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It Really Does Depend: An Exploration Into the Dichotomous Positions Held Across the Psycho-Motoric Concomitants to High-Level Performance

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Abstract

As the practice of performance psychology has evolved, so too has the underpinning knowledge within this field. Throughout this evolution, however, a number of theoretical stances or positions have emerged which often sit in stark contrast to one another, therefore creating divides or disagreements amongst the practitioners attempting to optimise translational impact. Accordingly, this thesis aimed to explore these contrasting positions, presented as paired dichotomies, and better understand which side of the dichotomy was more representative of high-level performance and/or practice. Of note, these dichotomies were divided into absolutist (whereby the positions or contentions made were seen as *the* explanations) versus nuanced (in which a number of possible explanations exist to explain performance) positions.

    As an applied practitioner and academic, this thesis employed a pragmatic philosophy which meant that a number of real world scenarios that I, and my peers, often encounter were explored in order to better understand the dichotomies. These were examined through three empirical studies and one desk-based study, exploring a variety of sports. Following a literature based desktop study, the veracity of the belief in 'natural talent' was explored through a literature and media analysis in Motorsport. Next, EEG measures were taken during a Golf-putting task in which participants used two different visual aiming styles. In the second empirical chapter, the role of cognition and understanding in decision making by elite Rugby Union players was explored. Finally, to consider a sport which has not experienced as much, if any, formal coaching, I sought to understand the practice habits and learning tools of Skateboarding performers.

    Taken together, the results of this research indicate the following: i) from a learning perspective, performers are not born with a natural talent, but instead develop their skills and a number of effortful learning behaviours through both deliberate cognitive processes as well

as an ongoing interaction with their environment; ii) from a learning, performance and refinement perspective, performers still require a combination of cognition and explicit knowledge as well as an ongoing interaction with the environment, notably, practitioners are able to switch between appropriate levels of focus as required; and iii) exclusively from a performance perspective, very little execution is fully automatic and instead, scalable cognition is required for high-level performance. In short, practitioner should take an 'it depends' approach to their research and practice.

Lay Summary

For applied psychology practitioners, coaches, athletes and other stakeholders, there are a vast number of contrasting tools, ideas and concepts being promoted within the sporting domain which often contradict one another. These contrasting positions, or dichotomies, tend to manifest as absolutist (what is offered is the only answer) versus nuanced (a number of possible answers). Reflecting this, my thesis aimed to explore the dichotomies in more detail to better understand which might be the most appropriate approaches when striving to create and support high-level performers. As an applied practitioner myself, I achieved this by testing the dichotomies against a number of real world problems I have experienced in the past.

Following a review of the relevant literature in a desktop study, the development and performance habits of elite Motorsport drivers were explored. Next, participants completed a Golf-putting task under two different visual aiming techniques with different degrees of familiarity. Following this, elite level Rugby Union players discussed their experiences of employing effective decision making. Finally, to understand an environment which does not have formal coaching, Skateboarding performers discussed their preferred tools and processes for practice and development.

The dichotomies were divided into three groups: i) learning, ii) performance, learning and refinement and iii) performance. Across these three groups, my findings indicated that in each context a nuanced approach is the most appropriate. This suggests that practitioners should deploy an 'it depends' perspective to their research and practice, which simply means that no single answer is the right answer all of the time. Instead, most likely, a number of tools, concepts and beliefs should be deployed to best support performers.

A key consideration that should be taken into account by practitioners is the role of thinking and understanding across all contexts. Of note, the findings of this research would

suggest that the role of thinking, and indeed the direction of this thought, can change across a number of different performance scenarios but it is ever-present. Therefore, it should not be ignored at any stage, least of all during learning.

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List of Abbreviations

Abbreviation	Full Term
BFA	Ball Focused Aiming
CAH	Constrained Action Hypothesis
CDM	Classical Decision Making
CLA	Constraints-Led Approach
COC	Central Organising Concept
DM	Decision Making
DoF	Degrees of Freedom
DP	Deliberate Practice
EcoD	Ecological Dynamics
MAP	Multi-Action Plan
NDM	Naturalistic Decision Making
PJDM	Professional Judgement and Decision Making
RPDM	Recognition Primed Decision Making
SMM	Shared Mental Model
SMU	Shared Meaning Unit
TFA	Target Focused Aiming
UCM	Uncontrolled Manifold

Glossary of Terms

Central Organising Concepts – Previously thought of as higher-order themes in thematic analysis, Central Organising Concepts are the co-collaborated terms, which encompass shared meaning units under a common theme (Braun et al., 2018).

Classical Decision Making – A style of decision making in which performers will typically generate and think through various options prior to making a decision (Mascarenhas & Smith, 2011).

