cognitions, the over by over game plan was extracted from the interview transcripts to provide an indication of the strategy and intentions involved throughout the session.

Set	Over	Ball	Runs	Field setting	Shot type / outcome	QoC	FoBS	PoS	PoA	SLEQ	Game plan for next over
Set 1 **Full pitch ~115km/h**	**1** **Score 0/1**	1	0	3 slips – gulley – point – mid-off – mid-wicket – mid-on – fine leg *Batter to leg-stump guard*	Leave	0	0	6	2	5.52	"Probably leave a couple more and not force much. Just if there is a couple of bad balls just hit them"
		2	0		BFD	2	1				
		3	0		BF Play And Miss	0	4				
		4	1		BFD	2	1				
		5	0		BFD	2	1				
		6	0		BFD	1	3				
	2 **Score 0/3**	1	0	Changes = 0	Leave	0	0	6	4	5.48	"Just try and keep it the same"
		2	0		Off Drive	2	3				
		3	0		Sway / Leave	0	0				
		4	0		BFD	2	1				
		5	0		FFD	2	1				
		6	2		BF Punch	2	3				

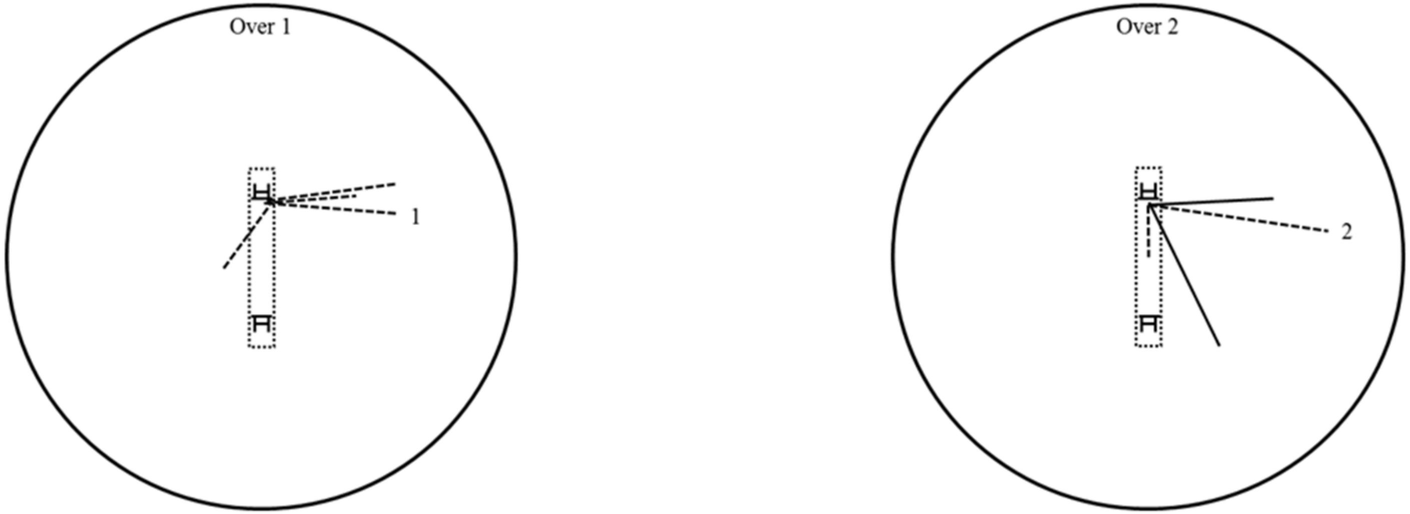


Figure 5.7. Set 1 (over 1 – 2) summary

Set	Over	Ball	Runs	Field setting	Shot type / outcome	QoC	FoBS	PoS	PoA	SLEQ	Game plan for next over
Set 2 **0.75m shorter pitch ~120km/h**	**3** **Score 0/10**	1	1	Changes = 1 3rd slip moved to extra cover	BFD	2	1	7	5	5.35	"Still the same, still try to keep it simple"
		2	2		BF Push	2	2				
		3	3		BF Push	2	3				
		4	0		BFD	1	1				
		5	1		BFD	2	1				
		6	0		Miss Hit Glance to Mid- Off	1	3				
	4 **Score 0/20**	1	2	Changes = 2 Mid-on moved closer – mid-wicket to 2nd cover (deeper) *Middle guard*	Leg Side Whip	2	3	6	4	6.60	"Probably be a bit more reserved in my onside play because he got a midwicket in now so I can't really risk playing across the line now too much"
		2	0		On Drive	2	3				
		3	0		Cover Drive	0	3				
		4	4		Cover Drive (Air)	1	4				
		5	4		Leg Side Whip	2	3				
		6	0		BFD	1	2				

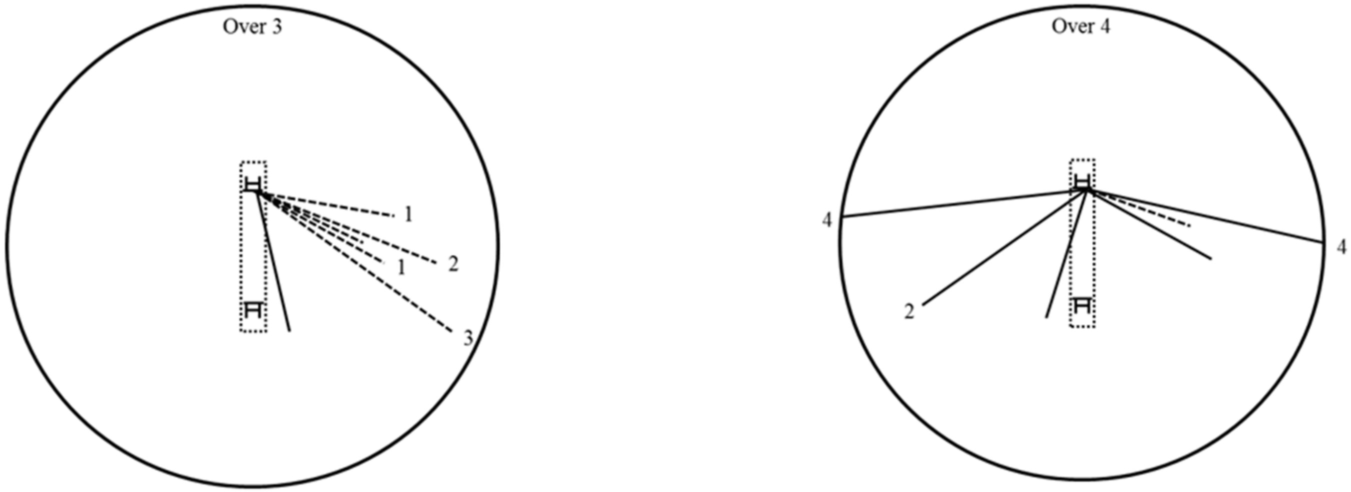
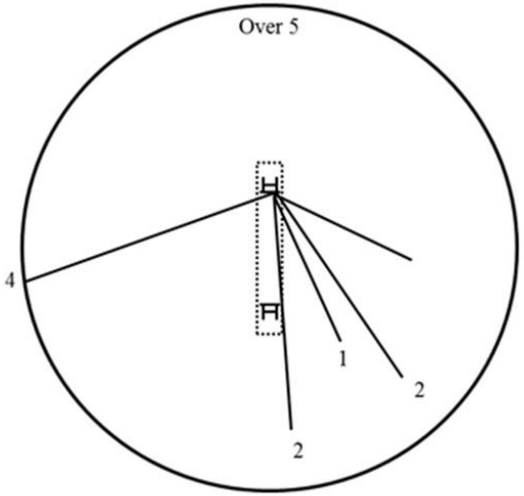


Figure 5.8. Set 2 (over 3 – 4) summary

Set	Over	Ball	Runs	Field setting	Shot type / outcome	QoC	FoBS	PoS	PoA	SLEQ	Game plan for next over
Set 3 1.25m shorter pitch ~125km/h	5 Score 0/29	1	0	Changes = 1 2nd slip moved to mid-wicket	Cover Drive - Push	2	3	7	5	7.12	"Stay the same. Keep trying to hit the gaps. If it's a bad ball, hit it"
		2	4		Leg Side Whip	2	3				
		3	2		Off Drive	2	3				
		4	0		Play And Miss	0	2				
		5	2		Straight Drive	2	3				
		6	1		Off Drive	2	2				
	6 Score 0/31	1	0	Changes = 1 Gap between cover and extra cover tightened	Leave	0	0	7	3	6.63	"Going to stay the same. If there is a bad ball, hit it. Try and get a single of it"
		2	0		Off Drive	2	2				
		3	0		BFD	2	1				
		4	2		Leg Side Whip	2	4				
		5	0		BFD	2	1				
		6	0		Cover Drive	1	4				



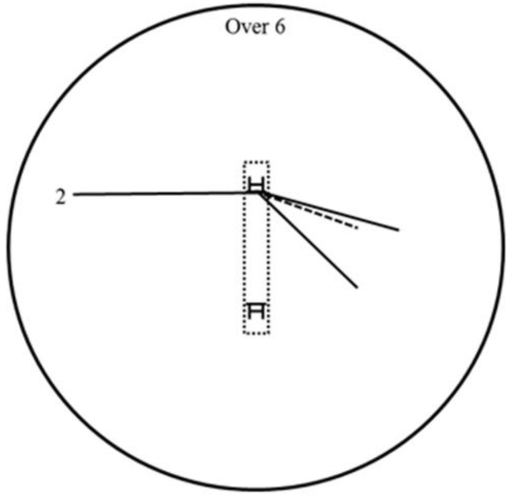


Figure 5.9. Set 3 (over 5 – 6) summary

Set	Over	Ball	Runs	Field setting	Shot type / outcome	QoC	FoBS	PoS	PoA	SLEQ	Game plan for next over
Set 4 2m shorter pitch ~130km/h	7 Score 0/39	1	0	Changes = 0	Off Drive	2	3	8	5	8.07	"Probably try and keep it the same that over, score a couple more runs and if the bad ball is there make sure I put it away"
		2	0		Straight Drive	1	3				
		3	4		Leg Side Whip	2	4				
		4	0		On Drive	2	3				
		5	0		Play And Miss	0	3				
		6	4		Leg Side Whip	2	3				
	8 Score 0/50	1	2	Changes = 3 Gulley to deep square leg – fine leg moved squarer – 1st slip moved to floating 2nd slip	BF Glide - Gully	2	1	8.5	5	9.70	"Probably stay the same, still try to attack him a bit more"
		2	0		Off Drive	1	2				
		3	0		Leg Byes – Fine Leg	0	3				
		4	1		Off Drive	2	4				
		5	4		BF Through Slips	2	3				
		6	4		Straight Drive	1	4				

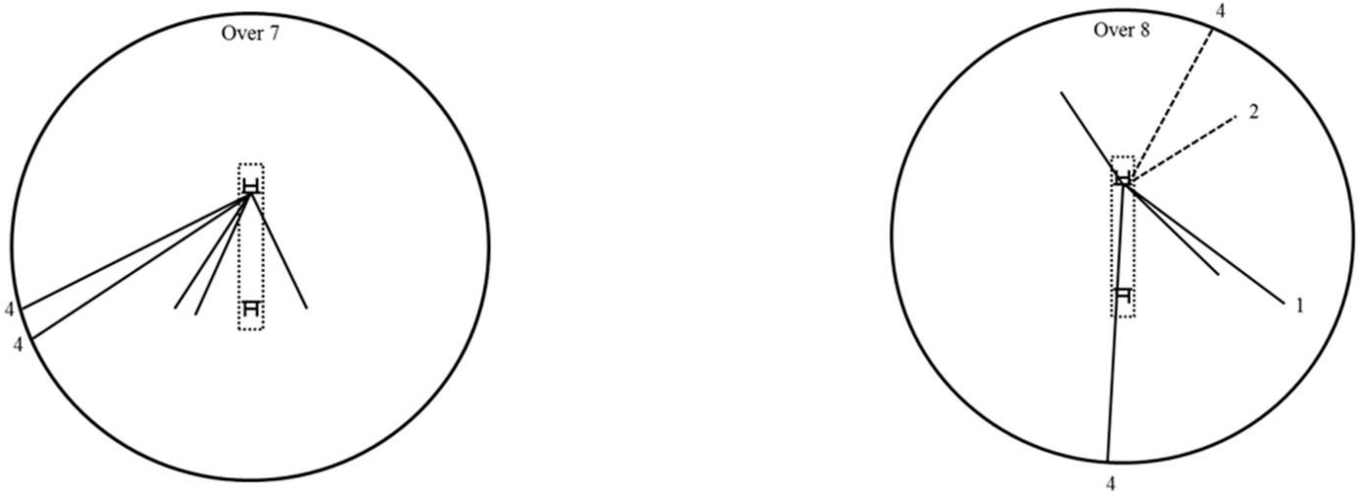


Figure 5.10. Set 4 (over 7 – 8) summary

Set	Over	Ball	Runs	Field setting	Shot type / outcome	QoC	FoBS	PoS	PoA	SLEQ	Game plan for next over
Set 5 2m shorter pitch 120km/h bowler ~135km/h (not achieved)	9 Score 0/52	1	0	Changes = 1 Slip moved to third man	BFD	2	1	9	1	10.22	"Might go a bit more reserved. Stay a bit more still and try access the ball from there"
		2	1		BF Leg Side Whip	2	4				
		3	0		Straight Drive	2	3				
		4	0		Cover Drive	2	3				
		5	0		BF Push	1	4				
		6	1		Edge To Fine Leg	1	4				
	10 Score 0/67	1	1	Changes = 0	Leg Side Whip	2	3	9	5	9.42	NA
		2	1		Leg Side Whip	2	4				
		3	1		BF - Leg Side Tuck	2	4				
		4	4		Leg Glance	1	3				
		5	4		Straight Drive	2	2				
		6	4		Cover Drive	2	4				

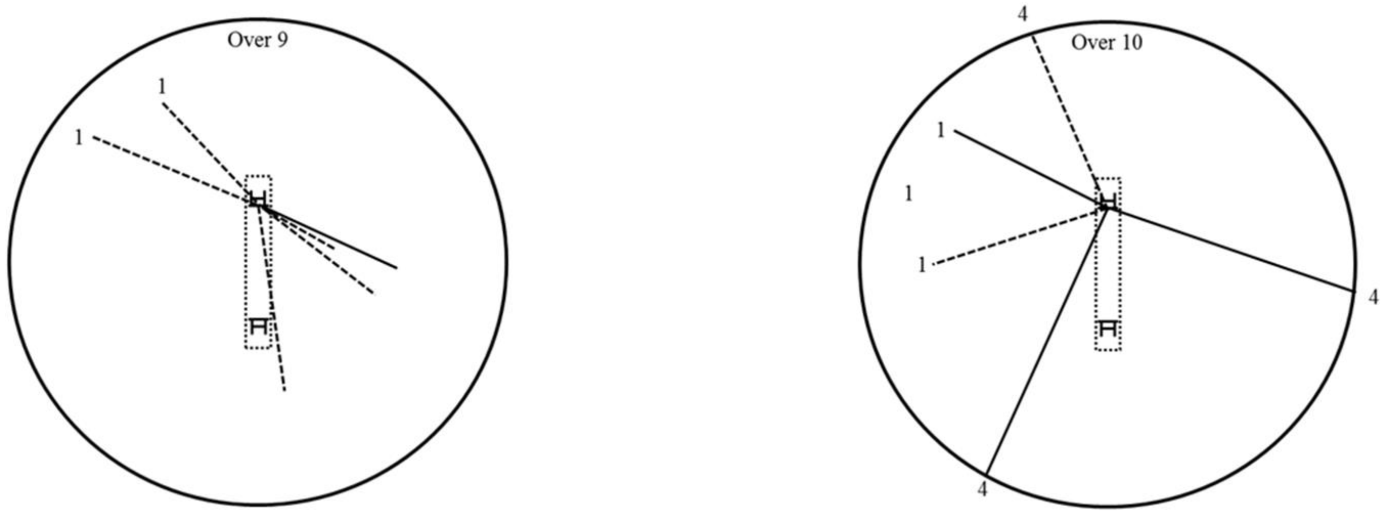


Figure 5.11. Set 5 (over 9 – 10) summary

Discussion

The aim of this chapter was to establish any potential links between actions, emotions, and cognitions when space-time constraints were manipulated in a game-based cricket batting task. Reviewing the results from the simulated practice game suggests that manipulation in delivery speed revealed observable dynamic changes in the intertwined relationship between SLEQ scores, cognitions (game plans, tactics), movement characteristics, and performance outcomes of the participant. Therefore, the holistic and representative nature of this situation specific learning / skills session provides evidence to support the concepts of Affective Learning Design (ALD), and Representative Learning Design (RLD) advocated throughout the previous and following chapters (Headrick, et al., 2015; Pinder, Davids, et al., 2011b; Renshaw, et al., 2014).

Action findings

From the 10 overs faced the batter was found to score 67 runs without being dismissed, which represents a more than satisfactory start to a one-day match innings (run rate of 6.7). Movement and performance outcome variables observed throughout the session provided several indications regarding the emergent behaviour of the batter following manipulations to task demands. Distances (forward or back) covered by the batter's front foot were found to vary significantly between overs 7 and 9 for both the 2nd foot movement and combined (1st and 2nd) movements. Over 7 was the first over of the simulated ~130km/h condition, which ultimately was the fastest speed replicated given the speed requirements during the final two over set were not met. Interestingly during over 8, the second over in the ~130km/h set, foot movements increased to an average distance comparable with overs from previous slower speed sets. Therefore, it can be concluded that during the initial exposure to this speed the batter adapted his actions to shorter front foot movements, likely due to the decreased time available to act in a functional manner (complete a successful shot) (Hristovski, Davids, Araújo, & Passos, 2011). Shorter foot movement distances could also be interpreted as the batter 'freezing' his degrees of freedom to maintain functionality (score runs) under the influence of perceived increases in task demands (Bernstein, 1967; Berthouze & Lungarella, 2004; Newell, Broderick, Deutsch, & Slifkin, 2003). From a cricket batting perspective, reducing the degrees of freedom signifies more compact, less extravagant movements, for the intention of scoring runs in a select few areas of the field, or simply surviving (i.e. not being dismissed). Furthermore the batter appeared to embrace system degeneracy, by continuing to exhibit functional performances despite observable changes in movement organisation (Edelman & Gally, 2001; Komar, Chow, Chollet, & Seifert, 2015; Pinder, et al., 2012).

The observation of foot movement distance increasing again during the second over at this speed (130km/h - over 8) indicates that the batter had adapted and attuned to the demands of the 'new' task, even within the space of 6 deliveries (Headrick, Renshaw, et al., 2012). Hence, it could be suggested that some of the previously 'frozen' degrees of freedom were released (Hong & Newell, 2006). This finding is supported by previous cricket batting research findings where step length changed as a result of manipulated constraints (Headrick, Renshaw, et al., 2012; Pinder, Davids, et al., 2011a; Pinder, et al., 2009). The absence of significant findings for first foot movement distance and bat lift height suggest that these movement characteristics were less susceptible to the influence of increased delivery speed. Both these characteristics could also be considered as consistent preparatory movements of the batter throughout the session (Woolmer, et al., 2008).