Constraints-Led Approach – A tool utilised by coaches which states that manipulating, or constraining, either the performer, their environment or their task results in behaviour change (Newell, 1986). As a performer, you will influence the movement through the interaction with a perception–action coupling mechanism and therefore result in motor learning (Davids et al., 2008).

Deliberate Practice – A structured activity which should include the opportunity for repetition with error detection and correction, require full attention, with maximal effort and complete concentration, and requires immediate access to useful feedback (Ericsson et al., 1993).

Dynamical Systems Theory – A theory exploring complex interactions within natural sciences, such as viewing human movement as a complex system (Kugler et al., 1980), whereby all outcomes occur as a result of the interaction between the task, environment and organism (Newell, 1986).

Ecological Dynamics – A framework for understanding human behaviour which originates from ecological psychology and dynamical systems theory. Ecological practitioners

emphasise the reciprocity between a performer and their environment (Renshaw & Chow, 2018).

Grey Literature – Material which is produced outside traditional academic publishing, including media articles and white papers (Paez, 2017).

Naturalistic Decision Making – A style of decision making whereby performers will apparently make decisions using intuitive judgement, or a 'gut feel' process (Collins & Collins, 2015), however these intuitions are grounded in previously developed and subsequently embedded understanding (Klein et al., 1993).

Pracademic – An individual that operates as both an applied practitioner and an academic.

Shared Meaning Units – Previously thought of as lower-order themes in thematic analysis, Shared Meaning Units encapsulate raw data themes into one component based on their common implications (Braun et al., 2018).

Publications Emanating From the Thesis

Carson, H. J., Collins, R., Moffat, D., & Collins, D. (In Review). Promoting performance in golf: EEG concomitants of differing putting styles. *International Journal of Sport and Exercise Psychology.*

Collins, R., Collins, D., & Carson, H. J. (In Press). Muscular collision chess: A qualitative exploration of the role and development of cognition, understand and knowledge in elite-level decision making. *International Journal of Sport and Exercise Psychology.*

Collins, R., Collins, D., & Carson, H. J. (In Review). Show me, tell me: An investigation into the learning process within an informal coaching environment. *International Coaching Studies Journal.*

Chapter 1. A Pracademic's Predicament

Referring to yourself as a pracademic in the domain of sport science is becoming increasingly popular (cf. Collins & Collins, 2018). However, being a pracademic, the term used to describe individuals who operate as both practitioners and academics (Posner, 2009), should be about more than just 'dual-careers'. As such, our view of the term 'scientist' must be more flexible (Corrie & Callahan, 2000). In essence, individuals operating in the disciplines of science should be at least consumers, if not producers, of knowledge. Therefore, as we attempt to make sense of the world in which we practice, hoping to leave it in a better state than which we found it, McFee suggests that pracademics must be concerned not only with "collecting data, but with the nature of that data as *data*" (p. 3, 2010). When digesting McFee's contentions, I interpreted this to suggest that we cannot only be concerned with our data as findings, but also with the meaning, origin and the representation of these data.

Similar to many early career researchers, I have wrestled with understanding how my world-view could impact the way in which I approach research. Indeed, 3 hours discussing the makeup of a table in my first ever postgraduate research methods session left me feeling somewhat baffled as to my epistemological and ontological thoughts. However, the views I hold on the reality in which I operate have heavily influenced both the inception, construction and production of this project. Therefore, as this is a pracademic's thesis, it seemed logical to adopt a pragmatic position (the factors surrounding this are explored in Chapter 2).

However, when operating within high performance sport, unfortunately things are a little more complex than some traditional research might lead us to believe. Regardless of one's epistemological and ontological standpoint, coaches and sport scientists (henceforth referred to collectively as practitioners) are faced with an ever-increasing popularity of black

and white opinions, sometimes in spite of glaring evidence for the contrary. Consequently, a number of dichotomies have emerged within research and practice. Dichotomies which, for the purposes of this thesis, I will label as absolutist versus nuanced approaches. Whilst typically one might stick to scientific definitions in a thesis, it seemed appropriate to use a dictionary definition at this point to demonstrate the far reaching impact of these dichotomies (beyond the world of academia). As such, from a very well trusted source (*Collins English Dictionary*, 2011), for the purposes of this thesis, absolutist is defined as "belief in a principle that is thought to be true in any circumstance" (p. 6) and nuanced is defined as "a subtle difference in meaning" (p. 693). Of course, some practitioners are open-minded to the possible breadth of ideas and tools that exist to support performers in their pursuit for excellence. Importantly, however, there are a number of worrying implications that could exist should a practitioner struggle to see beyond their preferred, typically absolutist, position.

First of all, when researchers hold an absolutist view, from a theoretical perspective, they will often craft a research question and choose their research design in a way to support their position. Goginsky and Collins (1996) demonstrated an example of this in their review of imagery research, highlighting the causative link between study design and study outcome. Instead, research design decisions were seemingly made on the basis of the theory researchers were anticipating their data would support. Of course, this confirmation bias approach to research is a problematic implication of the absolutist perspective, since not only does this skew our current understanding of a topic or construct, but also stifles the growth of further knowledge.

Next, and from an applied perspective, recent research has explored the extent to which practitioners make nuanced and complex decisions. An absolutist perspective typically fuels an 'it's this way or the high way' attitude, attempting to shoehorn tools or approaches to

suit *all* athlete needs. However, the Professional Judgment and Decision Making (PJDM; Martindale & Collins, 2005) approach suggests that true expertise lies within a practitioner's ability to consider many contextual factors in their practice and engage in a consistent and on-going reflective process. This process aims to critically consider the approaches and tools used to support a performer, something which is unlikely to occur if the practitioner sits firmly in the absolutist camp. In short, the PJDM approach considers the 'what', 'how' *and* 'why' underpinning decisions. This is acknowledged as crucial to accuracy in the process of case conceptualisation.

Finally, as a compounding effect, if practitioners are steadfast in their absolutist viewpoint it is unlikely that they will consider, or be open to learning, other ways of operating. For example, if a practitioner believes that an external focus of attention is not only the best, but the *only* option for performance, they will recommend this regardless of the performer's individual preference, the context or the objective. This can sometimes be due to a lack of understanding, as Winter and Collins (2015) highlighted when exploring the contextualised perspectives of applied sport psychology practitioners. Many practitioners did not feel confident contributing to some aspects of performance, such as motoric skill acquisition, execution and refinement, due to a lack of clarity resulting from insufficient training and education. Of course, this could also relate to one's view of the world. For example, practitioners are increasingly rejecting some theoretical approaches outright, as these do not align with their ontological view, such as ecologists rejecting a cognitive approach. This has been explored in peer reviewed literature (Lobo et al., 2018; Turvey, 1992), as well as non-peer reviewed sources. For example, a YouTube video with 3,973 views at the time of writing, titled 'The Two Skill Acquisition Approaches: Key Differences' (Gray, 2020).

At this stage, it is worth noting the blessing and curse of social media platforms, and other non-peer reviewed communication tools such as blogs and podcasts, for practitioners. Stoszkowski and Collins (2016) highlighted that practitioners are increasingly turning to platforms of this nature as a source of knowledge. However, MacNamara and Collins (2015) questioned the extent to which the information shared on these platforms is evidence based. A contention explored more recently by Stoszkowski et al. (2020) in which they highlight the 'cherry-pick' approach these platforms afford, alongside the obvious limitations to the communication tools, such as character limits, therefore increasing the likelihood of biased opinions, or at the very least a lack of awareness towards contemporary coaching evidence (Stoszkowski & Collins, 2016).

Reviewing these implications, one could argue that the absolutist side of these dichotomies appear to be impacted more by a practitioner's ontological bias, as opposed to their epistemological beliefs. Furthermore, and reflecting the stance taken by Gray (2020), these ontological biases are often likely to be portrayed through the less critically policed platforms. However, *all* implications that arise from the existence of these dichotomous positions are bad for applied practice and translational research. These implications act on the client and practitioner, both directly and indirectly, through the social milieu they create. As a pracademic, I have experienced these dichotomies in action first-hand and, as such, I decided to attempt to open the dialogue on these dichotomous opinions across a range of applied contexts, in an effort to clarify an otherwise inevitably hazy world. To accurately portray this concerning haze, my thesis makes use of literature from all three bases: peer-review, grey (material which is produced outside of traditional academic publishing, including media articles and white papers; Paez, 2017) and social.

Reflecting this narrative, the overall aim of this thesis was:

to explore the evidence for and against a number of dichotomous perspectives

in an attempt to better understand which position, the absolutist or nuanced,

is better supported through literature-based and empirical research.

This aim was realised through the following objectives:

Chapter 2

- To establish the literature underpinning each of the absolutist and nuanced

  dichotomies.

- To explore the implications currently experienced by applied sport psychology

  practitioners and coaches, thereby highlighting the utility of a pragmatic approach to

  understanding these dichotomies.

Chapter 3

- To explore the literature, both peer-review and grey, for evidence that the existence

  and superiority of natural talent is a true assumption. This will include seeking expert

  opinion.

- Next, to address the implications of this assumption, and test them against the

  psychomotor literature in other areas.

- Finally, to explore the literature, again both peer reviewed and grey, for alternative

  perspectives.

Chapter 4

- To explore visual engagement under both TFA and BFA to better understand the

  dichotomies outlined, in striving for peak performance.

- To compare visual engagement during effective and suboptimal performance (i.e.,

  missed putts).

Chapter 5

- To examine contextual priors in high-level Rugby Union. Specifically, to identify the macro, meso and micro factors considered when a ball is out of play. Do these prime subsequent decisions, focus and action?