Emotion findings

Scores for total SLEQ and each of the subscales indicated that emotional intensity and/or engagement fluctuated during the session with a general trend of increasing scores. The trends of each subscale plotted in Figure 5.5 show that the positively orientated subscales of Enjoyment and Fulfilment tended to increase during the first two sets (~115km/h and ~120km/h) before plateauing for much of the remaining overs. Nervousness and Anger, the negatively orientated subscales, appeared to show a decreasing trend during the first 3 – 4 overs respectively before increasing to a peak at the end of over 9 (first over of intended ~135km/h condition). These reductions could be interpreted as the batter becoming more attuned to his environment (Headrick, Renshaw, et al., 2012; Hristovski, et al., 2006; Oudejans, Michaels, & Bakker, 1997). Over 10 scores showed Nervousness and Anger to decrease (or at least stabilise) and both Enjoyment and Fulfilment increase, potentially as a result of the designated speed simulation not being reached. This implies that the batter (who was under the impression that speed would be increasing) might have perceived that the speed had not in fact increased from the previous set and adopted a previously stable (attractor) state of organisation accordingly (see Figure 5.4).

Comparisons with PANAS, a pre-established affect measurement scale, revealed clear similarities with SLEQ scores when considering Pre and Post session responses. PANAS scales for both positive and negative affect increased by 16% and 10% respectively, while SLEQ and individual subscale scores increased by at least 45% over the same time period. Returning to Figure 5.5 these trends can be observed, with the obvious limitation of only comparing Pre and Post measures is highlighted in terms of the fluctuation in SLEQ scores throughout the session. This point reinforces a key advantage of the SLEQ given that it was designed specifically to be completed multiple times during throughout a session in relation to a specified task or activity. Furthermore, as stated in Chapter 4 and by Jones et al. (2005), the PANAS was originally intended for use in daily living contexts and only considers the broad categories of positive and negative affect, rather than the four distinct subscales derived specifically for sport of the SLEQ. The SLEQ also differs in that it provides indication score of overall emotion intensity that indicates an individual's engagement with a task as opposed to separate scores corresponding with positive or negative affect. Therefore the SLEQ score reflects the importance of overall emotional engagement in a task rather than focussing on scores for individual emotions or contrasts between positive and negative orientations (Jarvilehto, 2000a, 2009; Lewis, 2004).

Cognition findings

The perception of speed (PoS) and perception of achievement (PoA) scales, derived to provide indications of how the batter rated the delivery speed (0-10) and winner of each over (1-5), also fluctuated following delivery speed manipulations (Figure 5.7 – 5.11). The batter's PoS ranged from a score of 6 (medium – fast) in the first set (~115km/h) through to 9 (express) in the final set of overs, which were intended to simulate deliveries of approximately 135km/h, but ultimately were closer to 130km/h as in set 4. Interestingly, the batter rated set 4 (overs 7 & 8) slightly slower at 8 – 8.5 (fast) than overs 9 & 10 in the final set, even though the delivery speed did not increase. Part of the reason for this difference may have been the safety requirement of informing the batter that the pitch was shortened and the bowler asked to bowl faster. Alternatively, the batter may have attuned to key bowling action or body language information which was perceived as pre-emptive of changes in delivery speed characteristics (Müller & Abernethy, 2012). Of further interest is the increased intensity of Fulfilment scores between overs 9 and 10. This suggests that even though the batter thought the deliveries were faster in this set, he attuned to key perceptual information and self-organised to exploit the constraints functionally (i.e. scored more runs in over 10 than over 9).

Perception of achievement ratings revealed that the batter believed he had competed successfully against the bowler for all overs apart from overs 1 and 9. During these overs 1 and 2 runs were scored respectively. However, in very different periods of the simulated game scenario. Over number 1 was the beginning of the game and therefore it would be expected (traditionally) that a batter shows some restraint as they begin to build an innings and become attuned to the bowler's actions and pitch characteristics. Over 9 was the first over of the final set, where the batter was anticipating an increase in speed from the previous set while also attempting to maintain the run-rate from a 50 over game perspective (see Figure 5.6). The final set also signalled the end of enforced field restrictions from a game context perspective. Referring to Figures 5.4 and 5.5 it can be seen that Anger and Nervousness subscales, along with overall SLEQ score peaked following over 9, while Fulfilment and Enjoyment decreased from the previous overs. The Anger scale (angry, frustrated, and annoyed) showed a substantial increase in intensity at this point, suggesting the batter had not met his own performance goals or expectations, thus reflecting the low PoA rating.

Combined findings

Bringing the action, emotion and cognition observation findings together provided an insight as to how these individual measures intertwined throughout the session. Correlations of changes in z scores are presented in Table 5.12 and show several strong (and significant) relationships. Moving from left-to-right, the first key relationship is that of Enjoyment with both 2nd foot movement, and total foot movement distances. These strong negative correlations indicate that shorter foot movements were linked strongly with higher intensity scores on the Enjoyment subscale. Therefore in this case shorter foot movements are not indicative of poor performance, instead suggesting an efficiency of movement for the intention of 'accessing' identified scoring zones through a shift in body weight (Woolmer, et al., 2008). In fact the highest Enjoyment scores were reported for overs 4, 5, 7, and 8 which also corresponded with the shortest average values for total foot movements (Figure 5.4). A strong negative relationship was also found between change in Fulfilment and Anger scores, which seems quite logical given the opposing trends in these scores particularly between overs 8 and 9 as discussed previously. Building on this point is the strong positive correlation between the Anger subscale and total SLEQ score for the session. This relationship implies that an increase in SLEQ score was often accompanied by an increase in scores for the items in the Anger subscale (angry, frustrated, and annoyed). Together these relationships indicate how emotion intensities and actions can interact, which provides further support for principles advocated by ALD (Headrick, et al., 2015).

Additional correlations were found when contrasting changes in the cognition derived variable, perception of achievement, alongside runs scored, and total foot movement. A strong positive relationship was observed between PoA and runs scored which seems logical given the batter's overarching aim for the session was to score runs. The negative relationship between total foot movement and PoA indicates that when the batter believed he had won an over his total foot movement distance tended to be shorter. This notion is further supported by the next set of positive relationships between runs scored and both 2nd and total foot movements. Interpretation of these interactions suggests that overs where more runs were scored also exhibited shorter foot movements. Finally, as would be expected from earlier findings the positive interaction between 2nd and total foot movement variables was also very strong given that the 2nd foot movement contributed substantially to total movement.

Therefore an indirect finding from these correlation results is as follows; Increased runs linked with increased PoA → increased PoA corresponded with decreased total foot movement → decreased total foot movement corresponded with increased enjoyment (and vice versa). This synchronisation between variables representing action (runs, total foot movement), emotions (Enjoyment), and cognitions (PoA) further supports the integration of ALD principles (specifically principle ii) into learning environments in sport. Understanding how observable variables such as these interact during learning events provides rich information for coaches, teachers, and practitioners regarding the influence of manipulated constraints on the emergent behaviour of an individual (Pinder, et al., 2015). Consequently, these findings highlight the need for coaches to include situational information (affective constraints) that specifies a particular context in a match or competition setting, and attempt to monitor the emergent behaviour from a holistic approach, not restricted to outcomes or physical observations (Headrick, et al., 2015; Renshaw, et al., 2009).

Over by over summaries

The cricket specific information presented in Figures 5.7 – 5.11 provides a detailed description of how the simulated game progressed throughout the session. Of particular interest is how the range and type of shots played develops over the course of the session. The initial 2 – 3 overs revealed a restricted range of shots (mostly Back foot defence) concentrated between the positions of point and mid-off, and scoring few runs ('building an innings', see Woolmer, et al., 2008). As the session continued the range of shots expanded with the exception of over 6 and 9 where the batter also indicated the over was equal, or won by the bowler respectively. The expansion of shots and run scoring culminated with over 10 where each of the 6 balls were scored off including three boundaries (4s) to different areas of the field.

When revisiting previous results involving the significantly shorter total foot movement in over 7 compared with 9, it can be deduced that this tendency was functional for the aim of the batter for a number of reasons. Firstly, over 7 produced 8 runs (two boundaries) indicating that the batter did "hit the bad balls" as indicated in the game plan reported after over number 6. Following over 7, the bowler chose to make three changes to the field positions which would suggest his strategy was no longer deemed functional for his goals. This equates to the batter perturbing the state or balance of the game and forcing the bowler to explore other options (metastable period) (Hristovski, et al., 2009; Kelso, 1990, 2012). These ideas are further supported by the PoA score (5) for the over, indicating that the batter believed he won the over convincingly. The five shots where bat-ball contact was made during this over were also made on the front foot which implies that the batter was shifting his weight towards the bowler, but with relatively short (efficient and functional for the task) foot movements. These findings somewhat contradict previous cricket batting literature where longer front foot movement distances are considered to be preferred or "technically correct" (Woolmer, et al., 2008). Finally, all four SLEQ subscales, and therefore total SLEQ score, increased following this over indicating that the emotional engagement of the batter was further enhanced.

Reviewing the same observations for over 9 (highest average front foot movement) shows that only 2 runs were scored by the batter, and the game plan revolving around "try to attack him a bit more" was not executed well. This may have been a result of the 3 field changes made prior to over 8 perturbing the game plan of the batter and restoring some balance or stability between the two players as with interpersonal dynamics in sport research (e.g., Headrick, Davids, et al., 2012; Passos, et al., 2008). The PoA score (1) confirms that the batter believed the bowler had convincingly won the over. Thus, the findings from this over strongly support the consideration of SLEQ intensities alongside cognitive game plans to interpret how emotions link with the goals and objectives of a task. Five of the six shots in over number 9 were played from the back foot including the two scoring shots, which travelled to the same general area of the field. Overall SLEQ score for this over was the highest for the session with Anger and Nervousness subscales peaking, and Enjoyment and Fulfilment dropping off compared with previous overs. These findings indicate high overall emotional intensity was largely due to increased Anger (angry, frustrated, annoyed) and Nervousness (nervous, stressed, fear, pressure) scores. Finally the game plan in relation to over 10 reflects the batter's thoughts about the failure of his strategy with the previous over and his revised plan that he "Might go a bit more reserved. Stay a bit more still". This change in intentions or strategy appeared to be successful given that over 10 produced a session best of 15 runs.

Implications

Building on the theoretical implications from the Endball study (Example A) this more detailed individualised study provides further evidence of the critical relationship between action and emotion, along with cognition. By chronicling measures relating to each of these concepts in a representative cricket batting task the manipulation of space-time information was found to create periods indicative of system metastability (Hristovski, et al., 2009; Kelso, 2012). Incorporating principles of ALD into the task also provided the opportunity to observe the interpersonal battle between the batter and bowler due to the competition or game context simulated (Pinder, Davids, et al., 2011b). The sampling of information and match characteristics into this practice task was found to be very effective given that many of the batter's cognitions were very specific to the state of the game. On several occasions these cognitions (e.g. game plans from overs 7-9) were pre-emptive of fluctuations in emotion intensity, movement characteristics and performance outcomes reflecting self-organising tendencies of these distinct yet clearly interrelated measures.

Practical implications arising from this investigation again focus on the applicability of ALD principles to systematically manipulated sport environments (Headrick, et al., 2015). The inclusion of more detailed analysis techniques provided evidence of individual movement characteristics (i.e. foot movements) fluctuating alongside outcome based measures (runs, shot type) providing future scope for studying emergent behaviour at various scales of analysis. The SLEQ was again found to be highly effective in assessing the emotional engagement of the batter and compared well with a previously used scale in PANAS, particularly given that the SLEQ was suitable for tracking rich emotion responses throughout the simulated game. In terms of implications for cricket batting practice the design of this preliminary investigation appeared to be successful in implementing shorter pitch distances to simulate faster delivery speeds, while also maintaining an environment with sufficient contextual and situational information to engage both batter and bowler.

Limitations and future research

A potential limitation that must be acknowledged involves the manipulation of the pitch length to simulate different delivery speeds. As a result of decreasing the pitch length it can be assumed that the bowler was forced to release the ball later in the bowling action in order to bounce the ball at approximately the same length as when bowling from a full pitch distance. Therefore, based on previous work investigating the perception of information during interceptive actions (e.g. Müller & Abernethy, 2006; Pinder, Davids, et al., 2011a; Renshaw & Fairweather, 2000; Stone, Maynard, North, Panchuk, & Davids, 2015), the batter may have perceived the balls delivered from the reduced pitch lengths as short balls (i.e. balls normally played off the back foot on a full length pitch). As such the movement behaviour and shot choices displayed by the batter might have also been influenced by the delayed ball release point. However, despite the potentially confounding influence of this change in bowling action characteristics, the proportion of back foot shots played did not increase as pitch distance was reduced (see Figures 5.7 – 5.11). This suggests that the batter still anticipated, and crucially, was able to perceive and discriminate between either short or full deliveries as the pitch distance was shortened. Furthermore, the finding that front foot movement distance was on average longest during over 9 (i.e. fastest target delivery speed and equal shortest pitch distance) indicates that the batter was still attempting to play both front and back foot shots, rather than ‘camping’ on the back foot. Therefore, the manipulation of pitch length may have constrained critical bowling action characteristics that a batter attunes to. However, the role of simulated delivery speed and interlinked affective constraints should not be discounted as influences on movement behaviour and batting performance outcomes.

Reflecting on this study further there are some key considerations that could be incorporated in subsequent investigations. Firstly, in this case the bowler did not achieve the desired maximum delivery speed and therefore the last set of overs was somewhat compromised even though some key findings were evident during this period of the session. Next, if the study was to be repeated the actions, emotions, and cognitions of the bowler should also be collected to investigate perceptions, intentions, and emergent behaviours alongside those of the batter. Such measures would also be of great interest in relation to the above discussion about changes in bowling action characteristics respective to the length of the pitch. The requirement of the bowler to consistently meet designated speed and length (not bounce above chest height) requirements also has the potential to eliminate tactical deliveries such as slower/off pace balls, cutters, and bouncers. Incorporating these refinements, future work should look to study a range of batter – bowler combinations to examine the effectiveness of this approach for different skill levels, ages, and playing styles (e.g. spin bowlers, lower order batters). Finally the possibility of completing this task outdoors on a ‘real’ grass cricket pitch and field should be explored to further enhance the simulation of a match scenario.

Conclusion

Overall using cricket as a task vehicle to explore the interaction between actions, emotions, and cognitions was successful in that several links between these categories of measures were observed as the batter was exposed to increased space-time demands following the manipulation of pitch length. Theoretical and practical implications indicate the effectiveness of an ALD approach for incorporating contextual information and affective constraints into learning tasks, and considering actions, emotions, and cognitions in unison when critiquing emergent behaviour in relation to performance goals. Furthermore, manipulation in space-time demands was found to be an effective method for studying changes in emotions and linked emergent behaviour characteristics in a cricket batting task.

Chapter 6: A conceptual model of affective learning design

The previous chapters have discussed the theoretical underpinnings of Affective Learning Design and provided two examples of how ALD principles can be adopted in sport settings. By incorporating these ideas and findings the following chapter proposes a conceptual model of ALD that intends to provide coaches, teachers, and sport practitioners with a theory driven framework for applying these principles.

Abstract

Successful learning and practice environments should effectively represent and sample information that is present in the simulated performance environment; therefore, acknowledging the relationship between an individual and the environment is imperative. The influence of affect in learning design is often neglected or suppressed because it is perceived as a source of unwanted variability. Here it is argued that a principled integration of emotion in learning experiences should be embraced and considered as an integral component of designing representative learning tasks. By adopting an ecological dynamics approach a holistic model of 'Affective Learning Design' that embraces the role of affect (emotion) in the design and implementation of learning tasks is proposed. To support the conceptual model, two applied examples are discussed providing practical insights into each of the key model phases. Therefore, this model provides implications for the practical application of affective learning design principles in practice and future research, recognising the interaction between affect, behaviour, and cognition across different time scales of analysis.

Introduction

Learning is an inherently emotional experience where an individual must frequently deal with success, failure and associated physical and psychological challenges (Davids, 2012; Pinder, et al., 2014; Seifert, Button, et al., 2013). For example, the experiences of learning to walk, read or drive a car are everyday activities that pose unique challenges for individuals at different stages of life (Dolan, 2002). In the case of sport, recognising the role of emotion during periods of learning is essential to understand the manner in which individual athletes perceive and act in specific environments. Australian Test cricketer Ed Cowan (2011, p. 11) described the process of learning to hit boundary shots (for T20 games) as an experience that involved dealing with the emotions of initial inadequacy and a fear of failure even though he was an experienced professional cricketer. Each individual arrives at a learning experience with specific capabilities that must be modified or adapted in order to meet the demands of the new task (Kelso, 2003; Schöner, et al., 1992). Therefore, designing learning experiences must adopt an individualised approach and consider concepts including perception, intentions, attention, actions, cognitions, and emotions (Davids, 2012; Kelso, 2003).

Why it is important to consider emotion in learning

Historically, much like movement variability, emotion during learning (and performance) has often been considered as unwanted noise (Davids, et al., 2003; Seifert & Davids, 2012; Smith & Thelen, 2003). Therefore, sport scientists, teachers, and coaches often attempt to remove or suppress emotion from learning and experimental environments to facilitate controlled and predictable behaviour (de Weerth & van Gert, 2000). Suppressing emotions during learning suggests a focus on manufacturing predictable performance outcomes rather than allowing individuals to explore the environment and learn from their own positive and negative experiences. By distancing emotions from learning, the role of individual differences in learning is also diminished, preventing individuals from establishing personalised behavioural characteristics in particular environments and situations (Davids, et al., 2003; Seifert & Davids, 2012). Furthermore, the role of emotion during learning has often been neglected because emotion-laden responses are considered irrational or instinctive, and therefore perceived as negative (Hutto, 2012; Lepper, 1994). Emotionless responses made from a purely rational perspective have been described as ‘cold cognition’, whereas emotion-laden responses are viewed as ‘hot cognition’ (Abelson, 1963; Lepper, 1994). The expression of ‘sit on your hands’ in relation to choosing a move in a game of chess is an example of the view that it is necessary to suppress or remove emotions in order to make rational decisions (i.e. cold cognition) (Charness, et al., 2004). Jarvilehto (2000a, p. 53) summarised this idea when writing that “emotion was regarded only as a factor bringing chaotic or irrational elements to the computational process”. Crucially in sporting contexts, learners are often not afforded this ‘thinking’ time and must act impulsively based on the interaction between their perceptions of the task and pre-existing physical, cognitive, and emotional capabilities (Davids, 2012).

Progress in understanding emotions has been limited by traditional cognitive thinking perpetuating the debate over the pre-eminence of cognition over emotion; where cognitions of events are thought to result in emotional reactions (Headrick, et al., 2015; Lewis & Granic, 2000; Renshaw, et al., 2014). These ideas highlight that this outdated reductionist approach to understanding emotions by cognitivists has hampered the ability to model relations between goals, emotions and emotion regulation (Lewis & Granic, 2000). However, some psychologists have recently begun to acknowledge the advantages of nonlinear dynamic systems in explaining behaviour and this has led to the emergence of a dynamical systems perspective of emotional development (Lewis, 1996; Lewis & Granic, 2000). Yet to be seen in the literature, however, is a principled exploration of the role of emotions during learning for sports performance.

Tasks that are emotion-laden are considered to facilitate a 'deeper' engagement for learning and performance (Jones, 2003; Solomon, 2008). Indeed, emotional engagement is seen as being essential for effective learning (Pessoa, 2011). Emotions should also be considered as part of learning experiences on account of the relationship between emotion, behaviour and cognition, which form a trichotomy of feeling, acting, and knowing respectively (Breckler, 1984; Hilgard, 1980). Behaviour not only encompasses overt actions which in their simplest form involve moving towards or away from an object, but also verbalisations about acting and intentions to act. Cognition has been conceptualised as the knowing of the object including thoughts, beliefs and perceptual reactions (Ajzen, 1989; Breckler, 1984; Hilgard, 1980).

While cognition and emotions are often treated as separate entities (Mathews & MacLeod, 1994; Pessoa, 2008; Schwarz, 2000), the three components of affect, behaviour and cognition have been shown to influence each other to form emergent appraisals of experiences (Frijda, 1993; Lewis, 1996). During the appraisal of an experience the interaction between cognition and emotion in particular is critical (Frijda, 1993). From this approach, cognition and emotion are considered to influence each other in a coupled feedback loop where cognitions bring about emotions, and emotions shape cognitions (Lewis, 2004). This cyclical interaction underpins the self-organisation of cognitive, emotional and perceptual aspects of experiences to form what Lewis describes as emotional interpretations (Lewis, 1996, 2000a). Emotional interpretations (EI) are stable attractor states that form when emotional and cognitive characteristics become linked or synchronised, and subsequently facilitate the emergence of an action tendency (behaviour) (Lewis, 2000a). For example, the observable differences in movement behaviour (completion time, exploratory movements) when induced anxiety was manipulated through wall climbing traverses of different heights (Pijpers, et al., 2005), or critical differences in movement patterns between expert and beginner ice climbers due to variations in individual constraints (i.e. intentions, perceptions - Seifert, Button, et al., 2013).

Evidence suggests that emotions are ‘triggered’ subconsciously before perceptions or cognitions, meaning that an appraisal of an experience cannot be completed without the influence of emotion (Jarvilehto, 2001; LeDoux, 2000; Lewis, 2000a). Emotional experiences are also considered to be vivid and memorable (Todd, et al., 2012), influential on attentional processes (Padmala & Pessoa, 2008; Pessoa, 2011), and associated with increased arousal (Anderson, et al., 2006). Consequently, emotions must always be considered as a primary influence or precursor of learning experiences (Jarvilehto, 2000a, 2001). The action tendencies, or physical behaviour, corresponding to emergent cognition-emotion interactions will subsequently set precedence for how an individual acts or functions in similar situations in the future (Lewis, 1997, 2000a, 2002).

The need for a principled integration of emotion into learning

Taking into account the previous conceptualisations, the under-estimated or even complete disregard of emotions, highlights the need for a theoretical framework that will enable an accurate and detailed description of emotional experiences in learning and performance (Hanin, 2007b; Headrick, et al., 2015; Vallerand & Blanchard, 2000). Previous work investigating emotions in relation to sport has largely focussed on a 'snapshot' of performance at one point in time. Studies such as those reviewed by Lane et al. (2012) typically present emotions as either positive (e.g. joy) or negative (e.g. fear) with respect to performance. With a broad and complex range of emotions isolated into two categories some emotions, often negatively orientated emotions, are considered dysfunctional for the performance of a given task (Jones, 2003). On the other hand, so called negative emotions have also been shown be beneficial to performance, and in some cases perceived positive emotions have been found to be detrimental to performance (Hanin, 2007a, 2010). The approach advocated here is that due to the dynamic emergence of emotions as individuals interact with learning tasks, any study of emotions should consider the learning experience holistically with affective constraints incorporated and emotions tracked throughout (Headrick, et al., 2015; Pinder, et al., 2014). Furthermore, the presence of emotions during learning should be embraced to create engaging and representative learning and practice environments. Through the following sections the aim is to meet both goals by proposing a principled model of Affective Learning Design.

An ecological dynamics approach to emotion and learning

An ecological dynamics approach to learning recognises the mutual relationship between an individual and the environment described through an integration of key concepts from ecological psychology and dynamical systems theory (Araújo, et al., 2006). In comparison, traditional approaches have focussed primarily on the processes and structures within organisms to understand behaviour, described as an organismic asymmetry (Davids & Araújo, 2010; Dunwoody, 2006).

Describing behaviour from the organism-environment scale takes into account how perceptions, actions, intentions and cognitions emerge under the constraints of information that are both internal and external to an individual (Jarvilehto, 2009; Seifert & Davids, 2012; Shaw & Turvey, 1999; Warren, 2006). Ecological dynamics concepts have been applied to learning and skill acquisition in relation to the coordination of physical movement behaviour in clinical settings (Newell & Valvano, 1998), motor development (Smith & Thelen, 2003; Thelen, 2002) and recently in sport (Araújo, et al., 2006; Balagué, et al., 2013; Chow, et al., 2011; Davids, et al., 2005; Vilar, et al., 2012).

Ecological psychology

A key concept in Ecological Psychology is the link between perceptual information available in the environment and the resultant actions or behaviours of complex system agents, such as humans (Araújo, et al., 2006). In the study of visual perception, Gibson (1979) stated that the movements of an individual bring about changes in information flow from which affordances (opportunities for action) are perceived to support further movement. Therefore, information and movement are deemed to be dependent on each other in a dynamically coupled relationship. As a result, a cyclic process is created where action and perception feed off each other to support goal-directed movement behaviour (Davids, et al., 2008). This concept provides a foundation for describing how goal directed movement emerges throughout a wide array of applications in the study of human behaviour. Consequently, perception-action coupling is an important consideration for the design of skill acquisition practice tasks and investigative methodologies in experimental research.

Egon Brunswik (1956) advocated that for the study of individual-environment relations, cues or perceptual variables should be sampled from an organism's environment to be representative of the environmental stimuli that they are adapted from, and to which behaviour is intended to be generalised. The sampling of perceptual variables from an individual's 'natural' environment in an experimental task, was captured by the term representative design (Brunswik, 1956; Dhami, et al., 2004). More recent work has discussed the concept of representative design in relation to the study of human performance and behaviour in contexts such as sport (Araújo, et al., 2006; Araújo, et al., 2007). As a result, the term representative learning design (RLD) has been adopted to highlight the importance of creating representative learning and practicing environments where key perceptual variables are sampled from the performance setting (Pinder, Davids, et al., 2011b). By incorporating representative design into practice tasks, practitioners ensure that the crucial cyclical relationship between perception and action in a performance environment is maintained (Gibson, 1979). To this point, empirical work discussing RLD has focussed on visual information provided in performance tasks (Pinder, Davids, et al., 2011a), practice in differing performance environments (Barris, Davids, et al., 2013), and changes to the complexity of tasks in team games (Travassos, et al., 2012). Similarly, learning and development studies have concentrated on the influence of practice on the organisation of movement tendencies or action (Newell, et al., 2001) While these advancements have provided a solid foundation for developing RLD, it is postulated that further progress can be made by taking into account the role of emotions in devising learning tasks to effectively simulate future performance.

Dynamic systems theory and emotions

An individual's intentions, perceptions and actions in specific environments are strongly influenced by the type and intensity of emotions experienced (Jones, 2003; LaBar & Cabeza, 2006). This idea fits well within a complex systems approach that considers an individual as many interacting parts that self-organise under the influence of individual, environment, and task constraints (see Newell, 1986) to achieve specific objectives (Kelso, 1995). Therefore in the regulation of human behaviour, the perceptions, actions and cognitions of an individual self-organize to form emergent physical and psychological responses (Warren, 2006).

Complex dynamic systems such as humans have the capability to self-organise their actions or behaviour to achieve specific task objectives without direct input from higher order structures or predetermined rules (Kelso, 1995; Lewis, 2000b). When considering a human as a complex dynamic system, the informational variables in an environment, along with associated goal objectives and intentions, influence how an individual behaves in specific contexts. This takes into account the self-organising processes of emotions, cognitions, and behaviours in relation to both physical and psychological activity (Kelso, 1994; Lewis, 1996). States of system organisation that are stable for a given task are described as attractors. Attractors are considered to have deep 'wells' (see Figure 6.1), which represent previously learnt and commonly adopted patterns of behaviour such as an emotional response like excitement when playing fun games (Kelso, 1995; Renshaw, et al., 2012; Thelen & Smith, 1994). Depending on the depth or stability of an attractor, changes in informational variables (e.g. control parameters, see Balagué, et al., 2012; Passos, et al., 2008) and/or task objectives have the potential to perturb stable states of behaviour. Perturbations lead to a phase transition in the state of the system, often producing instability and changes to order parameters. Unstable states, or repellors, correspond to a ‘hill’ above potential ‘wells’ (see Figure 6.1) where behaviour is highly variable and often less functional . Unstable states are easily influenced by changes to informational variables both internal and external to the system (individual). For example, an increase in an internal informational constraint such as anxiety could lead to a change in the perceptions of the climbability of a rock wall. Conversely, changes in perceptions of task constraints, such as facing a cricket bowler with a reputation for hitting batters, could lead to an increase in anxiety and lead to movement changes through freezing of the degrees of freedom (Bernstein, 1967).

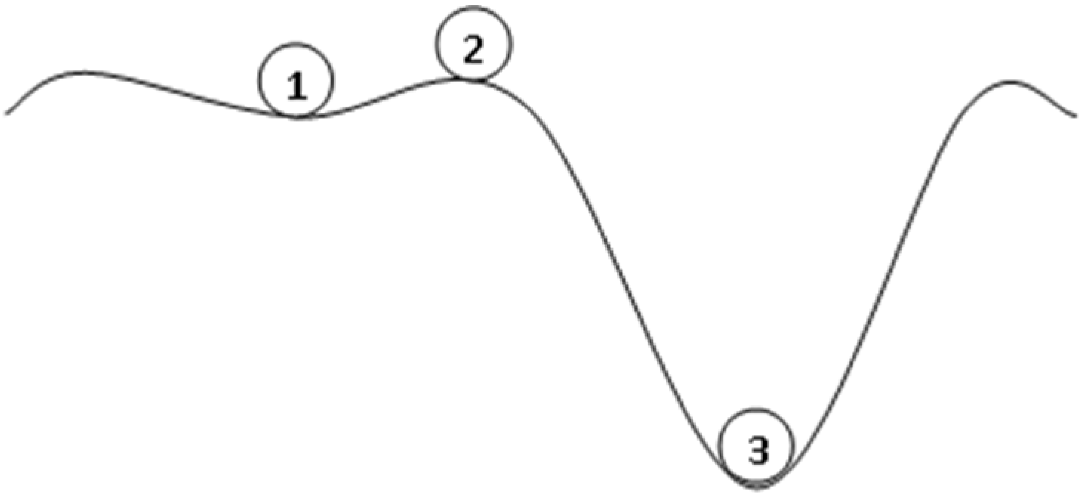


Figure 6.1. Changes in complex system stability. (1) represents a weak attractor state within a shallow (unstable) well. (2) represents a metastable region where the system lingers between attractor states (i.e. 1 & 3). (3) represents a strong attractor state with a deep (stable) well

During periods of change, a previously unstable repellor may emerge into a more stable attractor, initially as a shallow well, before potentially strengthening to a deep well (Kelso, 1995; Kelso & Tognoli, 2009; Vallacher & Nowak, 2009). Therefore, while initially an individual adopts a novel and functional response, portrayed as a stable pattern of organisation, over time the pattern becomes a characteristic response to a specific experience or environment (Lewis, 2000b; Thelen, 2002; Thelen & Smith, 1994). In some cases an individual may develop several coexisting attractor states that are available to choose from, referred to as multistability (Kelso, 2012). A system displaying multistability has the ability to switch between selected attractor states as necessary, which can be advantageous with regards to adaptability, but also potentially detrimental due to inconsistency in performance (Chow, et al., 2011; Kelso, 2012). A system can also display metastability, which is a partial and temporary state or pivot where a system is poised to emerge into a new stable state (Kelso, 2012; Kelso & Tognoli, 2009). Metastability reflects the tendency of system components competing in an attempt to function both individually, and in unison concurrently (Kelso, 2008). Therefore, metastability is a state of partial organisation that allows a system to function while transitioning (i.e. learning) between states of organisation (Chow, et al., 2011; Pinder, et al., 2012).

Learning

Learning and performance are difficult to separate from each other, with learning processes derived from observable performances, typically under highly controlled conditions (i.e. learning to perform) (Schmidt & Wrisberg, 2008). As learning is inferred from performance, learning and experimental environments should sample the conditions of the relevant performance environment to uphold representative learning design (Pinder, Davids, et al., 2011b). In complex systems terminology, learning can be described as the transition to a preferred functional state (attractor) from a previously learnt and now ineffective state (Chow, et al., 2008; Jarvilehto, 2009; Liu, et al., 2006; Thelen, 1995). Learning and development are often discussed alongside each other as distinct, yet integrated concepts (Newell, et al., 2001). In general, learning relates to changes (e.g. performance, ability) over short time scales while development describes changes over longer periods of time (Granott & Parziale, 2002; Newell, et al., 2001). The interaction between the time scale of perception-action (short term – seconds and minutes) and the time scale of learning and development (long term – days, weeks, and months) influences how situational constraints of an environment are approached (Davids, et al., 2001; Lewis, 2002; Thelen, 1995). From a dynamic systems perspective, short term events shape long term developmental patterns or states, and conversely the established developmental states influence performance and learning in real time (Lewis, 2000a, 2002). These reciprocal influences between short and long term experiences have been described as 'cascading constraints' on learning and performance (Lewis, 1997, 2002). Therefore established EI's of an experience influence how an individual will approach learning an unfamiliar task (Lewis, 2000a, 2004).

In summary, ecological dynamics concepts have been adopted to describe how individuals develop interpretations of experiences in relation to the self-organising relationship between cognition and emotion (Lewis, 1996, 2000a, 2000b, 2002, 2004; Thelen & Smith, 1994). During development, the relationship between cognitions and emotions in respect to an experience may change, resulting in phase transitions from unstable to stable states of organisation (Fogel, et al., 1992; Lewis, 2004; Thelen & Smith, 1994). Like physical behaviour, the development of cognition-emotion links may lead to metastable periods where an individual has the potential to adopt one of a 'cluster' of possible states, indicating a sensitivity to changes in situational constraints (Hollis, et al., 2009; Lewis, 2000b, 2004). During a period of metastability, behavioural tendencies would be expected to exhibit increased variability until a more stable state of self-organisation emerges (Chow, et al., 2011; Hollis, et al., 2009). Accompanying this variability in behaviour, variable and individualised emotional responses would also emerge reflecting the instability in the system as exploration of the environment and learning takes place (de Weerth & van Gert, 2000; Lewis, 1996, 2004).

A model of affective learning design

By capturing the theoretical concepts and processes discussed in the previous sections, the remainder of this paper will introduce and discuss a model of *affective learning design*. Affective learning design (ALD) has been posited as a complementary aspect of representative learning design (Pinder, Davids, et al., 2011b; Renshaw, et al., 2014). ALD is focussed on the critical interactions between emotions, cognitions and behaviours that underpin a holistic approach to learning (Headrick, et al., 2015; Pinder, et al., 2014). This proposed model provides a principled description of learning founded on an ecological dynamics approach in unison with the experiential knowledge of coaches, sport psychologists, pedagogues, and sport scientists. The key phases of the model are *evaluation*, *planning*, *implementation*, and *observation & monitoring* (see Figure 6.2). Together these phases form a cyclical loop where each phase underpins the next across short and long time scales. Due to the cyclical nature of the model there is no standardised start or end points. Instead the model is open for interpretation from various phases.

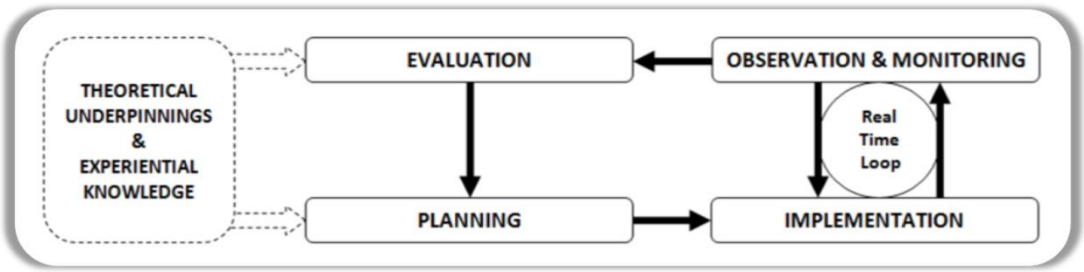


Figure 6.2. A model of Affective Learning Design

Evaluation

The evaluation phase of the ALD model concentrates on how the capabilities, or intrinsic dynamics of individuals are matched to the demands of a task (Newell & Ranganathan, 2010; Schöner, et al., 1992). Assessing the convergence ('match up') between intrinsic dynamics and task demands involves identifying individual rate limiters (Thelen, 1995) on performance that must be overcome in order for the individual to be successful when experiencing specific situational constraints (Davids, et al., 2001). From an ALD perspective, rate limiters could be individual task or environmental constraints. Potential individual constraints include factors such as one, or a combination of emotions, cognitions, and actions relating to the task that are restricting or preventing successful performance. Generic rate limiters include lack of physical strength, poor perceptual skills, an unstable/dysfunctional emotion-cognition state, misguided goals or intentions, and low self-efficacy. Rate limiters such as these may be identified to be barriers to successful performance alone, or in synchronisation with one task or environmental constraints. For example, the interaction between balance beam performance and (dys)functional emotions (Cottyn, et al., 2012), track sprinting success and self-efficacy (Gernigon & Delloye, 2003), the effect of induced anxiety on movement behaviour whilst climbing (Pijpers, et al., 2005), throwing darts, and shooting free throws in basketball (Oudejans & Pijpers, 2009).

Identifying key rate limiters for performance is a challenge that can be achieved through various methods. Performance outcomes (e.g. time, score), performance analysis (number of possessions, distance travelled), biomechanical analysis (joint angles, velocities), physiological analysis (heart rate, oxygen consumption, sweat response), and pure observation (video, real time) are all common techniques used to evaluate specific aspects of performance (Cooke, Kavussanu, McIntyre, Boardley, & Ring, 2011; Glazier, 2010). However, evaluating which measures are most meaningful and applicable to the individual and task in question is the key challenge for a coach, or sport scientist. One rarely accessed source of information that can be used to help identify key rate limiters is the experiential knowledge of coaches and teachers, sport psychologists, sport scientists to highlight aspects of performance that require improvement (Greenwood, Davids, & Renshaw, 2014).