- To examine whether those factors then carry through as foci for attention once the game recommenced. Does this priming subsequently operate?

- To establish if those factors were selected and developed through training. If they exist, where do these priming ideas come from?

Chapter 6

- To explore how Skateboarders learn new skills in the absence of formal coaching.

- To identify how and/or why 'top-enders' are more successful performers.

Notably, whilst some doctoral theses will run sequentially, this thesis is an intact piece of work. The four studies presented here (four of many possible studies!) are overlapping and need to be taken together to address the overall aim. In fact, I believe these studies could be presented in several possible sequences and it would not particularly change the findings of this thesis—something my supervisors and I contemplated many times throughout this journey. However, as is presented throughout the thesis, the order selected was the most coherent progression of information from my perspective. Rather than presenting hypotheses, each of the chapters are designed to test between two and four of the dichotomies which are presented in the next chapter in Table 2.1. With regards to the studies selected, in part, these reflect the environments I either work in or enjoy. More pertinently, however, each of the four studies offered a particular 'laboratory' to test a combination of dichotomies.

Chapter 2. Different Sides of the Elite-Level coin: A Critical Exploration of the

Underpinning Literature Demonstrating Pertinent Dichotomies

2.1. Introduction

Building on the ideas set out in Chapter 1, this chapter aims to present, discuss and exemplify pertinent psychological dichotomies that relate to performance and its development. In examining these literatures, I rapidly discovered overlaps and interdependencies both within and between ideas, suggesting the presence of many complimentary, although not always acknowledged, bodies of evidence. Furthermore, conflicts in understanding, or dichotomies, can impact on either the learning or the execution of skills (a process which can be broadly seen as performance) and, in some cases on both; a situation that is far from ideal for the evidence-based practitioner seeking the perhaps unattainable ideal of categorical clarity!

Evidently, elements of several dichotomies challenge the received wisdom currently advocated within sport psychology. Through a combination of personal experience, research findings and trending new ideas often promulgated through social media, certain concepts, often simplistic and generalised concepts, have become widely accepted by psychologists, coaches and even athletes (explicit evidence of this can be seen in Chapter 6; cf. Stoszkowski et al., 2020). Notably, however, through the growth of *applied* research within sport science, a contrasting body of knowledge has emerged which suggests a more nuanced approach as necessary in order to sufficiently support athletes in their pursuit for success. In short, complex problems are being found to require more complex solutions.

As such, this chapter explores dichotomies by considering the literature-based arguments which underpin the contrasting stances. To begin with, however, I will examine the philosophical and practical limitations which may have led to this situation, then set out the philosophical stance I have taken for the thesis. My aim in doing this is to 'set the scene'

for the following empirical studies, through exploration of the *why* (reasons underpinning my methodological approach), the *how* (principles underpinning the ways in which I have pursued the questions) and finally the *what* (the dichotomies I explore through the thesis).

2.2. One Possible Origin of Dichotomous Thinking – The Three Ages of Science and the Pragmatics of the Academic Research Game

Collins and Kamin (2012) proposed a three-stage evolution of research within a domain which, though not inevitable, would seem to be a useful progression for support sciences in general and, as pertinent to this thesis and so as presented below, to psychology in particular. This work offered a structural underpinning to the ideals of translational research; an approach which, as I stated in Chapter 1, is central to my personal aims and philosophy. Collins and Kamin suggested that a science (in this case psychology) would often progress as follows:

1. Psychology *through* sport – At this stage, research is focused on the development of the parent discipline by using investigations in a variety of environments. Sport could be one of these but the main thrust would be to advance psychology.

2. Psychology *of* sport – As a discipline progresses, it starts to develop a distinct body of knowledge. In this case, what we could properly call *sport* psychology; specific theories pertaining to sport emerge and are codified as a separate discipline.

3. Psychology *for* sport – At this stage, ideas, theories and approaches are being used with sport as the primary focus. Psychology still plays an important role but the focus is on sport. In this case the parent discipline is subjugated to the target domain.

Importantly, the intention of any research, whilst it might come from one or even two of these fundamental, value-based positions, will never usually be able to satisfy all three. It is now that the pragmatics of career advancement combine with the scientist's perceptions that view some categories of research as more 'valuable' than others. For example, there is little doubt

that psychology *through* or *of* sport research carries greater value in research exercises, such as the UK's Research Excellence Framework, which drive so much of the career advancement process for researchers. In contrast, research primarily targeted for translational purposes, with the performance outcome as the fundamental judgement index, seem to be less valued. The interested reader might consider the lower impact factors assigned to/associated with any journal with 'applied' in the title. Alternatively, as an even better test, how much of the information enclosed in a research article actually carries meaningful and original implications for performance.