To ascertain subjective components of performance such as emotions and cognitions, the coach-athlete relationship is also of great importance (Davis & Jowett, 2014; Greenwood, Davids, & Renshaw, 2012). Determining the emotions and cognitions associated with physical performance can be achieved through methods including self-report measures (e.g. questionnaires, rating scales), self-confrontation techniques (guided reviews of performance), and formal/informal communication (interviews) (e.g. Gernigon, et al., 2004; Pijpers, et al., 2005).

In relation to ecological dynamics concepts, the evaluation phase represents an existing stable state of system (intrinsic dynamics) organisation, which may or may not be functional for the task. The identification of rate limiters through methods such as those previously mentioned, indicates that the existing intrinsic dynamics of the individual are not functional in relation to the current and/or future task demands (Newell & Ranganathan, 2010). Therefore, as detailed in the following sections, the system needs to be somewhat destabilised in order to facilitate a phase transition to a different attractor state that is functional for performance (Jarvilehto, 2009; Kelso & Zanone, 2002). The critical role of an individual and/or coach is to assess previous performance and recognise control parameters that can be manipulated to create metastable periods where an individual must explore for new functional states of organisation (Kelso, 2012; Pinder, et al., 2012).

Planning

Following the evaluation of existing intrinsic dynamics–task demands convergence and identification of key rate limiters, the next phase of the model involves planning the design of the learning event. As with the evaluation phase, the integration of experiential knowledge with theoretical underpinning concepts is crucial for designing learning experiences that effectively cater for the individual needs of a performer (Renshaw, et al., 2009). The planning phase concentrates on identifying control parameters (informational variables linked with rate limiters) that can be manipulated in order to create instability in performance, therefore forcing the individual to search for novel solutions to task demands (Balagué, et al., 2012; Warren, 2006). Through scaled changes to control parameters, a system can be destabilised resulting in phase transitions, self-organisation, and ultimately a change in order parameter (Passos, Araújo, & Davids, 2013; Warren, 2006). Examples of control parameters in sport include relative velocity and interpersonal distance in Rugby Union sub-phases (Passos, et al., 2008). Critically, control parameters do not directly relate to specific changes in system order, but can be manipulated to promote instability and facilitate self-organisation (Thelen, 2002). The aim of manipulating control parameters is therefore to guide an individual into regions of metastability (see Figure 6.1), to provide opportunities to transition between co-existing states of organisation (Kelso, 2012).

Tasks that bring about metastable states are commonly associated with increased variability in emotions, cognitions, and actions (Lewis, 2004). Increased variability suggests that the individual is exploring the environment in search for new attractors which will inherently be accompanied by periods of failure and uncertainty before success or functionality is achieved (Alexandrov & Jarvilehto, 1993; Collins & MacNamara, 2012; Warren, 2006). Therefore when planning a learning event it is imperative to consider the influence that successful/unsuccessful performances might have on psychological concepts including self-efficacy and motivation (Renshaw, et al., 2012). From an ALD approach these psychological (individual biased) concepts are considered in unison with physical performance outcomes and achievements (efficacy) of an individual under specific situational constraints (Davids, et al., 2001; Gigerenzer & Goldstein, 1996; Simon, 1990). This reflects the interaction between the individual and the environment instead of solely focussing on the internal thoughts and verbalisations of the performer (Davids & Araújo, 2010; Jarvilehto, 1998a; Simon, 1956). Consequently, when planning learning events a coach should take into account thoughts and emotions expressed or displayed by a performer, along with observed actions and performance outcomes (Headrick, et al., 2015).

Specifying clear goals and intentions for a learning event is another key aspect of the planning phase. Designing tasks with set goals provides some context to a learning event and subsequently a reason or motive for participation (Araújo, et al., 2006; Shaw & Turvey, 1999). Performance goals relate to being successful, and being judged by others as competent, while mastery goals refer to the development of skills and competency (Ames & Archer, 1987; Elliot, 2005). Competence is one's mastery of a task in relation to the task demands, an individual's own previous and potential performance achievements, and in comparison to the achievements of others (Elliot, 2005). In the case of performance orientated tasks, a performer would be expected to display competence and achieve successful outcomes, indicating they are in a stable and functional attractor state. Mastery focussed tasks on the other hand would be expected to be associated with greater variability and reduced functional performance outcomes, suggesting a metastable state (Pinder, et al., 2012; van de Pol, et al., 2012a). From an ALD approach these differences in performance incorporate actions, cognitions, and emotions to provide a holistic understanding of how an individual interacts with the situational constraints of a learning environment (Davids, et al., 2001; Headrick, et al., 2015). Establishing whether a future session or task is orientated toward performance or mastery goals is therefore critical for stipulating the purpose of the learning event.

Implementation

Implementing plans devised to address mismatches between intrinsic dynamics and (expected) task demands is the next phase of the ALD model. While this phase is again theoretically founded on ecological dynamics concepts, it now requires theoretical and strategic planning to be incorporated into practice through the skills of a coach (Greenwood, et al., 2012; Renshaw, et al., 2009; Renshaw, et al., 2012). The planning and implementation phases are therefore closely linked and have the potential to influence each other from one learning event to another. Central to the implementation phase is the use of constraints to guide the self-organisation of emotional, cognitive, and behavioural tendencies (Newell, 1986; Newell & Ranganathan, 2010). Constraints are commonly associated with physical or structural aspects of an environment that act as boundaries or restrictions on behaviour. For example, the use of a 'battle zone' for cricket practice where the playing area is restricted in comparison to a full game (Renshaw, Chappell, et al., 2010), or the use of implements exhibiting different haptic characteristics during a dynamic interceptive task (Headrick, Renshaw, et al., 2012).

From an ALD approach, informational constraints that specify situational, contextual, instructional aspects of a task must also be taken into account (Davids, et al., 2001; Headrick, et al., 2015; Newell & Ranganathan, 2010; Seifert & Davids, 2012). Previous applications of informational constraints to sport performance include specifying instructions relating to game play scenarios in basketball sub-phases (Cordovil, et al., 2009), and inducing anxiety by increasing the height of climbing traverses (Pijpers, et al., 2006). Including informational constraints affords the opportunity to create practice vignettes that stipulate situational and contextual information (e.g. time, score and game scenario) to engage the emotions and thoughts of a performer (Davids, et al., 2013; Headrick, et al., 2015). By effectively manipulating key constraints the role of the coach is to create an environment that facilitates learning, and the emergence of successful/functional performance, without becoming overly prescriptive (Millar, Oldham, & Donovan, 2011; Renshaw, Oldham, Glazier, & Davids, 2004). Therefore performers are encouraged to explore and problem solve in environments that are designed to target and address identified rate limiters (Renshaw, et al., 2009; Renshaw, et al., 2012).

When planning and then implementing the constraints that will be applied to learning events, a major challenge is ensuring that the environment is representative of the constraints experienced in a performance or match environment (RLD - see Pinder, Davids, et al., 2011b). Designing and executing learning events to take a holistic approach to the implementation of constraints ensures that physical (e.g. technical), physiological and psychological aspects of performance are accommodated for during learning and practice (Pinder, et al., 2014; Renshaw, et al., 2004). From this perspective, learning to exploit the emotional constraints of a task is equally as important as developing technique or physical fitness for a specific task

(Headrick, et al., 2015; Pinder, et al., 2014). In order to facilitate challenging and engaging practice environments a coach must at times manipulate constraints with the intention of creating periods of failure (instability) (Chow, et al., 2011; Collins & MacNamara, 2012). Inducing failure through the disruption of behaviour that had previously 'worked' or 'felt good' has potential psychological consequences (Gernigon & Delloye, 2003; Pinder, et al., 2014; Thelen & Smith, 1994). Therefore, coaches must judge carefully how representative a learning environment should be based on their knowledge of and relationship with an individual. In order to nurture the psychological state of performers, learning environments will rarely be completely representative of competition conditions, but must attempt to stimulate as many key aspects of the intended competitive setting as possible (Brunswik, 1956; Pinder, Davids, et al., 2011b).

Observation and monitoring

Observation and monitoring is the final phase of the model of ALD. This phase involves within session or 'real time' assessment of the plans implemented and how the learning event is addressing the targeted rate limiters. Where the previously discussed evaluation phase involves detailed analysis methods to identify key rate limiters, the observation and monitoring phase involves more subjective methods based on the experiential knowledge of a coach/practitioner and their understanding of the performer (Greenwood, et al., 2014). These 'on the run' methods might include the visual inspection of action tendencies, communication with the performer, assessing group engagement in a task, or recording fundamental performance outcomes (i.e. completion times, scores). Therefore, the implementation phase along with this observation and monitoring phase form a real time loop within the ALD model (see Figure 6.2). This loop provides an avenue for on-line modifications during the learning event to deal with unexpected emotions, cognitions or behaviours through refinements to the learning experience within the broad objectives of the session.

A key observational indicator of performance from an ALD approach is determining the intentions of an individual in regards to displaying competence in a task, when compared with their own previous performances or those of others (Elliot, 2005). An individual may attempt to approach success and therefore display competence; or aim to avoid failure to prevent the display of incompetence (Elliot & Church, 1997; Elliot & Harackiewicz, 1996). The approach-avoidance dichotomy has been investigated in Judo training bouts to explore the nature of goal orientations in various situations (Gernigon, et al., 2004). Here it was found that goal involvement states (approach-avoid) fluctuate according to the constraints of the task and the emergent relationship between actions, thoughts, and emotions (Gernigon, et al., 2004; Lewis, 2004).

From an ALD approach the observation and monitoring of learning events should take into account a combination of actions, cognitions, and emotions. By adopting this approach, observed changes in one of these concepts can be intertwined or associated with others to provide an enhanced understanding of how individual performers attempt to function in metastable periods. Gernigon et al., (2004, p. 592) summarised this relationship stating that "…cognition is seen as indissociable from action, feelings, and experience, and closely linked to ecological constraints". For example, the link between increased anxiety, completion time, and exploratory movements in climbing tasks at different heights (Pijpers, et al., 2005), or the relationship between balance beam performance and functional or dysfunctional emotions due to increases in task difficulty (Cottyn, et al., 2012).

Further studies have investigated similar relationships when comparing between practice and performance tasks. In target shooting, competition situations corresponded with increased anxiety, decreased shooting accuracy, shorter quiet eye (QE) periods, and several gun barrel kinematic differences when compared with the practice situations (Causer, Holmes, Smith, & Williams, 2011). The benefits of training with induced anxiety have also been studied in dart throwing and basketball shooting tasks (Oudejans & Pijpers, 2009, 2010). Performance in these sport specific tasks was found to be enhanced following training in induced anxiety conditions, even though participants were observed to display increased heart rates, perceived exertion ratings, and subjective anxiety scores which when isolated from performance could be interpreted as detrimental responses. Similar findings were observed in police officers who trained and performed handgun shooting under pressure (Nieuwenhuys & Oudejans, 2011; Oudejans, 2008). These findings exhibit how observable changes in performance outcomes and movement responses are accompanied by emotional and cognitive tendencies that become recognised as characteristic responses for specific situations (Lewis, 2000b; Lewis & Granic, 2000).

Following the observation and monitoring of these intertwined actions, emotions, and cognitions a coach or practitioner can identify key aspects of performance that need to be addressed further. Therefore the cyclic model of affective learning design returns to the evaluation phase where the next ‘round’ of evaluation, planning, and implementation can commence to create enhanced learning environments. To highlight the potential practical implications of this applied model the following section discusses the phases of evaluation, planning, implementation, and observation / monitoring in relation to the preliminary studies presented in Chapter 5.

Examples of ALD principles in practice

Example 1: Action-emotion relationships in a team passing game

During a team passing game (Endball – see Chapter 5A) session the task constraint of maximum possession time was systematically manipulated with the aim of creating metastability in actions (game events) and emotion intensity. Using this example as a hypothetical, a coach may have identified slow ball movement as a rate limiter during the *evaluation* of previous performances in a possession game such as Netball. During the *planning* phase, interventions to address this rate limiter were investigated and the task constraint of manipulating ball possession time was identified as a *candidate control parameter* that may force players to re-organise their perception-action couplings in order to dispose of the ball faster without explicitly being instructed. Moving to the *implementation* phase a game situation was created where the training environment remained largely representative of the information present during match or competition conditions including: direct opponents; field markings; and game context in the form of goals scored (Cordovil, et al., 2009; Headrick, Davids, et al., 2012; Orth, et al., 2014). During the constrained games (3, 2, and 1 second possession time limits) the actions and emotions of the players were *observed and monitored* to determine whether the interventions were going to plan. Observation and monitoring was carried out 'in session' in the form of subjective perceptions of the coach. Key measures were also collected at key periods during the session detailing game events (touches, passes etc.), emotions (SLEQ), and perception of difficulty (PoD) for later analysis and further *evaluation*.

Results from the evaluation of the game events and emotion intensity scores revealed several findings regarding the impact of manipulating the constraint of possession time. For example, one team of players reported consistently higher emotion intensity scores across the session, and also happened to score more goals in each period of play. Overall findings revealed that during the transition from 3 – 2 second possession time limits, increases in the number of goals scored linked with elevated intensities of Enjoyment and Fulfilment SLEQ subscales along with decreased Anger subscale intensities. When transitioning from the 2 – 1 second possession game the number of touches, incomplete passes, and errors were found to increase when more goals were scored. Finally when comparing the transition from the 1 – 3 second game Enjoyment decreased when complete passes increased, Nervousness increased in line with incomplete passes, PoD decreased as Fulfilment increased, and Anger increased alongside elevated numbers of incomplete passes (and vice versa).

Therefore when evaluating the effectiveness of the session a coach could interpret these findings as suggesting that the manipulation of this specific constraint did influence the intertwined actions and emotions of the players as a group. In terms of the hypothetical objective of improving the speed of ball movement it appears that the 1 second time limit for possession predicts elevated touches, however, with the expectation of more errors and incomplete passes.

Example 2: Action, emotion, and cognitions in a representative cricket batting task

In this example a cricket batting task was devised where delivery speed was manipulated throughout a batting practice session. Again using a hypothetical skill development scenario, the *evaluation* of previous performances in this case identified the ability to face increasingly fast bowling as a rate limiter. In an attempt to address this rate limiter a phase of *planning* identified the systematic manipulation of cricket pitch length as a method for simulating faster deliveries while maintaining the critical bowling action characteristics of a suitable bowler. To *implement* this plan the manipulations were incorporated into a simulation representative of the first 10 overs of a one day cricket match, including contextual information regarding the position of fielders, and the competitive relationship between batter and bowler. Throughout the session *observation and monitoring* took place through a number of methods. Actions (movement analysis) and performance outcomes (runs, delivery speed, shot type and direction), emotion intensity (SLEQ), and cognitions (brief confrontational interview questions) were all collected for within session and post session analysis where appropriate. For this example the *real time loop* between implementation and observation/monitoring phases was also in action, due to the bowler not meeting the designated delivery speed in the final manipulation. When this event occurred the decision was made to continue as planned with the session despite an unexpected situation arising.

When *evaluating* the observations and measures collected throughout the session a key finding revolving around total front foot movement was identified. Specifically, shorter total distances covered by the front foot (both forward and back) were found to strongly link with increases in Enjoyment scores, perception of achievement ratings (PoA - based on interview responses of who ‘won’ each over), and runs scored per over. These findings reveal clear relationships between actions (foot movement), performance outcomes (runs), emotions (Enjoyment score), and cognitions (PoA rating). Therefore a coach or sport scientist could deduce from these findings that the batter in question was more functional for this task when he made shorter (potentially more efficient) foot movements when facing increased delivery speeds. As such the next planning phase may investigate tasks that encourage the batter to explore employing shorter foot movements.

Summary

Overall this chapter has proposed a detailed theoretical background to the concept of ALD arguing that action, emotion, and cognitions should all be integrated in a holistic approach to the design of learning environments. In order to transfer these conceptualisations into practice a four phase model of ALD is proposed drawing on theoretical underpinnings and the experiential knowledge of a coach, teacher, researcher, or practitioner. The key principle driving this model is the constant integration and recognition of actions, emotions, and cognitions throughout all phases supported by findings from the two practical examples. Future work should look to further test the design of this model across a range of individuals and different sports to enhance the representative and holistic nature of research tasks, coaching approaches, and performance analysis methods.

Chapter 7: Epilogue

Introduction

The major aim of this PhD programme was to provide a principled approach for the integration of emotion in learning. To achieve this aim a combination of theoretical conceptualisations, methodological developments, and applied examples have been proposed, reported, and discussed. The following sections provide an overview of the pivotal findings and implications of this PhD, and how they might inform future research from both theoretical and applied perspectives.

Theoretical findings and implications

Affective learning design

Through Stage 1 the theoretical position underpinning this PhD programme was introduced and applied to the holistic study of action, emotions, and cognitions. Reviewing and critiquing previous literature revealed the predominance of traditional, cognitive biased (‘cold cognition’) approaches to the interaction between actions, emotions, and cognitions. These approaches reflected an internal (to the individual) bias in the emotion literature that did not account well (if at all) for the interaction between an organism (individual) and environment in terms of perceptions, actions, and intentions (Davids & Araújo, 2010; Warren, 2006). In contrast, a small number of studies and theoretical modelling papers were found to have advocated for a dynamic systems approach for discussing emotions. The work of Lewis and colleagues (e.g., Lewis, 1996, 1997, 2000a, 2000b, 2002, 2004, 2005) in particular supported the application of dynamic systems concepts such as self-organisation, attractors, and phase transitions to describe the commensurate interactions between cognitions and emotions across various time scales. Similar conceptualisations by Jarvilehto and colleagues (e.g., Jarvilehto, 1998a, 1998b, 1999, 2000a, 2000b, 2001, 2009) discussed the organism – environment system and the dynamic influence emotion has on the self-organisation of functional tendencies.

To develop these theoretical approaches to emotion further, a primary outcome from this thesis is the introduction of the concept of *Affective Learning Design* (ALD, Headrick, et al., 2015). Founded on ecological dynamics concepts and complementary to Representative Learning Design (Pinder, Davids, et al., 2011b), ALD promotes two key principles: (i) the design of emotion-laden learning experiences that effectively simulate the constraints of performance environments in sport; (ii) recognising individualised emotional and coordination tendencies that are associated with different periods of learning (see Chapter 3). Therefore, an ALD perspective supports a holistic approach to the intertwined relationship between actions, emotions, and cognitions during representative learning environments that simulate the contextual and situational demands of sport performance. The targeted and systematic manipulation of constraints during these learning experiences aims to force individuals into metastable periods where self-organisation (of actions emotions, and cognitions) is required in order for functional, goal directed behaviour to emerge (Hristovski, et al., 2011; Kelso, 1995, 2012).

The design and findings of the studies discussed in Chapter 5 vindicates this novel theoretical approach, and its application in future theoretically informed research. Very few previous studies have set out to investigate, let alone demonstrate, the dynamic interaction between actions, emotions, and cognitions in sport (with the exception of Gernigon, et al., 2004). The findings of the cricket batting investigation in particular, reveals the complimentary interaction between goals (i.e. game plans), emotions, and actions (outcomes, movement characteristics), supporting the second principle of ALD above. Consequently, this thesis has proposed an innovative, theoretically driven approach for incorporating emotion into learning. It has also demonstrated how this approach can be applied in sport contexts, providing an outstanding foundation for future work, with potentially ground-breaking implications.