My point is that, to paraphrase Animal Farm (Orwell, 1945), some research is more equal than others! Consequently, it is often an implicit, or even explicit, career choice for researchers to frame their work against the contribution to the parent discipline rather than its translational or applied power. This exists even in a subject area which should explicitly include the word 'applied' in its title, such as sport science. As one of many consequences, authors will usually present their work within a particular theoretical perspective or paradigm. Indeed, this perspective is also often a requirement of academic journals and, therefore, drives a necessity to share new and potentially more optimal solutions with others, even when the research is atheoretically intended. Indeed, if the perspective locking is done poorly, it might prove difficult for these solutions to make it through a peer review process, and therefore have any impact at all.

In this case, perhaps inevitably, positions will become dichotomised. An example of one such extreme is, "an external focus of attention is a *conditio sine qua non* of performance" (Wulf, 2016, p. 1293). Positively, it would be hard to be confused about this authoritative statement from an esteemed researcher… but is it completely accurate? As another potential outcome, researchers may often design flawed studies with control groups that fail to meet real life standards of practice (cf. Bobrownicki et al., 2020; Goginsky &

Collins, 1996; Winter & Collins, 2013). The *through* agenda is satisfied as the study results demonstrate positive support for the intervention and, therefore, the theoretical stance. The stance taken within their research will emerge with greater significance, larger effect size and an increased chance of publication. Importantly, however, has the intervention really been shown to offer advantages for the practitioners who use it, and the performers who experience it?

In either case, but notably for a multitude of reasons, conforming to a philosophical or theoretical position will become more the norm within the literature. In summary, for my present purpose it seems as though genuinely translational research might become an increasingly endangered pursuit.

2.3. My Perspective on the Theory to Practice Continuum

Irrespective of the ideas presented above, my personal focus on performance as the outcome of interest has led me to work in a quite specific manner. Research usually focuses on a theory-to-practice link; however, my work is more a practice *through* theory approach. Therefore, my studies have been driven by a desire to address real world problems through theory, rather than to answer theoretical issues through real world sport (cf. my distinction earlier).

This practice *through* theory approach will become clear in Table 2.1 and the empirical chapters which form the majority of this thesis. In Table 2.1, I identify seven dichotomies, each offering an absolutist (single answer) view and a nuanced (multiple answer) view. As stated earlier, however, it may be possible to present studies which support *either* of these two positions, as shown in the work of Goginsky and Collins (1996) on mental imagery or Bobrownicki et al. (2020) on focus of attention and instructional strategies. Therefore, and again reflecting the *conditionality* of knowledge which is likely to apply to real world situations, I have taken several genuine issues and then used these to address the

dichotomies, rather than conducting seven studies—one for each pair of positions. One of several consequences for this approach is that each dichotomy will be addressed in several contexts.

To avoid confusion, I provide a series of expectations for each of the real world problems (i.e., empirical chapters) to reflect the two positions being examined; that is, one set of predictions should the 'absolutist' view be true and another set of predictions should the 'nuanced' view be true. Against the academic purpose of the thesis, these 'either-or' statements may be seen as testable hypotheses, in that each chapter will offer a weighted evidence-based position between one of the two ends of the spectrum. I will then return to the whole picture, reproducing Table 2.1 in the final discussion (Chapter 7; Table 7.1) to explore the dichotomies against my research findings.

2.4. My Philosophical Approach in the Thesis

Since my working context is characterised by a need to apply levels of pragmatism, balancing empirical and theoretical knowledge, this thesis naturally lent itself to the application of a pragmatic research philosophy (Creswell, 2003). A pragmatic research philosophy offers an opportunity to close the longstanding gap between research and practice by providing an appropriate 'worldview'. It guides the process in a way that the primary importance of the outcomes are valued more than the philosophical 'worldview' that underlies the method (Creswell & Plano Clark, 2011; Giacobbi et al., 2005). Notably, these divisions between ontological, epistemological and methodological stances between academics and applied practitioners have been extensively reviewed (Brustad, 2002; Bryman, 2008; Giacobbi et al., 2005). Pragmatism rejects the forced choice between positivism and constructivism. Unlike the hierarchal positioning of other paradigms where the 'worldview' dictates the research process, pragmatism concerns addressing practical questions through

uniting methods from other paradigms, even though these may often be conventionally

regarded as incompatible (Creswell & Plano Clark, 2011).

Of course, pragmatism is not without its limitations. Multiple methods research (as

used in this thesis) through a pragmatic lens essentially places the researcher at the centre of

the contrast between these paradigms. This can lead to epistemological concerns through

methodological questions arising from phenomena essentially being multi layered (Morgan,

2014). Whilst a multiple method approach seeks to overcome these gaps by using 'bespoke'

combinations of quantitative and qualitative methods, this dualism can make integrating the

different outcomes challenging (Bryman, 2008). Presenting findings by juxtaposition (i.e.

simply putting different methods alongside each other and discussing the findings separately)

does not lend itself to being truly integrated and may even 'defeat the original purpose' of

using the mixed methods approach. As such, pragmatists are prepared to use methods that

originate from different 'worldviews' and not bind themselves to an ontological or

epistemological view of the world, provided their use produces findings of practical value for

addressing the research problem (Denscombe, 2007; Morgan, 2007).