Affective constraints as control parameters

In reference to constraints, the theoretical underpinnings and practical findings discussed in the following sections also provide support for the recognition of 'affective constraints' on emergent behaviour (Headrick, et al., 2015). Cognitive science literature suggests that emotions are controlled or shaped by cognitions, however the modelling of Lewis (Lewis, 2004, 2005; Lewis & Stieben, 2004; Lewis & Todd, 2005), Jarvilehto (Jarvilehto, 2001, 2009), and findings reported in Chapters 5 and 6 indicate that emotion also influences cognition in an intertwined relationship along with action tendencies. The development of the SLEQ (Chapter 4) for measuring emotion intensity during learning is underpinned by the conceptualisation of affective constraints. By considering SLEQ scores as intensities rather than categorising responses into positive or negative valences, the opportunity was created for individualised thresholds or regions to emerge, indicative of predicted transitions from stable to unstable system states (Kelso, 1990, 1995). Therefore, specific intensities of emotion can be considered as control parameters that drive a dynamic system (individual) towards metastable regions of organisation (Kelso, 1995; Lewis, 2000b, 2004; Passos, et al., 2008). It is within these metastable regions that increased variability in performance, intentions, and emotions would be expected as an individual searches for functional tendencies in relation to his/her intentions (Davids, Araújo, Seifert, & Orth, 2015; Lewis, 2004). Consequently, it is essential that those designing learning experiences consider the sampling of contextual or situational information alongside more physical constraints (e.g. visual information), to account for the influence of affective constraints on emergent behaviour.

For example increased intensities of anxiety can often be functional for learning up to a specific threshold, but beyond that become dysfunctional and detrimental to learning due to corresponding negative influences (Jones, 1995; Kelso, 1995; Lewis, 1996). This draws parallels with the Cusp Catastrophe Theory of Hardy and Fazey (1987), where increases in physiological arousal (or somatic anxiety) are believed to facilitate successful performance up to a threshold, but beyond this point a 'catastrophe' occurs and performance deteriorates dramatically (Fazey & Hardy, 1988). The catastrophe point in performance is also dependant on increased cognitive anxiety levels as part of this multi-dimensional model (Hardy, 1996; Hardy & Parfitt, 1991). However, the Catastrophe model differs from the approach advocated throughout this thesis in that it focusses on individual (internal to the individual) constraints, rather than the interaction between constraints shared by the individual and environment (Jarvilehto, 2009; Lewis, 2004; Newell, 1986; Newell, et al., 2001).

Emotions such as enjoyment could be also considered a constraint by individuals of varying experience or expertise. For example, higher intensities of enjoyment might be essential to engage children or novice performers in learning tasks, whereas adults or experts who are already 'invested' in a sport would be expected to exhibit more intrinsic motivation, and therefore require lower thresholds of enjoyment to remain engaged in a task (Deci & Ryan, 1985; Renshaw, et al., 2012; Ryan & Deci, 2000b; Toering et al., 2011). These conceptualisations incorporate aspects of Self-Determination theory, where intrinsically motivated individuals exhibit increased levels of competence, autonomy, and relatedness for a specific task (Deci & Ryan, 1985, 2008; Renshaw, et al., 2012). Self-deterministic individuals also tend to enjoy learning tasks more without the influence of external influences, due to an innate interest or engagement in the task (Moy, Renshaw, & Davids, in press). The incorporation and manipulation of affective constraints in learning environments must therefore be considered from an individualised perspective due to characteristics (organismic constraints, e.g. personality, experience) that distinguish individual learners (Lewis, 1997).

Overall, the theoretical implications discussed highlight the novel approach to emotion in learning advocated throughout this thesis. This represents a substantial contribution to the literature, which was found to be lacking a principled approach to the role of emotion in learning environments, particularly in sport contexts. The principles of ALD therefore provide clear and theoretically sound underpinnings for adopting these advancements in practice, as discussed in the following section.

Practical findings and implications

Development of the Sport Learning and Emotions Questionnaire (SLEQ)

Following the above theoretical conceptualisations the next stage of the PhD programme was to provide evidence supporting the adoption of ALD principles in practice. In order to carry out this aim the first step was to determine a method for measuring or tracking emotion during a learning experience. Reviewing the literature revealed a dearth of methods for measuring emotions during learning, with existing methods considered unsuitable as they were specifically designed for pre / post competition contexts; focused on a select few or single emotions; were static in nature; or were originally designed for environments other than sport (e.g. PANAS, POMS). The only questionnaire developed and currently used within sport that was deemed to be even close to meeting the needs of the experimental studies was the

Sport Emotion Questionnaire (SEQ) of Jones et al. (2005). However, the SEQ was only validated for use before competition. Therefore there was a clear need to develop a new emotion measurement questionnaire specific to learning in sport. This new questionnaire needed to be able to capture and track emotions throughout a learning event and be as unobtrusive, and user friendly as possible. While not ultimately suitable to the purposes of this programme of work, the SEQ provided a framework or guide for the development of the new questionnaire. The construction process (Chapter 4) consisted of three phases that were all completed in sport orientated contexts. During phase 1, emotion items (words/phrases) relevant to learning in sport were identified by survey respondents before being trimmed for initial comparisons with those words generated during the SEQ development. Findings from this phase revealed obvious differences in emotion items associated with learning versus competition, and provided further justification for the development of a new emotions measurement tool specific to learning, rather than simply using the existing SEQ.

In phase 2 the items and the five factor structure of the SEQ were subjected to face validation by another cohort of survey respondents to determine the relevance to learning of each item overall, and the relevance of items to each of the SEQ factors (i.e., subscales: anxiety; dejection; anger; excitement; happiness). Findings revealed that, at best, only three of these factors (anxiety, excitement, and happiness) were deemed relevant to learning, therefore warranting further investigation and development of potentially new factors. Hence, phase 3 asked another cohort of respondents to rate how relevant they perceived each of the remaining emotion items to learning in sport. These results were subjected to factor analysis techniques culminating in four learning specific factors with relevant items loading on to each.

Based on the loading items these factors were labelled as Enjoyment (5 items), Nervousness (4 items), Fulfilment (5 items), and Anger (3 items). Structural Equation Modelling analyses found this proposed questionnaire structure to fit or represent the response data adequately. As a result this new proposed tool for measuring emotion intensity during learning in sport was coined the *Sport Learning and Emotions Questionnaire* (SLEQ). Considered in tandem, the conceptualisation of ALD and development of the SLEQ represent two major contributions to the field.

The SLEQ was designed to produce a total score for emotion intensity (i.e. engagement) along with individual scores for the four subscales. The fact that the SLEQ records emotion intensity rather than individual scores for particular emotions reflects a key addition to the literature (as discussed in the theoretical implications). As mentioned previously a desired feature of this tool was the capability to track emotion intensity across several time points to determine the influence of manipulations to constraints, reflecting the principles of ALD. Therefore the development of the SLEQ represents a major practical contribution of this PhD programme to the fields of motor learning and sport and exercise psychology. Given that the SLEQ was designed within a sport context, for use in sport contexts, it has great potential for use by researchers, coaches, teachers, and sport practitioners interested in how emotion impacts on skill learning tasks, sessions, or programmes.

Application of the SLEQ

Following the extensive development phases of the SLEQ, the next objective of the PhD programme was to provide examples of how this badly needed tool could be implemented in applied sport tasks. Chapters 5 and 6 detailed two investigations where the SLEQ was implemented to collect emotion intensity scores alongside action (e.g. movement characteristics, performance outcomes) and cognition (e.g.

perception of difficulty, confrontational interview responses) variables. Both examples provided evidence to suggest that manipulating constraints to produce metastable regions related to intertwined changes in all three categories of variables. This indicates that individuals were forced to explore, and attempt to exploit the variable task demands, exhibiting self-organising tendencies by adopting functional emergent behaviour (Davids, et al., 2005; Davids, et al., 2013; Hristovski, et al., 2006).

Findings from the Endball example (Chapter 5A) revealed that manipulations to the task constraint of maximum ball possession time produced interlinked changes in SLEQ score and game events. This was particularly evident during the transitions from different games, for example, when comparing the 2nd half of the 3 second game with the 1st half of the 2 second game. The interlinked changes in variables (e.g. Enjoyment and goals scored) highlighted the practical value of the SLEQ in terms of providing emotion intensity data at the time of critical game events, and also distinguishing the unique individual and team tendencies predicted through the application of a dynamic systems approach to emotions in sport (Lewis, 2000b, 2004).

The second applied case example (Chapter 5B) reported on a single case investigation using cricket batting as a task vehicle for observing interactions between actions, emotions, and cognitions. The design of this study provided an abundance of rich data from the SLEQ, confrontational interviews taken after each over, along with performance outcomes (runs, shot types) and in-depth movement variables (foot movements, bat lift height). Through the incorporation of ALD principles the batting task included clear contextual information specifying the situation of the simulated game and encouraging competition between the batter and bowler. Pitch length was manipulated in order to simulate a bowler capable of bowling faster paced deliveries, and once again the transition between different conditions appeared to reveal the most evident links between measures. Specifically, correlated relationships were observed between total foot movement distance, Enjoyment subscale scores, runs, and perception of achievement. Including confrontational questioning to determine cognitive responses provided crucial insights into the game plan or intentions of the batter. On several occasions the intentions of the batter were reflected in the observable performance outcomes, movement characteristics and emotion intensities. These findings further supported the intertwined nature of the relationship between, actions, emotions, and cognitions, reinforcing the importance of considering all such variables in unison during applied sport tasks.

A second key practical implication from this cricket example was the effectiveness of shortening pitch lengths to manipulate the space-time demands of a cricket batting task. The findings of this study revealed that repositioning the bowler, along with key vertical reference information (e.g. stumps, umpire), was successful in simulating targeted increases in delivery speed. This was evidenced by the observed fluctuations in performance characteristics such as shot types, runs scored, and foot movement changes as observed in previous work (Davids, et al., 2015; Pinder, et al., 2012). Recording emotion intensity, thoughts and intentions throughout the targeted speed manipulations provided further support for this method given that the batter reported noticeable changes in these variables. Therefore this method is proposed as a novel approach for manipulating delivery speed and retaining key bowling action characteristics that would otherwise be lost when using a ball projection machine (Pinder, 2012; Pinder, Davids, et al., 2011b; Pinder, Renshaw, et al., 2011). Given that cricket coaches are often limited in terms of the availability of bowlers, the implementation of targeted constraints to replicate different delivery speeds has great potential for adoption into cricket (and other interceptive action sport) talent development programmes.

Support for case study approaches

Integrating the theoretical implications, SLEQ development, and findings from the two applied studies enables this PhD programme to demonstrate strong support for adopting individualised case study approaches to the study of actions, emotions, and cognitions across various time scales of learning. Findings such as the range of SLEQ scores between individuals in the Endball study, and the individualised movement characteristics of the cricket batter indicate that individual tendencies are an integral part of skill acquisition research and practice. Therefore, in order to appropriately conceptualise a learner as a complex system all contributing aspects of emergent behaviour must be considered, observed, and evaluated. Based on noticeable fluctuations in key measures following the manipulation of constraints (e.g. foot movement and Enjoyment in the cricket study), case study designs provide the opportunity to develop in-depth knowledge about the individual. This individual specific knowledge can be used to inform the design of tailored learning environments, as predicated in the model of ALD discussed in the following section. Hence the methodological approaches described in Chapter 5 provide a pivotal framework for coaches, and sport practitioners to incorporate in applied sport settings going forward.

A conceptual model of ALD

Chapter 6 of the PhD programme brings the vital implications of the previous chapters together to propose a model of ALD. This model is founded on the theoretical framework of ALD and informed by the experiential knowledge of a coach or sport practitioner. Four interlinked phases (evaluation, planning, implementation, and observation/monitoring) are discussed, specifying both theoretical interpretations and practical considerations. The two applied case examples from Chapter 5 are then revisited and discussed within the framework of the model to demonstrate how ALD principles and the SLEQ can be integrated across different interacting time scales of learning (Lewis, 2002; Newell, et al., 2001). Time scales of learning are reflected in the design of the model in terms of the overall cyclical structure where previous implementations and evaluations inform subsequent planning phases (cascading constraints, see Lewis, 1997). The 'real time loop' also represents a dynamic process of constantly updating the constraints of a task in response to changes in actions, emotions, or cognitions, indicating the task is no longer addressing key rate limiters identified in earlier phases.

A key feature of this model to be considered by coaches and sport practitioners is the focus on incorporating affective constraints to create representative learning designs that immerse learners in situations that sample information from the simulated performance environment (Pinder, et al., 2015; Pinder, et al., 2013; Pinder, et al., 2014). Therefore, learners are constantly exposed to crucial perceptual variables that enhance aspects such as task engagement, relatedness, enjoyment, and investment, underpinning nonlinear pedagogy and game - based approaches to learning (Chow, et al., 2015; Chow, et al., 2006; Renshaw, Chow, et al., 2010). Taking these key features into account, this model is readily accessible to applied practitioners and researchers alike and provides a comprehensive summary of the novel approaches advocated throughout the PhD programme.

Limitations and future research

Limitations of this PhD programme that should be acknowledged focus largely on the experimental studies described in Chapter 5. The small sample size in each of these studies somewhat limits the conclusions able to be drawn from the findings. However, as described previously, a key feature of the cricket batting study in particular was the in-depth single case design that provided individual specific manipulations and emergent behaviours to be analysed (Barker, Mellalieu, McCarthy, Jones, & Moran, 2013). Nevertheless, future work should look to recruit increased numbers of participants to take part in the same game based session to identify further individualised trends. This could include batters of different skill levels and bowlers from different ranges of standard delivery speeds (both faster and slower) to simulate a range of game situations (e.g. overs 30 – 40). Furthermore, in subsequent simulated competitions the bowler should also be studied to a similar extent to ascertain his/her emotion intensity and cognitions in contrast with the batter, thus providing a more comprehensive interpretation of the interpersonal interactions during the 'game'.

The second limitation of the studies described previously is the short time scales of analysis for observing the interaction between actions, emotions, and cognitions. Future investigations should aim to track individuals over extended time periods to observe how variables observed across interacting time scales (i.e. individual sessions within a weekly programme) might fluctuate in relation to the manipulation of targeted constraints. This would also provide the opportunity to further assess the validity and reliability of the SLEQ with (i) increased numbers of participants, and (ii) several time points. The implementation of the SLEQ might also be improved through the development of an electronic version that automatically calculates intensity scores during a session, providing immediate and crucial information to a coach, practitioner, or performer during a task or session.

Crucially, future work should focus on recognising the influence of affective constraints during learning, and the intertwined relationship between actions (e.g. individual movement tendencies, performance outcomes), emotion (intensity via SLEQ), and cognitions (e.g. intentions, strategy, goals) in a range of different sports and simulated scenarios. Therefore, the deliberate manipulation of targeted control parameters can be studied from a multi-faceted approach to identify the intensity or value of such variables that predicts the emergence of metastable regions. When a metastable region is identified, another challenge for future work is establishing how long an individual should remain in this region for effective learning to take place, again linking with incorporating different time scales of learning (Newell, et al., 2001). Furthermore, the systematic manipulation of control parameters by a researcher or coach should be compared with giving the individual the choice (autonomy) of when to change these key variables. The latter method would be expected to reflect different individual constraints (e.g. experience, personality), providing additional support for an individualised or case study approach to learning tasks.

Finally, future work should aim to adopt individualised approaches to investigate the intertwined relationship of actions, emotions, and cognitions between learning and performance tasks (i.e. convergence between intrinsic dynamic and task demands, Chapter 6). Given that one of the underpinning concepts of this PhD is the design of learning experiences that represent performance environments (i.e. competition, match), a critical next step is analysing key variables in both situations, for the same individual(s). Consequently, results would provide an understanding of how closely a learning task simulates the demands of an actual match or competitive event. This would provide evidence to support, or refute, various task designs, depending on how effectively the key perceptual and informational variables of a simulated, and intended performance environment are sampled (including affective constraints).

Conclusion

In summary, this PhD programme has conceived a principled approach advocating for the consideration and recognition of emotion during learning events in sport. This Affective Learning Design (ALD) approach has then informed the development of a new tool designed specifically for use in sport, the Sport Learning and Emotions Questionnaire (SLEQ). By incorporating the SLEQ and principles of ALD in two applied sport investigations, pivotal findings have demonstrated the effectiveness, and value of the holistic approach advocated throughout this PhD for understanding dynamic emergent behaviour. Conclusions drawn from these findings have identified numerous implications for practitioners in terms of designing, evaluating, and enhancing learning tasks in the future.

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Appendices

Appendix A – Selected interpretations of emotion

The following quotations represent a selection of interpretations, perspectives, and opinions regarding the concept of emotion that reflect ideas and arguments presented throughout this thesis supporting the interaction between emotions, cognitions, and actions. Originating from a range of backgrounds and approaches, spanning over three centuries, these perspectives and opinions exemplify the difficulty of formulating a comprehensive and agreed definition of emotion.

> "By emotion [affectus] I understand the affections of the body by which the body's power of activity is increased or diminished, assisted or checked, together with the ideas of these affections. Thus, if we can be the adequate cause of one of these affections, then by emotion I understand activity, otherwise passivity."
>
> (Spinoza, 1674/2006, p. 62)

> "My theory is that the bodily changes follow directly the perception of the exciting fact and that our feeling of the same changes as they occur is the emotion."
>
> (James, 1884, p. 204)

> "Emotional phenomena are noninstrumental behaviours and noninstrumental features of behaviour, physiological changes, and evaluative, subject related experiences, as evoked be external or

mental events, and primarily by the significance of such events. An emotion is either an occurrence of phenomena of these three kinds or the inner determinant of such phenomena; the choice will be made later.”

(Frijda, 1986, p. 4)

“Emotion: Differently described and explained by different psychologists, but all agree that it is a complex state of the organism, involving bodily changes of a widespread character— in breathing, pulse, gland secretion, etc. —and, on the mental side, a state of excitement or perturbation, marked by strong feeling, and usually an impulse towards a definite form of behaviour. If the emotion is intense there is some disturbance of the intellectual functions, a measure of dissociation, and a tendency towards action of an ungraded or protopathic character. Beyond this description anything else would mean an entrance into the controversial field.”

(Lazarus, 1991, p. 36)

“...emotion is not felt experience alone, nor a pattern of neural firing, nor an action such as smiling. Emotion is the process that emerges from the dynamic interaction among these components as they occur in relation to changes in the social and physical context.”

Fogel et al., (1992, p. 129)

"We define emotions as episodic, relatively short-term, biologically based patterns of perception, experience, physiology, action, and communication that occur in response to specific physical and social challenges and opportunities."

(Keltner & Gross, 1999, p. 468)

"What is an emotion? My *definition* of emotion as a phenomenon is that it is an organized psychophysiological reaction to ongoing relationships with the environment, most often, but not always, interpersonal or social. This reaction consists of responses from three levels of analysis – namely, introspective reports of subjective experience (often referred to as an affect), overt actions or impulses to act, and physiological changes that make the emotions organismic."

(Lazarus, 2000, p. 230)

"Thus, emotion could be very generally defined as a process of reorganization (integration - disintegration) of the organism-environment system, expressed most clearly in relation to the realization of the expected behavioural result."

(Jarvilehto, 2000a, p. 56)

"Is an emotion a separate psychological process, or can it be simply ascribed to the activity of some brain area (for example, limbic area, prefrontal cortex)? What is the relation between emotional and cognitive processes? Are emotions only those feelings about which we can report? What is the relation between consciousness and emotions?”

(Jarvilehto, 2000a, p. 54)

"Emotions denote special organizational aspects related to the achievement of results: negative emotions refer to disorganization related to failure in this achievement of the result, and positive emotions to the integration of action after successful achievement of the result. As the reorganization of the system is a continuous process, emotions are always present and there is no action without emotions.”

(Jarvilehto, 2000b, p. 43)

Appendix B – Emotions during learning in sport survey (phase 1)

QUT Ethics Approval Number: 1400000571

Emotions During Learning in Sport Survey

The purpose of this survey is to identify emotions that performers experience when learning a skill in sport. Participation involves written completion of this short survey. All responses will remain anonymous and confidential. Participation is entirely voluntary, and you may withdraw at anytime without comment or penalty. Your decision to participate will in no way impact upon your current or future relationship with QUT (for example your grades).

If you have any questions about the survey please feel free to contact: Jonathon Headrick: jj.headrick@qut.edu.au

Part A: Background Information

1. Age (in years): ____

2. Gender: _________

3. Have you previously or are you currently learning to perform / play a sport competitively?

Please circle one: **YES** **NO**

(If **NO** do not complete any further questions)

4. What was/is the main sport that you participate in? ________________________________

5. For this sport what is your highest level of participation (e.g. school, club, district, regional, state, international)? ____

Part B: Emotions

6. Please take some time to recall emotions relating to your experiences of learning to perform a skill in any sport. Consider emotions (words or phrases) relating to **success** and **failure** in your responses. List as many emotions as you can below **(minimum of 5)**.

1 ____________	6 ____________	11 ____________
2 ____________	7 ____________	12 ____________
3 ____________	8 ____________	13 ____________
4 ____________	9 ____________	14 ____________
5 ____________	10 ____________	15 ____________

This is the end of the survey. Thank you for your participation

RESEARCH TEAM ONLY		
Number	Unit	Logged

Page **1** of **1**

Appendix C – A Preliminary exploration of emotion items in a golf putting task

A Preliminary exploration of emotion items in a golf putting task

Following the first phase where emotional items were identified, this exploratory pilot study was devised to determine whether the items from phase 1 were again identified during an actual learning event in a practical sport environment. This study used a golf putting task as a vehicle to initially assess the appropriateness of the items identified in the first phase alongside those previously included in the preliminary stages of the SEQ development (Jones, et al., 2005). This exploratory study was not intended to necessarily determine exactly which items should be included in the final emotions tool, instead it provided an initial indication of whether participants related to items identified in phase 1 during a practical sport task. Including the physical putting task also provided the opportunity to observe performance outcomes in unison with the emotions experienced across a session, similar to the experimental design of Cooke et al. (2011). It was hypothesised that during the golf putting task trends would emerge revealing patterns between putting performance scores and the number/valence of emotions selected. Furthermore, it was expected that items from the phase 1 list would be selected more frequently than those from the preliminary SEQ due to the learning context of the putting task.

Methods

Participants

Thirty-three male (n=24) and female (n=9) undergraduate exercise science students participated in the pilot investigation (mean age 22.45 ± 4.93 years). Students were enrolled in an introductory sport and exercise psychology subject and were a mix of left and right handed putting styles. No students reported having a golf handicap, with self-reported golf experience ranging from 0 to a maximum of 4 years. All students provided informed consent to participate in the study which was also to be used as an assessment piece. Students involved in this study did not participate any of the phases of the emotion tool development.

Procedure

The putting task was completed during scheduled class time with collected data also intended for use as a class project. Pairs of participants assembled around practice holes positioned on a flat artificial grass putting green at an outdoor golf facility. Using a tape measure, each pair marked a point 3m from the hole to indicate where the ball was to be placed for each putt. Before each set of putts the participants were asked to read and follow a set of generic putting instructions that described five key aspects of a putting stroke (see page 266). Participants completed five sets of ten putts each from the same position alternatively. Putting attempts were scored by measuring the distance from the nearest edge of the hole to the centre of the ball. If the putt was holed the score was a zero.

Prior to each set participants were provided with a list from which they were asked to identify up to ten emotional items from a randomised list, reflecting what they were feeling at that moment in relation to the task. All putting scores and identified emotion items were recorded by the participants on a paper recording sheet. The list of 54 items included the 39 items from the preliminary SEQ of Jones et al. (2005), along with 15 unique items carried forward from phase 1 (see Table 4.1). For the purposes of this pilot study, the yet to be confirmed item ‘achievement’ was not included in order for the primary focus to be on contrasting the other 15 confirmed items with those of the preliminary SEQ (see phase 2 for further discussion of ‘achievement’).

Putting instructions

Read these instructions through carefully a couple of times. Try to follow them as closely as possible each time you putt a ball.

- In a good putting stroke, the putter should move back and through smoothly; with the putter very low to the ground.
- The body should be bent over until the eyeline is directly over the ball-to-target line.
- The person should feel that a balanced stillness can be maintained in the body as the arms and putter make the stroke.
- Ball position is also critical, as the ideal point of contact is when the putter is travelling at the lowest point of its swinging arc.
- The actual swing of the putter is made by the arms with the hands serving as the connecting link.

Analysis

Putting scores and identified emotion items were collated into a spreadsheet by the researcher. Totals, means, and standard deviations for putting scores were calculated in order to initially inspect the results. Overall putting scores were subjected to a one-way repeated measures ANOVA with pairwise comparisons (alpha level < .05), and Bonferroni corrections to control for Type I error. Male and female scores per set were also compared using a one-way independent ANOVA.

Counts of emotion items identified per set were collated to provide an initial understanding of the valence (i.e. positive / negative feelings) and number of emotions associated with each putting set. These results were analysed using one-way repeated measure ANOVAs with pairwise comparisons. Bonferroni corrections were again used to control Type I error and the Greenhouse-Geisser method used to correct for violation to the sphericity assumption (Field & Hole, 2003). Effect sizes were also calculated to accompany all ANOVAs using omega (ω), with the following classifications: small = 0.10; medium = 0.30; large = 0.50) (Field, 2013). As a measure for determining the change in putting scores and emotion, item selection between sets' z scores were calculated. The z scores provided data specifying the change in putting score, number of positive items selected, and number of negative items selected through the five putting sets. Changes in z scores were then subjected to a correlation (Pearson's correlation coefficient, *r*) analysis to determine any relationship between putting score and emotion item values (alpha < .05, 95% confidence intervals).

Hierarchical cluster analysis using Ward's method (Ward, 1963) was performed on the 54 emotion items to establish whether certain items appeared / clustered together across the sets of trials. This was followed by a one-way ANOVA to determine whether any cluster was more predominant on any of the five occasions where emotions were selected by participants. Finally, a second cluster analysis was performed to determine whether groups of participants could be grouped together in terms of their putting performance and emotion item (positive and negative) selection for each set. All statistical analysis was performed using SPSS Version 22.0 (IBM SPSS Statistics for Windows, 2013).

Results & discussion

Putting scores

Results for the putting scores revealed a trend of scores decreasing through the five sets. Table A1 displays the mean and standard deviations for participants overall, along with male and female participant data for each set of trials. Analysis of overall putting scores for each set revealed a significant main effect between sets ($F_{4, 128} = 4.67$, $P < .05$, ω =.32). Pairwise comparisons returned a significant difference in putting score between sets 1 - 2 (set 1: 1.31 ± 0.70 m; set 2: 1.07 ± 0.67 m; $p < .05$); 1 – 4 (set 1: 1.31 ± 0.70 m; set 4: 1.03 ± 0.66 m; $p < .05$); and 1 – 5 (set 1: 1.31 ± 0.70 m; set 5: 1.03 ± 0.83 m; $p < .05$). Analysis of standard deviations (variability in putting performance) returned significant main effects across sets ($F_{3.76, 120.20} = 3.81$, $p < .05$, ω =.14) and a significant pairwise comparison between set 1 and 5 (set 1: 0.93 ± 0.47 m; set 5: 0.71 ± 0.45 m; $p < .05$). Gender results show that as a group, female participants missed the hole by significantly greater distances in comparison to the male participants in set 1 ($F_{1, 31} = 5.94$, $p < .05$, ω = .36); set 2 ($F_{1, 31} = 4.49$, $p < .05$, ω = .31); set 5 ($F_{1, 31} = 7.28$, $p < .05$, ω = .40). Scores were not significantly different between males and females for set 3 ($F_{1, 31} = 3.79$, $p > .05$, ω = .31) and set 4 ($F_{1, 31} = 3.04$, $p > .05$, ω = .28).

Table A1. Summary of putting scores and emotion items for each set.

	Putting Scores (m)				Emotion Items					
Set	**Overall Score Mean ± SD**	**Mean Variability ± SD**	**Male Mean ± SD**	**Female Mean ± SD**	**Positive Items**	**Negative Items**	**Total Items**	**% Positive**	**Mean Positive ± SD**	**Mean Negative ± SD**
1	1.31 ± 0.70	0.93 ± 0.47	1.14 ± 0.60	1.76 ± 0.79	140	98	238	58.82	4.24 ± 3.17	2.97 ± 2.46
2	1.07 ± 0.67	0.80 ± 0.45	0.92 ± 0.53	1.45 ± 0.87	171	64	235	72.77	5.18 ± 3.62	1.94 ± 2.56
3	1.05 ± 0.70	0.88 ± 0.51	0.91 ± 0.68	1.42 ± 0.67	177	69	245	71.95	5.36 ± 2.91	2.09 ± 1.88
4	1.03 ± 0.66	0.86 ± 0.52	0.91 ± 0.61	1.34 ± 0.72	182	55	237	76.79	5.52 ± 3.14	1.67 ± 1.93
5	1.03 ± 0.83	0.71 ± 0.45	0.81 ± 0.66	1.61 ± 1.00	158	49	207	76.33	4.79 ± 3.30	1.48 ± 1.80

Emotion items

Detailed counts of emotion items identified during the putting task are presented in Table A2. Raw data for each item is presented for each set, along with totals, and the origin of each item (see table caption). These raw results are also summarised in Table A1 revealing a clear dominance of positive over negative items. Statistical analysis of positive versus negative emotions per set revealed a significant main effect ($F_{3.72,\ 119.15} = 13.88$, $p < .001$, $\omega = .53$). Pairwise comparisons confirmed that positive (Pos) items were significantly more prominent than negative (Neg) items for: Set 3 (Pos: 5.36 ± 2.91; Neg: 2.09 ± 1.88; $p < .05$), Set 4 (Pos: 5.52 ± 3.14; Neg: 1.67 ± 1.93; $p < .05$), and Set 5 (Pos: 4.79 ± 3.30; Neg: 1.48 ± 1.80; $p < .05$). Pairwise comparisons did not reveal any significant differences across sets when assessing positive or negative item data separately (e.g. positive items in set 1 versus positive items in set 2 etc.). Total counts of emotion items (positive combined with negative) were also not statistically different between sets ($F_{4,\ 212} = 0.69$, $p > .05$, $\omega = .08$).

Table A2. Count of emotion items selected for each set and respective totals presented in descending order. Origin column indicates where the item originated: *SEQ* - exclusively from the preliminary list of 39 items of Jones et al. (2005); *Phase 1* - exclusively from the list of unique items in phase 1; *Both* – from both the preliminary SEQ and phase 1.

Item	**Set 1**	**Set 2**	**Set 3**	**Set 4**	**Set 5**	**Total**	**Origin**	**Cluster**
Competitive	9	12	16	15	12	64	Phase 1	3
Motivated	13	13	8	13	15	62	Both	3
Determined	10	10	20	7	13	60	Phase 1	3
Enjoyment	8	12	15	8	8	51	Phase 1	3
Fun	7	12	14	5	4	42	Phase 1	3
Successful	5	10	7	6	14	42	Phase 1	3
Excited	5	7	14	11	4	41	Both	3
Disappointed	12	5	9	7	8	41	Both	2
Comfortable	8	10	6	7	6	37	SEQ	2
Enthusiastic	12	7	4	8	5	36	SEQ	2
Frustrated	10	3	9	5	9	36	Both	2
Annoyed	13	4	8	8	3	36	Both	2
Happy	4	9	6	9	7	35	Both	2
Energetic	6	15	1	5	4	31	Both	2
Satisfied	4	2	2	12	9	29	Both	2
Irritated	7	7	5	6	3	28	SEQ	2
Cheerful	10	3	5	5	4	27	SEQ	2
Included	7	4	3	9	4	27	Phase 1	2
Eager	4	6	2	9	5	26	Phase 1	2
Pleasure	1	7	2	11	4	25	SEQ	2
Pleased	2	4	8	3	8	25	SEQ	1
Accomplishment	3	3	4	9	5	24	Phase 1	2
Proud	3	5	4	5	3	20	Phase 1	1
Pressured	4	4	8	2	1	19	Both	1
Unhappy	8	3	2	5	1	19	SEQ	1
Confusion	7	3	2	3	2	17	Phase 1	1
Bored	6	2	2	2	4	16	Phase 1	1
Relieved	1	3	3	1	8	16	Phase 1	1
Joy	3	3	4	2	3	15	Both	1
Attacking	3	2	3	4	3	15	SEQ	1
Nervous	6	2	3	2	1	14	Both	1
Alert	2	2	7	1	2	14	SEQ	1
Content	4	4	1	3	2	14	Both	1
Charged	3	0	6	4	0	13	SEQ	1
Fulfilled	1	3	3	4	2	13	Both	1

Stressed	2	3	4	2	2	13	Both	1
Anxious	2	1	3	2	3	11	Both	1
Uneasy	3	3	3	1	1	11	SEQ	1
Embarrassed	2	2	4	1	1	10	Phase 1	1
Exhilarated	0	5	1	2	2	10	SEQ	1
Tense	4	1	1	2	1	9	SEQ	1
Concerned	3	2	0	2	1	8	SEQ	1
Angry	3	3	1	0	1	8	Both	1
Daring	1	1	3	2	1	8	SEQ	1
Upset	0	2	2	1	3	8	SEQ	1
Apprehensive	0	1	1	1	2	5	SEQ	1
Furious	1	2	0	2	0	5	SEQ	1
Depressed	1	2	1	0	0	4	SEQ	1
Elated	1	1	2	0	0	4	Phase 1	1
Fear	2	0	0	2	0	4	Phase 1	1
Dejected	1	0	1	1	1	4	SEQ	1
Provoked	1	1	1	0	0	3	SEQ	1
Hatred	0	1	0	0	1	2	SEQ	1
Sad	0	1	0	1	0	2	Both	1

Combined results

From these results it can be observed that (overall) putting performance improved during the five 'learning' sets (significantly from: 1-2, 1- 4, and 1-5 - see Figure A1). The SD / variation in putting score showed a similar decreasing trend overall (significantly between sets 1 and 5) However, variability in sets 3 and 4 went somewhat against this trend. Positive items tended to outnumber negative items at each stage (significantly for sets 3-5), which is reflected in the percentages of positive items per set data presented in Table A1. Positive item data showed a trend of increasing from set 1 through to set 4, and then decreasing from set 4 to 5. Negative item data somewhat mirrored the positive item data, particularly in the early stages of the session. For the fifth set, mean putting score appeared to stabilise and variability was at the lowest value for the session (see Figure A1). Similarly, in terms of emotion items, the number of negative items identified reached the lowest value for the session at set 5. Interestingly the count of positive items also decreased at the final putting set to a value between that of sets 1 and 2.

Therefore, it can be interpreted that at the time of the first set the difference between positive and negative items was quite low, potentially reflecting the uncertainty and initial challenges of the task. As the putting session continued the difference between positive and negative items selected widened, suggesting that the participants were becoming more comfortable and successful with the task, which is reflected by the gradual decrease and stabilisation in mean putting scores (and to a lesser extent variation). The decrease in both positive and negative items at the final putting set might reflect that participants were now becoming accustomed and familiar with the task and no longer experiencing the range and intensity of emotions evident in earlier sets.

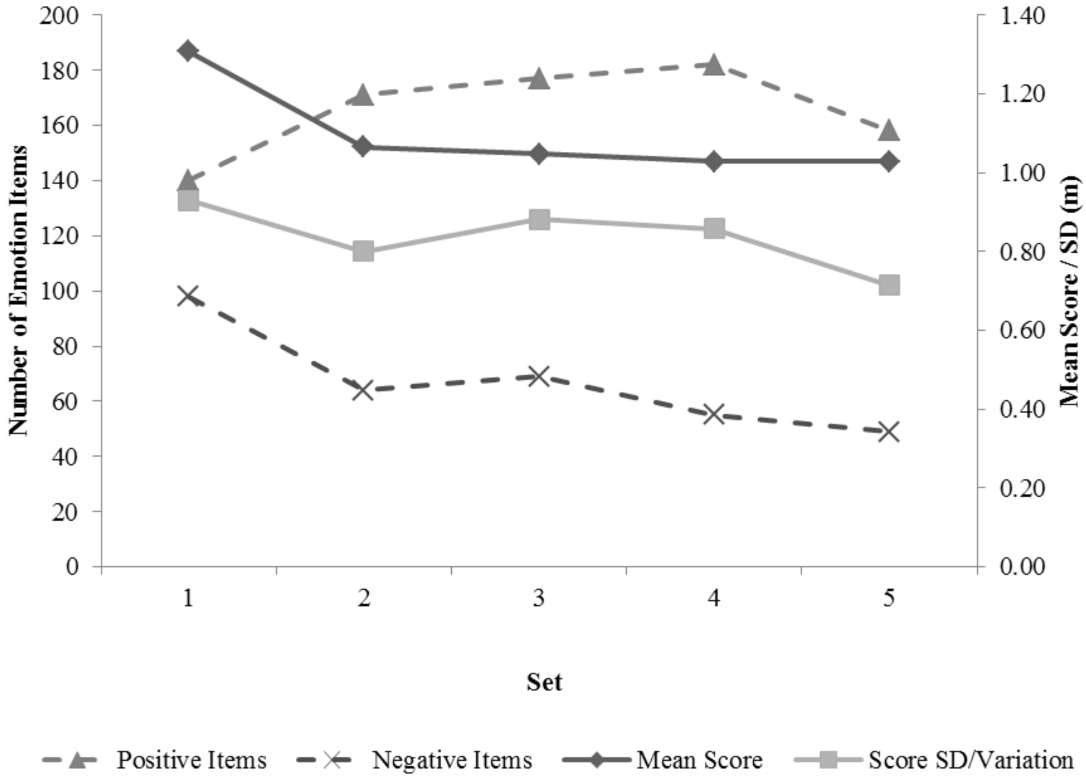


Figure A1. Representation of trends between emotion items and putting scores across sets.