Accordingly, and with these concerns consistently borne in mind, I used a pragmatic

approach to satisfy my intention of generating meaningful insights and even possibly

guidelines for fellow practitioners. Reflecting the challenges of using mixed methods, each

empirical chapter sets out clearly both the theoretical underpinnings and predicted

implications from the methods used.

2.5. The Thesis Structure – Literature Dichotomies to be Examined

Table 2.1 presents the dichotomies that underpin the content of the thesis. Reflecting

the pragmatic nature of this thesis, the final column demonstrates the impact of these

dichotomous positions in a real world setting. Of note, these implications inform the later

chapters, which address each of the dichotomous pairs.

In each case, I present the absolutist position contrasted against the more nuanced perspective. When nuanced, the latter are typified by ideas which may apply in different ways, conditional on different aspects of the context. The implications column then offers an overview of the contrasts between the two views. Section 2.6 then presents an overview of the different theoretical positions, with exemplar literature included.

Table 2.1.

The dichotomous theoretical positions and how they are tested by different chapters in the thesis.

	Dichotomy	Absolutists Exemplar(s)	Nuanced Exemplar(s)	Implications	3	4	5	6
Learning	'Pay attention in class!' *Role of explicit knowledge and cognition in learning*	Reinvestment Theory (Masters & Maxwell, 2008)	Meshed Control (Christensen et al., 2016)	Explicit knowledge of how a skill is performed leads the athlete to 'fall back on' this when under pressure, to the decrement of performance. ***vs.*** Different types of knowledge facilitate performance, enabling athletes to adapt using various control strategies in pressure conditions.				▮
	'Maybe she's born with it' *Developing talent*	Natural Born Talent and genetic endowment	Deliberate Practice (Ericsson et al., 1993)	Some individuals will enter the development pathway with inherent psychophysical advantages, which they will maintain through the pathway. ***vs.*** Progress on the pathway will be related to 'effortful learning behaviours', independent of, or at least extraneous to, inbuilt advantage.			▮	▮
	'Product of your environment' *Ecological considerations in skill acquisition*	Ecological Psychology (Gibson, 1979); Ecological Dynamics (Davids et al., 2012)	Schema Theory (Schmidt, 1979); Internal Representations (Schack & Mechsner, 2006)	Skills are acquired as a result of the performer-environment interaction, and can be learnt through the manipulation of that environment or task constraints. ***vs.*** Skills are acquired as a result of the performer-environment, as well as additional cognitive processes. As a result, elements of the skill are retained as internal representation.				▮

	Dichotomy	Absolutists Exemplar(s)	Nuanced Exemplar(s)	Implications	3	4	5	6
Learning, Performance and Refinement	'Where's your head at?' *Focus in Learning and Performance*	Constrained Action Hypothesis (Wulf and colleagues, 2001; 2003; 2013; 2015)	Skill Refinement (Carson & Collins, 2011); Cues (Winkelman and colleagues, 2016; 2017; Maurer & Munzert, 2013)	Whether working with an athlete to learn a new skill or perform a skill that they have already learnt, the psychological strategy remains the same. Coaches should always direct the performer's attention externally; that is, away from bodily mechanics and towards the action effect. *vs.* A blend of approaches are required: An 'it depends' differential will emerge, with both learning and performance outcomes reflecting mixed benefits.				
	'Context is Key' *Cognition in Decision Making*	Ecological Dynamics and Direct Perception (Araújo et al., 2019)	Contextual Priors (Broadbent et al., 2019); Recognition (Klein, 2008)	All information athletes use is directly perceived and decision making is emergent. *vs.* What a performer brings to a situation impacts on how they see their environment and interact with it. Therefore both the environment and internal lens (representation) need to be considered.				
Performance	'To think, or not to think?' *Role of Cognition in Performance*	Flow (Csikszentmihalyi, 1990)	MAP (Bortoli et al., 2012; Robazza et al., 2016); "Make it happen" versus "Letting it Happen" (Swann et al., 2016).	'Peak' performances will be associated with subconscious executions. Therefore to achieve the best possible outcome coaches should work with athletes to remove conscious control over their movements. *vs.* Optimal performances will occur under conscious *and* subconscious executional states. Therefore, coaches should work with athletes to think themselves into and maintain different functional performance modes. Part of this process will be to identify for each athlete what conscious motor processing strategies are most effective for them as individuals.				