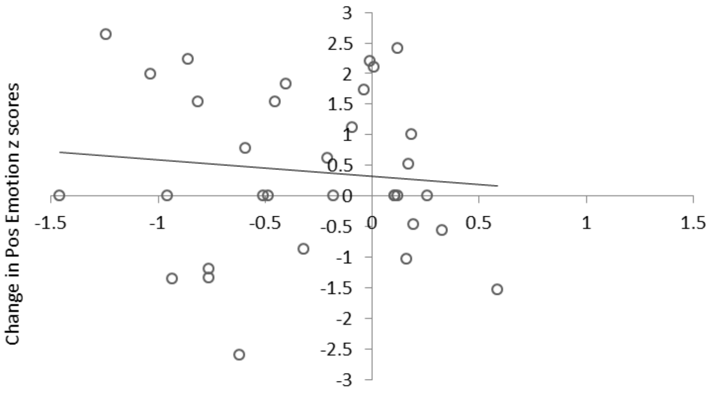
Correlations of change scores

Correlations for change in z score results revealed no significant correlations for between sets (e.g. set 1-2, set 3-4) or across the entire session (set 1-5). Change in putting score and positive item selection returned negative correlations for all sets and the session as a whole (Table A3). Correlations were generally quite small with the possible exception of set 3-4. Overall, these results revealed a trend of improved putting performance (decrease in z score) relating to increased selection of positive items (increase in z score) and vice versa. The correlation coefficients for changes in negative item selection in relation to putting scores were again quite small. Data comparing sets 3-4 and 4-5 did reveal trends of increased selection of negative items (increase in z scores) relating to a deterioration putting performance (increase in z scores).

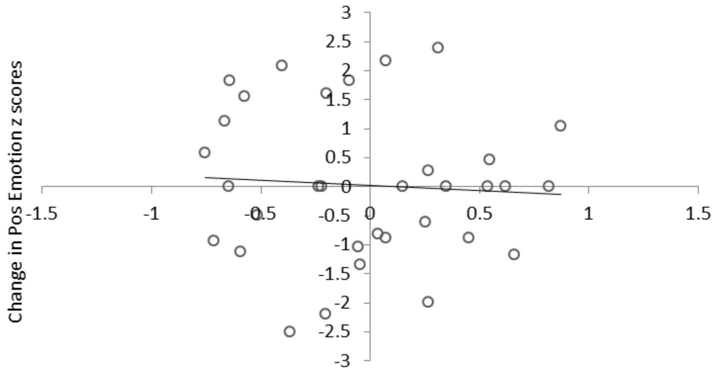
Table A3. Pearson (*r*) correlation coefficients [95% confidence intervals] for changes in z scores between putting performance and emotion item selection. S – putting score; P – positive items; N – negative items. No relationships were statistically significant at the .05 level.

	S1-S2	S2-S3	S3-S4	S4-S5	S1-S5
P1-P2	-.102 [-.487, .287]				
P2-P3		-.066 [-.358, .235]			
P3-P4			-.329 [-.614, .013]		
P4-P5				-.036 [-.390, .352]	
P1-P5					-.270 [-.571, .075]
N1-N2	.027 [-.241, .329]				
N2-N3		-.045 [-.398, .330]			
N3-N4			.222 [-.054, .513]		
N4-N5				.272 [-.003, .161]	
N1-N5					-.065 [-.403, .320]

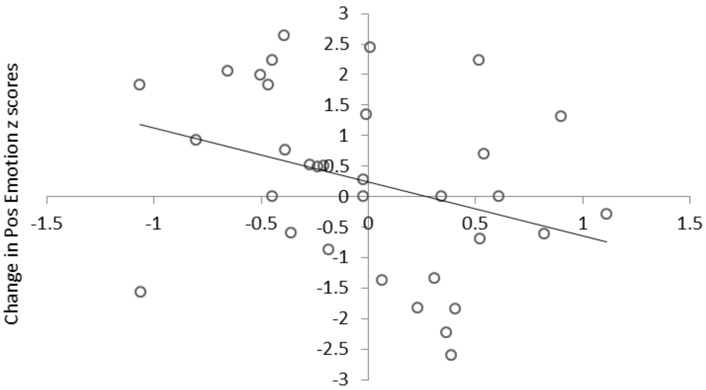
Figures A2 and A3 present the relationships between each of the sets graphically for positive and negative items respectively. Correlations of change between set 1-2 and 2-3 show little evidence of any trends for either positive or negative item data. This suggests that during these early sets the participants were still exploring the task and therefore selected a range of positive and negatively valenced emotion items, which is supported by the mean and standard deviation values reported in Table A1. Figures A2a and A3a show that many of the participants improved their putting scores between sets 1 and 2 with a majority of cases lying to the left of the y-axis, indicating decreases in putting score (i.e. distance to hole). Data from set 3 to set 4 (Figures A2c and A3c) revealed the most evident differences between positive and negative item relationships with putting performance. While the correlation values remained moderate at best, some trends can be observed. For positive item data, decreases in putting score related to increased positive emotion item selection (cases in the top-left quadrant), and increases in putting score related to decreased item selection (cases in the bottom-right quadrant). Conversely, negative item data revealed that decreases in putting score related to decreased negative emotion item selection (bottom-left quadrant), and increases in putting score corresponded to increased negative item selection (top-right quadrant). These results suggest that during these sets many participants were beginning to associate their putting performance (successful or unsuccessful) with specific emotion items. Similar patterns are evident between sets 4 and 5 however with a weaker/stronger correlation for positive/negative item data respectively.



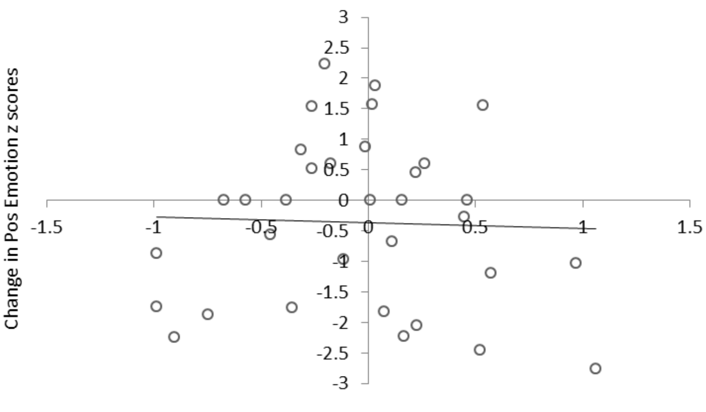
(a) Change in putting z scores Set 1-2



(b) Change in putting z scores Set 2-3



(c) Change in putting z scores Set 3-4



(d) Change in putting z scores Set 4-5

Figure A2. Correlations of changes in z scores for putting performance and number of *positive* item selections between sets.

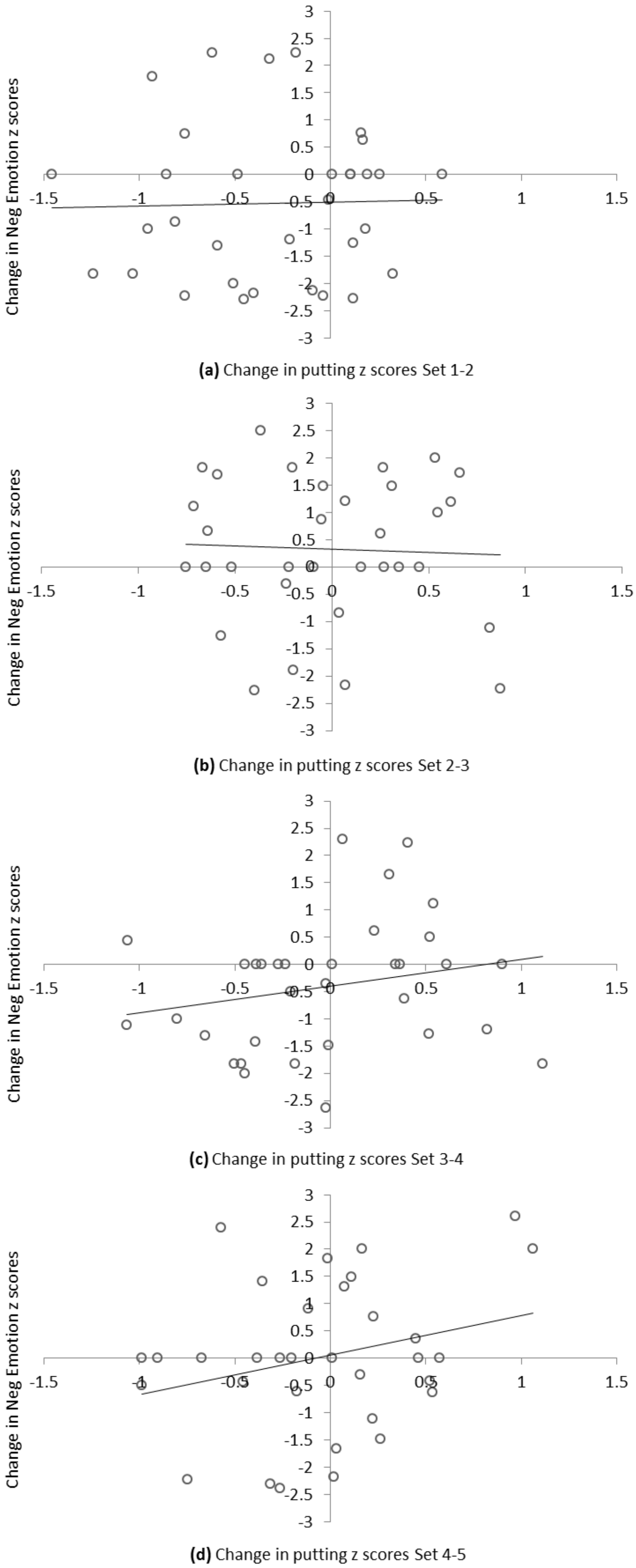
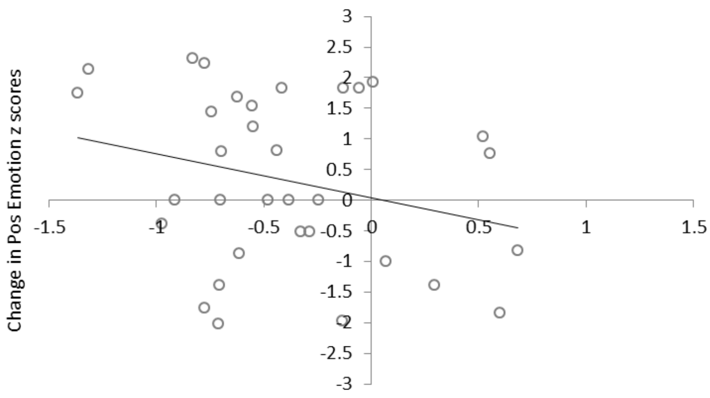
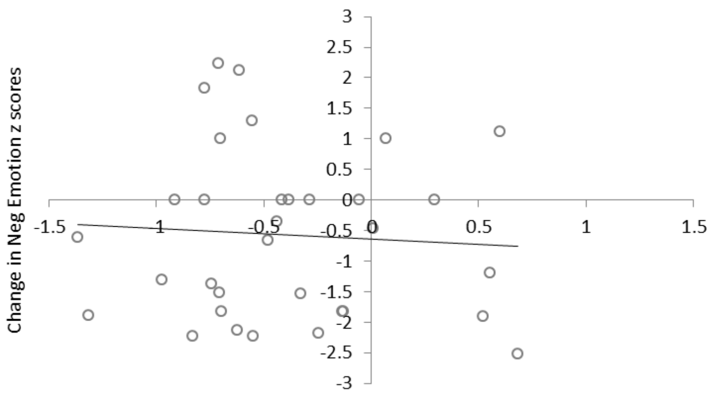


Figure A3. Correlations of changes in z scores for putting performance and number of *negative* item selections between sets.

Correlation data for change in z scores from the start to the end of the session (set 1-5) were also small – medium at best. Positive item data revealed a negative trend indicating that the majority of participants improved their putting performance throughout the session along with increased selections of positive items (Figure A4a). This supports the previous findings of putting performance (distance to hole) improving significantly throughout the session, and the significant predominance of positive items in sets 3, 4, and 5 (Table A1). Changes in negative emotion item data from the start to the end of the session were not as defined, this suggests increased individual variability in the prevalence of negatively oriented items throughout the session. As expected participant putting scores generally improved, however the changes in negative item selection were more ambiguous. This could reflect the predominance of positive items throughout the session and the possibility of participants continuing to select positive items even when their putting performance was not improving (i.e. a positive experience of the task regardless of result given that participants were not golfers and the task was carried out in a University setting).



(a) Change in putting z scores Set 1-5



(b) Change in putting z scores Set 1-5

Figure A4. Correlations of changes in z scores for putting performance and number of **(a)** *positive* and **(b)** *negative* item selections across the session(Sets 1-5)

Cluster analysis:

Emotion items

Hierarchical cluster analysis of the emotion items using Ward's method produced three clusters which contained items that were identified at significantly different frequencies on each of the five putting sets (see Table A4). Cluster 1 comprised of 33 items, with 16 (48.48%) originating from the phase 1 list. Cluster 2 comprised of 14 items, of which 9 (64.29%) originated from the phase 1 list. All seven items that grouped to cluster 3 originated from the phase 1 list. Significant main effects were found between clusters for each putting set: Set 1 ($F_{2, 51}$ = 23.45, p < .05, ω =.54); Set 2 ($F_{2, 51}$ = 51.80, p < .05, ω =.70); Set 3 ($F_{2, 51}$ = 47.35, p < .05, ω = .68); Set 4 ($F_{2, 51}$ = 66.14, p < .05, ω =.74); Set 5 ($F_{2, 51}$ = 36.52, p < .05, ω =.63). Cluster 3 items were found to be more frequently selected than cluster 1 items in all sets; along with cluster 2 items in sets 2, 3, and 5 (see Table A4 for mean and SD values). Further, cluster 2 items were more frequently selected than cluster 1 items in all sets. Returning to Table A2, it can be observed that of 21 of the 22 most selected items overall are from cluster 2, and 3 with the top 7 items making up cluster 3. Additionally, the 8 most selected items are all included in the list from phase 1. In contrast, the 32 least selected items overall are from cluster 1 with 16 originating from the preliminary SEQ only. This leaves a further 9 items shared between the SEQ and the phase 1 list, and 7 items originating exclusively from phase 1.

Table A4. Items grouping to the three clusters and the origin of these items (Phase 1 list or preliminary SEQ). Mean values display the predominance of Cluster 3 items for all occasions where emotion items were selected. Significant differences between clusters indicated for: cluster 1 and 2 [a]; cluster 2 and 3 [b]; cluster 1 and 3 [c].

	Cluster 1			Cluster 2			Cluster 3		
Phase 1 Items	Angry	Anxious	Bored	Accomplished	Annoyed	Disappointed	Competitive	Determined	Enjoyment
	Confusion	Content	Elated	Eager	Energetic	Frustrated	Excited	Fun	Motivated
	Embarrassed	Fear	Fulfilled	Happy	Included	Satisfied		Successful	
	Joy	Nervous	Pressure						
	Proud	Relieved	Sad						
		Stressed							
SEQ Items	Alert	Apprehensive	Attacking	Cheerful	Comfortable	Enthusiastic			
	Charged	Concerned	Daring	Irritated	Pleasure				
	Dejected	Depressed	Exhilarated						
	Furious	Hatred	Pleased						
	Provoked	Tense	Uneasy						
	Unhappy	Upset							

	Cluster 1 Items Mean± SD	**Cluster 2 Items Mean ± SD**	**Cluster 3 Items Mean ± SD**
Set 1 [a c]	2.42 ± 2.05	7.21 ± 3.77	8.14 ± 2.85
Set 2 [a b c]	2.18 ± 1.33	6.07 ± 3.52	10.86 ± 2.04
Set 3 [a b c]	2.55 ± 2.20	4.71 ± 2.64	13.43 ± 4.54
Set 4 [a c]	1.91 ± 1.38	7.86 ± 2.18	9.29 ± 3.77
Set 5 [a b c]	1.82 ± 1.93	5.43 ± 2.06	10.00 ± 4.65

Participants

Cluster analysis of individual participant results produced two distinct clusters based on putting scores and emotion items for each set (see Table A5). Participants grouped to cluster 1 were found to select significantly more positive items in all five putting sets than those from cluster 2 (P1-P5). Cluster 1 participants also selected significantly fewer negative items in the second putting set (N2). Despite no statistically significant differences, cluster 1 participants also showed a trend of achieving lower mean putting scores (i.e. closer to the hole) than cluster 2 participants in all sets (S1-S5). These results echo the correlation data with some participants (cluster 1) showing improved putting performance with associated increases in positive emotion item selection. On the other hand the remaining participants (cluster 2) appeared to select fewer positive emotion items, displayed higher mean putting scores, and on occasion higher counts of negative items.

Table A5. Comparison of participant gender breakdown, putting scores (S), positive items (P), and negative items (N) between the two clusters for the five putting sets. *Significant differences at the .05 level.

	Cluster 1 n = 17	Cluster 2 n = 16	*F (df)*	Effect size (ω)
Gender	M: 13 F: 4	M: 11 F: 5	$.23^{(1, 31)}$	.12
S1	1.24 ± 0.44	1.31 ± 0.48	$1.43^{(1, 31)}$	.09
P1 *	5.94 ± 2.88	2.44 ± 2.42	$14.20^{(1, 31)}$	.44
N1	2.47 ± 1.84	3.50 ± 2.94	$1.47^{(1, 31)}$	.09
S2	1.00 ± 0.56	1.13 ± 0.79	$.30^{(1, 31)}$	.11
P2 *	8.24 ± 1.86	1.94 ± 1.57	$110.16^{(1, 31)}$	.82
N2 *	0.59 ± 1.18	3.38 ± 2.87	$13.60^{(1, 31)}$	.44
S3	0.96 ± 0.76	1.15 ± 0.65	$.59^{(1, 31)}$	.09
P3 *	6.88 ± 2.18	3.75 ± 2.77	$13.14^{(1, 31)}$	.43
N3	2.24 ± 2.05	1.94 ± 1.73	$.20^{(1, 31)}$	.12
S4	0.96 ± 0.64	1.11 ± 0.69	$.41^{(1, 31)}$	.10
P4 *	7.59 ± 2.27	3.31 ± 2.36	$28.22^{(1, 31)}$	.58
N4	1.53 ± 1.77	1.81 ± 2.14	$.17^{(1, 31)}$	.12
S5	0.84 ± 0.74	1.22 ± 0.90	$.19^{(1, 31)}$	.12
P5 *	6.29 ± 3.06	3.19 ± 2.81	$9.20^{(1, 31)}$	.36
N5	1.18 ± 1.51	1.81 ± 2.07	$1.02^{(1, 31)}$	.02

When considered as a whole, the cluster analysis results indicated that the emotion items identified in phase 1 were found to be preferred by participants completing the putting task than those exclusively from the preliminary SEQ of Jones et al. (2005). To be specific, 16 of the 21 words from clusters 2 and 3 were from the phase 1 list (see Table A4). A likely reason for this finding is that the words from phase 1 were originally identified with the context of 'learning' in mind as opposed to 'competition' in the case of the SEQ. The predominance of cluster 3, and to a lesser extent, cluster 2 items across the entire putting session indicates that these words were most frequently selected as relating to learning. However, the majority of these words are also positively valenced which, as reported earlier, were selected significantly more across all sets. Previous work has suggested that negative emotions might be experienced less frequently, but at higher intensities (Diener, et al., 1985; Lane & Terry, 2000; Woodman, et al., 2009). Therefore, these results are not conclusive in terms of identifying the most relevant emotion items for learning, because the intensity of items (particularly negative items) is somewhat overlooked when analysing purely on frequency (Larsen & Diener, 1987). Nevertheless, the finding that the seven most identified items were all from the phase 1 list provides strong support for the need to develop a emotion questionnaire specific to learning contexts.