Dichotomy	Absolutists Exemplar(s)	Nuanced Exemplar(s)	Implications	3	4	5	6
'Just do it' *Motoric Automaticity*	Linear Theories of Skill Acquisition (Dreyfus & Dreyfus, 1986; Fitts & Posner, 1967)	Non-Linear Theories of Skill Acquisition (Bargh, 1994; Scholz & Schöner, 1999)	Skills are best developed to be automatically executed with little variance. *vs.* Different elements of the skill will be more or less automatic, so therefore more or less consistent.	▮		▮	

2.6. The Theoretical Dichotomies and Underpinning Literature

2.6.1. Pay Attention in Class: The Role of Explicit Knowledge and Cognition in Learning

Coaches and psychologists collaborate to support athletes when learning and developing new skills, a process that encompasses both skill acquisition and skill refinement (Williams & Hodges, 2004). In skill development contexts, the aim is usually to optimise competitive or pressured performance (e.g., playing an important match or executing moves under pressure such as paddling a rapid), which necessitates the development of both mechanics (what to do) and the optimum mindset for execution (how to do it). This latter requirement presents a dichotomy that challenges the commonly held belief that explicit knowledge about skill execution is *always* negative to high-level performance and, consequently, performers should learn without this. In contrast, others argue that a conscious focus on skill execution is not always negative and can be both required and positive.

Exemplifying the absolutist perspective, the theory of reinvestment (Masters, 1992; Masters & Maxwell, 2008) has received extensive research attention (Iwatsuki et al., 2018; Jackson et al., 2006; Jackson et al., 2013; Maxwell et al., 2006). The mechanistic premise of reinvestment is that pressure induces a conscious processing strategy over a movement during execution (i.e., from long-term memory) which is disruptive to performance automaticity because the skill fragments into chunks, thereby increasing the likelihood of errors. In other words, this process represents a regression in control back to the cognitive stage of learning (Fitts & Posner, 1967), a perspective supported by Beilock and Carr's (2001) Explicit Monitoring Hypothesis. As such, Reinvestment Theory suggests that the use of explicit and declarative knowledge of *how* to perform should be avoided, especially for those high in the trait towards this behaviour (Masters et al., 1993). As a direct implication of the approach, many coaches believe that performers should learn without thinking or without knowledge of the movement (Jackson & Farrow, 2005; Liao & Masters, 2001; Raab et al., 2011), on the

basis that if a performer lacks this knowledge they will not be able to reinvest when under pressure (Masters, 2000). Essentially, researchers propose that the benefit of an unconscious learning process is that an athlete will only generate procedural knowledge of a skill, instead of relying on underpinning declarative processes (Gebauer & Mackinstosh, 2007).

In an effort to better understand the impact of explicit learning, Bellomo et al. (2018) aimed to undertake a comprehensive test of Reinvestment Theory by exploring the incidence of 'chunking' by participants when performing a motor skill under pressure. Of note, the participants learnt the task either explicitly or implicitly and measures of movement self-consciousness, cognitive anxiety, task performance and cortical activity were assessed. Interestingly, Bellomo et al. concluded that Reinvestment Theory could not be supported *or* refuted. Conscious processing was reported to increase by the explicit participants, however this did not impact on task performance. Moreover, explicitly trained participants displayed increased cortical efficiency and quicker skill acquisition, suggesting that explicit learning is less detrimental than might have been first thought.

Reflecting this, an emerging body of literature suggests that knowledge and understanding is not, in fact, all bad and is sometimes essential. This nuanced viewpoint is exemplified in the theory of Meshed Control (Christensen et al., 2016), which depicts the task demands during expert performance as varying in complexity and difficulty. As such, the optimum cognitive contribution differs depending on the diverse range of task demands. According to Meshed Control Theory, experts change their control style as a reflection of such demands, implementing smooth control, adaptive control or problem solving control. Christensen et al. suggest that as a performer develops, thereby improving the accuracy and consistency of their skill execution, the cognitive contribution towards performance execution/implementation reduces (becoming smooth control) *but* is ever present. Attention is, therefore, available to address problem solving control tasks where necessary. For

complex movements and/or difficult tasks (the research would suggest highly consequential conditions as well; see Collins et al., 2001), there is a need for an increase in cognition towards execution/implementation control (i.e., 'just do it' does not seem to work when the performer is frozen by fear). In essence, Meshed Control is predicated on the concept that performance conditions for skilled performers are a constantly changing landscape and that empirical research has overemphasised the incidence of scenarios (mainly through implementing easy to perform task and/or conditions; Collins et al., 2016) only requiring a smooth control style within experts (Christensen et al., 2016).