Cluster analysis results concerning putting performance and emotion item selection for individual participants support the hypothesised link between emotion and performance (action, outcome) in a practical task. The finding that one group or cluster of participants selected significantly more positive items in all sets, and also tended to be more successful with the putting task provides initial evidence for considering these behavioural aspects in unison. From an alternate perspective, the second group of participants generally exhibited higher counts of negative items alongside their less successful putting performance, reflecting the individualised nature of learning experiences (Larsen & Diener, 1987). The less pronounced difference in negative items between clusters again exemplifies how these items might be identified less frequently, but potentially representing higher intensities (Diener, et al., 1985).

Considering all the previous findings, the conclusions from this exploratory pilot study suggest that the majority of items included on the SEQ are not appropriate for learning contexts. While some items were common between the SEQ and the phase 1 list, the items exclusive to the SEQ were on the whole neglected, implying that these items were not considered relevant. Therefore, the development of an emotion tool specific to learning in sport is warranted. Furthermore, this golf putting study reveals how performance outcomes (distance to hole), and emotions can interact during a learning task. Variability and fluctuations in key measures such as these has the potential to provide insights regarding the holistic experience of a performer, or group of performers over time.

Appendix D – Emotions during learning in sport survey (phase 2)

QUT Ethics Approval Number: 1400000571

Emotions During Learning in Sport Survey

The purpose of this survey is to identify emotions that performers experience when learning a skill in sport. Participation involves written completion of this short survey. All responses will remain anonymous and confidential. Participation is entirely voluntary, and you may withdraw at anytime without comment or penalty. Your decision to participate will in no way impact upon your current or future relationship with QUT (for example your grades).
If you have any questions about the survey please feel free to contact: Jonathon Headrick: jj.headrick@qut.edu.au

Part A: Background Information

1. Age (in years): ____

2. Gender: _________

3. Have you previously or are you currently learning to perform / play a sport competitively?

Please circle one: **YES** **NO**
(If **NO** do not complete any further questions)

4. What was/is the main sport that you participate in? ______________________________

5. For this sport what is your highest level of participation (e.g. school, club, district, regional, state, international)? ____

Part B: Emotions

THE FOLLOWING INSTRUCTIONS REFER TO THE TABLE OVER THE PAGE

In relation to your **experiences of learning to perform a skill in any sport** please read each word listed down the page, and place a ✔ to:

1. Indicate if a word is **relevant** to emotions you have experienced during learning in sport.
2. Indicate if a word relates to any of the five (5) identified categories (anxiety, dejection, anger, excitement, and happiness).

Place a ✔ in as many boxes as you feel appropriate and leave the remaining boxes blank.

Please see over the page for the response table.

Thank you for your participation

RESEARCH TEAM ONLY		
Number	Unit	Logged

Page **1** of 2

QUT Ethics Approval Number: 1400000571

	1	2				
	Relevant?	Anxiety	Dejection	Anger	Excitement	Happiness
Accomplishment						
Achievement						
Angry						
Annoyed						
Anxious						
Bored						
Competitive						
Confusion						
Content						
Determined						
Disappointed						
Eager						
Elated						
Embarrassed						
Energetic						
Enjoyment						
Excited						
Fear						
Frustrated						
Fulfilled						
Fun						
Happy						
Included						
Joy						
Motivated						
Nervous						
Pressure						
Proud						
Relieved						
Sad						
Satisfied						
Stressed						
Successful						

Page 2 of 2

Appendix E – Emotions during learning in sport survey (phase 3)

QUT Ethics Approval Number: 1400000571

Emotions During Learning in Sport Survey

The purpose of this survey is to identify emotions that performers experience when learning a skill in sport. Participation involves written completion of this short survey. All responses will remain anonymous and confidential. Participation is entirely voluntary, and you may withdraw at anytime without comment or penalty. Your decision to participate will in no way impact upon your current or future relationship with QUT (for example your grades).
If you have any questions about the survey please feel free to contact: Jonathon Headrick: jj.headrick@qut.edu.au

Part A: Background Information

1. Age (in years): ____

2. Gender:________

3. Are you currently learning to perform / play a sport competitively?

Please circle one: **YES** **NO**
(If **NO** do not complete any further questions)

4. What is the main sport that you participate in? ________________________________

5. For this sport what is your highest level of participation (e.g. school, club, district, regional, state, international)? ________________________________

6. How long have you been competing in total (years / months)?________________________

Part B: Emotions

THE FOLLOWING INSTRUCTIONS REFER TO THE TABLE OVER THE PAGE

7. Please read each word listed down the page and indicate (circle a number from 0-4) on the scale ***how you feel in relation to the session you have just completed***.

Please see over the page for the response table.

Thank you for your participation

RESEARCH TEAM ONLY		
Number	Unit	Logged

Page **1** of **2**

QUT Ethics Approval Number: 1400000571

Please make sure to circle a number for each word.

	Not at all	A little	Moderately	Quite a bit	Extremely
Accomplishment	0	1	2	3	4
Achievement	0	1	2	3	4
Angry	0	1	2	3	4
Annoyed	0	1	2	3	4
Anxious	0	1	2	3	4
Bored	0	1	2	3	4
Competitive	0	1	2	3	4
Confusion	0	1	2	3	4
Content	0	1	2	3	4
Determined	0	1	2	3	4
Disappointed	0	1	2	3	4
Eager	0	1	2	3	4
Elated	0	1	2	3	4
Embarrassed	0	1	2	3	4
Energetic	0	1	2	3	4
Enjoyment	0	1	2	3	4
Excited	0	1	2	3	4
Fear	0	1	2	3	4
Frustrated	0	1	2	3	4
Fulfilled	0	1	2	3	4
Fun	0	1	2	3	4
Happy	0	1	2	3	4
Included	0	1	2	3	4
Joy	0	1	2	3	4
Motivated	0	1	2	3	4
Nervous	0	1	2	3	4
Pressure	0	1	2	3	4
Proud	0	1	2	3	4
Relieved	0	1	2	3	4
Sad	0	1	2	3	4
Satisfied	0	1	2	3	4
Stressed	0	1	2	3	4
Successful	0	1	2	3	4

THIS IS THE END OF THE SURVEY

Page **2** of **2**

Appendix F – Perception of speed scale

PERCEPTION OF SPEED SCALE

0	Unplayable
1	Silly Slow
2	Slow
3	Slow – Medium
4	Medium – Slow
5	Medium
6	Medium – Fast
7	Fast-Medium
8	Fast
9	Express
10	Unplayable

Appendix G – Confrontational interview questions and answers

Over 1

Questions	Answers
So who do you think won that over, yourself or the bowler	Probably him
Why is that?	I scored one off the over and played and missed at a couple
What can you tell me about the bowler's skill level that over?	He probably wasn't that happy with how he bowled there. He didn't hit the same spot 6 balls in a row. Tried too much I think
Do you think the bowler had a game plan?	No not really, I don't think he had one.
Fair enough, did you have a target in mind?	Not really wasn't really thinking about it, just thinking bat on ball I think.
What can you tell me about your game plan next over?	Probably leave a couple more and not force much. Just if there is a couple of bad balls just hit them.
So are you doing anything differently this over?	Probably not play at wide ones like I did last over

Over 2

Questions	Answers
Who do you think won that over, yourself or the bowler	Probably myself
Why is that?	Left a lot more, didn't try anything stupid and got a couple runs of it
What can you tell me about the bowlers skill level that over?	Definitely improved. Executed his bumper, executed his balls outside off stump . Probably that last ball wasn't idea I don't think but thought it was a good over
Do you think the bowler had a game plan?	Yeah that one he did
What was it?	Bowl a couple outside off, then bump me. Try and make my feet stop moving
So was he successful?	Yeah
Did you have a target in mind that over?	No not really. Just try to survive like I did last time. And if there's a bad ball hit it again like I did
Did that change at any point during the over	Not really
And what can you tell me about your game plan next over?	Just try and keep it the same

How do you plan on scoring runs?	Through cover. There's a big gap through there so if I just punch it through there will be a couple runs. Or if he bowls on my pads then through square leg

Over 3

Questions	Answers
Who do you think won that over, yourself or the bowler	Me
Why is that?	I hit the balls he probably thought were good for runs and got him a bit frustrated then he tried to bowl on my pads to try and get a wicket on the last ball but misexecuted (sic).
What can you tell me about his skill level that over?	I thought he would probably try something else cause they weren't working bowling out there, maybe change the field or bumper. But it didn't
What do you think he did right and what do you think he did wrong	He probably tried to stay patient but it wasn't. He tried to stay patience but just wasn't executing.
Do you think he had a game plan?	A little bit but it wasn't very successful
What do you think it was?	Bowl outside off, same as before. Just bowl outside off and try make me play and miss or nick one.
Did you have a target in mind that over?	Nah not really. Just if I felt like I could hit it, I would hit it
And what can you tell me about your game plan next over?	Still the same, still try to keep it simple
Do anything different?	Nah
How do you plan on scoring runs?	Well he's moved cover out, so try and get it in the gaps or stay patient and wait for the bad ball and hit that
Any particular gaps	If he bowls outside off probably cover or square leg
Whys that?	Its where I feel comfortable

Over 4

Questions	Answers
Who do you think won that over, yourself or the bowler	Probably me.
Why is that?	He had a plan, I played against it and it was successful for me

What did he do right	He tried to, he had a 7-2 offside field and bowled out there. And I kept hitting him through the legside which he wasn't too happy about
What can you tell me about his skill execution that over?	It probably wasn't, he might have liked to bowl a little wider I think. He wouldn't have wanted me playing through the legside
Do you think the bowler had a game plan?	Try and bowl outside off with a 7 -2 off side field, get me frustrated and play against the ball on legside but his execution probably wasn't good enough for that
Did you have a target in mind	Nup
And what can you tell me about your game plan next over?	He's probably going to change the field so just have a look at the field change and think about where the best options to score are
If he keeps it the same?	Same then
Okay now he's changed it, what can you tell me about your game plan next over?	Probably be a bit more reserved in my onside play because he got a midwicket in now so I can't really risk playing across the line now too much.
How do you plan on scoring runs	If he bowls a bit wide maybe try dab him a bit through the slips cause there is 1 slip, 1 gully, no third man, so there is a definite 4 ball there

Over 5

Questions	**Answers**
Who do you think won that over, yourself or the bowler	Myself
Why is that?	Probably didn't execute and he was pretty frustrated throughout the whole over about fielding and bowling. So he didn't really think about it too much I don't think
What can you tell me about his execution?	He was a bit frustrated so he wasn't think about execution he was thinking about pace. I think his pace increased throughput the over
What do youy think he did right and what do you think he did wrong	He probably tried to bowl where he wanted to, but it was just not going where he wanted it to because he mentally not there

Do you think the bowler had a game plan?	I wasn't too sure about it, I think he just went for a standard one day ring field, try to bowl stump to stump
Was he successful?	I think so yeah
Did you have a target in mind	No
And what can you tell me about your game plan next over?	Stay the same. Keep trying to hit the gaps. If it's a bad ball, hit it
How do you plan on scoring runs	Same as I did last over, hit the gaps. If it's on the pads flick it through legside
Any gaps in particular?	Square leg, hit that one a bit straight. Probably could have hit it squarer

Over 6

Questions	**Answers**
Who do you think won that over, yourself or the bowler	I think that was even
Why is that?	He bowled pretty tightly and I didn't score too many runs. But I still felt pretty confident
What can you tell me about the bowler's execution that over?	It improved that over. He wasn't as frustrated I don't think
What do you think he did right?	Just bowled tight didn't give me much room to play with
Do much wrong?	No I don't think
Do you think the bowler had a game plan?	Yeah just bowl stump to stump. Make me hit in the air or change what I need to do
Was he successful?	I didn't change what I needed to do. I stayed pretty compact in what my plan was
Did you have a target in mind?	No
And what can you tell me about your game plan next over?	Going to stay the same. If there is a bad ball, hit it. Try and get a single of it.
Where are you looking to score runs?	Again through square leg and then if it's up try hit it back past him

Over 7

Questions	**Answers**
Who do you think won that over, yourself or the bowler	Me
Why is that?	Scored more runs, scored a lot more runs than normal. Just played a couple more aggressive shots - try and get him

	on the back foot.
What can you tell me about his skill execution that over?	I think it was pretty good, kept the same plan as last time and just make me make a mistake, then put a wider one in to tempt me into that wide shot and I fell for that.
So that's something he did right, did he do anything wrong?	Probably strayed a bit on my pads. I moved across during his delivery stride and he probably saw that and went, "oh I might try bowl on his pads" so I was able to put it away easier than if it was a normal ball
Did you have a target in mind	Nah I was a bit more aggressive that over though. Played a couple more big shots than normal
Was there any point during the over where that changed?	Nah I was feeling because he came a bit closer I could be a bit more risky cause he's a bit quicker and didn't have to, I just, a bit of power would help me get through it a bit. And there weren't risky shots per se but like shots I felt comfortable with playing, more aggressive
And what can you tell me about your game plan next over?	Probably try and keep it the same that over, score a couple more runs and if the bad ball is there make sure I put it away.
How do you plan on scoring runs	Probably couple more fours, not many singles on offer so if I can get it through the field I feel like it's going to be four Sorry, he's moved square leg back and taken gully out so there is a big gap behind point. So if he bowls anything wide I'm going to try and hit it through that gap. And probably not as many aerial shots through square leg but still trying to play through there.
Is that what you did last over?	No I played a bit more aerial because there wasn't anyone back I could risk it. But not that someone back I probably don't want to try getting caught on the fence

Over 8

Questions	Answers
Who do you think won that over, yourself or the bowler	Me
Why is that?	Scored a fair few runs
What can you tell me about his skill execution?	Yeah it was pretty good I think. He bowled a decent line and length, but a couple of balls I played an absolutely fluky shot and it went for four. And then just sort of hacked that last ball. So yeah I think he bowled pretty well.
Did he do anything wrong?	Nah I don't think so
Do you think the bowler had a game plan?	Did he? I think so he changed his field a couple of times during that over so he was still thinking which I think he's just trying to bowl outside off again but a couple of risky shots there from me helped confuse his game plan a bit.
So what do you think he was trying to do?	Bowl outside off and make me play across the leg side again
Was he successful?	Yeah I think so yeah
Did you have a target in mind	I was probably trying to increase the run rate a little, play a couple of big shots, get him to change the field which was successful
Did your target or game plan change at any point during that over?	A little bit yeah. Sort of just thinking a couple more runs in that over would be nice. So I played that risky shot in that last ball
And what can you tell me about your game plan next over?	Probably stay the same, still try to attack him a bit more
How do you plan on scoring runs?	Back past him I think and well he's put that man back at third man so that's an easy single. Just got to get some bat on it

Over 9

Questions	Answers
Who do you think won that over, yourself or the bowler	Him
Why is that?	Just bowled really tight, couldn't do much about it, was trying to invent stuff but it just wasn't working.
Any reason why?	Ah just kept bowling great line and

	length, like yorkers when he needed to, short balls, I couldn't really move my hands too much.
Yeah, so what did you then think of his skill execution?	His was really good
Did he do anything wrong?	Yeah I don't think so no
Do you think he had a game plan?	Yeah he was just trying to bowl either yorkers or short when I was moving around. So it wasn't, I couldn't really access the ball too much, get my hands through
So he was pretty successful?	Yeah
Did you have a target in mind	I was trying to score as many runs as possible
Yeah, how did you go?	Not too great.
Did it change at any point during the over?	No - same thing the whole way really
And what can you tell me about your game plan next over?	Might go a bit more reserved. Stay a bit more still and try access the ball from there
Why is that?	Cause I think it suits his game moving around a lot. Me moving around. So if I just stay still and try wait for the ball to come into my zone, it'll be easier to hit
How do you plan on scoring runs	Try hit over covers and back over his head. Then if it's on my hip dab it for a couple
Do you consider that more reserved than how you played last over?	Yeah cause I was moving around a lot trying to create something that wasn't there.
So what does reserved mean to you?	Well in this scenario reserved means staying still and just waiting for that bad ball. Whereas I was moving around trying to make a bad ball

Over 10

Questions	Answers
Who do you think won that over, yourself or the bowler	I think I ended up winning it after that last ball. I wasn't trying to play too many shots, but I suppose when its last ball I might as well. And the lucky four helped my cause, I only got singles off every other ball pretty sure
What can you tell me about the bowler's skill level that over?	I think I helped it go down because I didn't move around. He likes when people move around and try sort it out but I don't think it was as good as his last over
Did he do anything right?	Yeah he bowled pretty tight areas, I know that's his best ball so I try use it to my advantage by moving around in my crease. But not move too much
Did he do anything wrong?	Probably bowled a bit too much on my toes and my body the first three or four balls because, that was his, I think that was his plan though. Just cramp it up and then get me singles. But no, cramp me up for room and then he went away from that. Which wasn't very good
Did you have a target in mind?	My goal was not get out, and then get six singles or if it was there, a four or a couple.
And you mentioned you changed on the last ball?	Yeah I was, it was last ball I might as well risk it. And if I get four, I get four, otherwise it was going to be a dot because I wasn't trying to go in the air I was going to try play that shot and it was just successful

End of Game

Questions	Answers
How do you think you went overall for the 10 overs	I think I did pretty well
In terms of trying to achieve whatever your goal was?	Goal was to not get out and score as many runs as possible. And I think I did that
Do you feel like you were consistent throughout the whole test? Or were there periods where you did better than..	Periods at the start and end where I wasn't trying to score too many runs. Like mix patches. But I think you go through that in cricket, you go through that in batting
If you were to rate yourself from 1 – 10 on how successful you were?	Probably a 7
What do you think you might have done wrong?	Probably got a bit frustrated with myself towards the end. Once I went back to my plan I felt I was more successful?
Was there any point in particular did you feel you fell off or got frustrated?	Yeah I can't remember what over it was that over where I was running moving doing everything under the sun. But next ball, next over sorry I felt better
Was there any reason why you changed your game plan and started moving around?	Trying to score a few more runs. But then I realised that's not my game plan to move around too much and I should instead stay still