Considering hierarchical control, Christensen et al. (2016) state that, during 'normal' performance, lower level skills are automated (implementation control; not requiring cognitive control) allowing the performer to utilise their cognitive capacity on more complex features of performance (higher strategic control; see Figure 2.1). As a sporting example, consider a basketball player. In normal conditions, they can dribble using subconscious control, freeing their attention to take in court movement and make tactical decisions. Contrastingly, when the player is in a challenging or unfamiliar situation, or perhaps a situation of high consequence, their attention will shift to implementation control; in essence, switching to a different level of cognition with the purpose of promoting adaptability to complex conditions (Christensen et al., 2019). As such, Meshed Control would suggest athletes *do* require knowledge of their implementation control skills in order to perform them effectively *when required to do so*; something which would be lacking if they were never (explicitly) learnt!
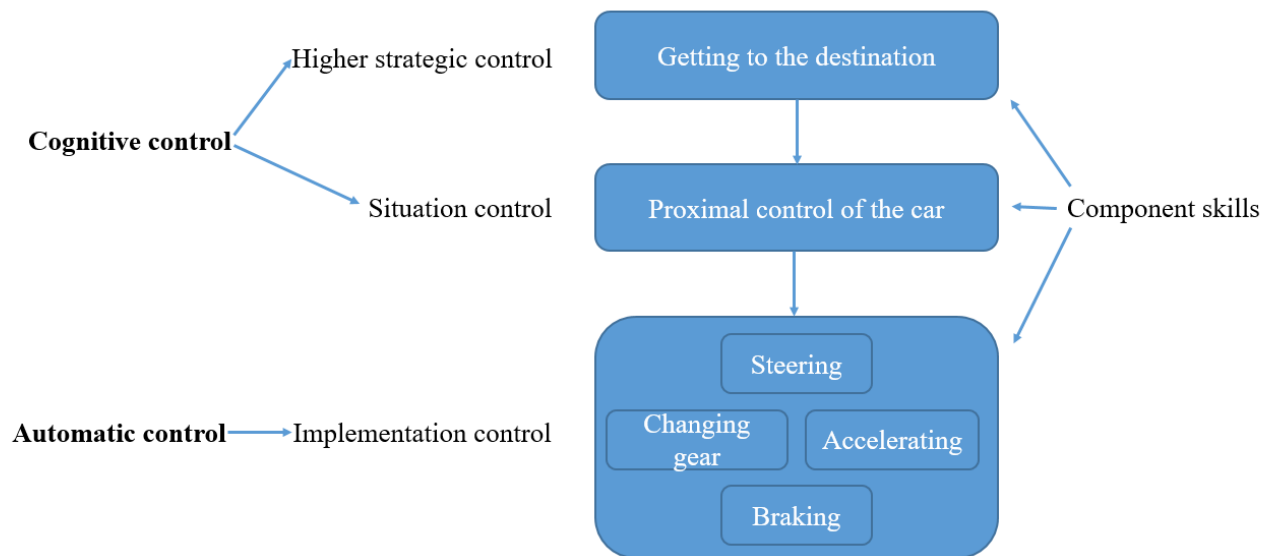
Figure 2.1. The Meshed Control hierarchy – example utilising the skill of road driving.

2.6.1.1. Key implications. Applying an absolutist view (deriving from Reinvestment Theory), researchers have begun to make recommendations to coaches (e.g., Lawrence et al., 2013), leading to the development of a variety of techniques to teach athletes skills without explicit information of the underpinning movement. Often referred to as implicit learning (Masters, 2000; Reber, 1993), techniques such as analogy learning (Lam et al., 2009; Liao & Masters, 2001), dual-task conditions (Gabbett & Abernathy, 2012) or the Constraints-Led Approach (CLA; Davids et al., 2008) have grown in popularity. These techniques purport to develop performers with minimal or no explicit skill information, and promote a focus away from the movement mechanics (Wulf, 2013). Indeed, Barkell and O'Connor (2013) suggest that many coaches will likely only rely on explicit coaching tools (i.e., instructional feedback, drill-like training sessions) if they have not been educated otherwise, as is seen in many popular podcasts and online blogs (cf. Emergence, 2020). Alongside the growth of implicit learning methods, some high-profile members of the coaching community have rejected some stalwart coaching tools and techniques, all but demonising their use. For example, a popular

podcast episode declared 'A war on drills', suggesting that the use of drills could cause "collateral damage… to the progression of kids in sport" (Armstrong, 2017).

Contrasting to this absolutist approach, I would argue that, based on the literature cited earlier in this section, there are clearly *some* occasions in which skilled action requires explicit knowledge. Therefore athletes should acquire this knowledge; in particular to support more complex skills or movements which will be performed in high pressure situations. For example, in attempts to extend sport neuroscience literature, Wang et al. (2020) have identified that whilst elite golfers display enhanced psychomotor efficiency in comparison to their novice counterparts in a putting task, analysis of Electroencephalogram (EEG) data demonstrates there is still evidence of visuospatial and cognitive motor processing up to 2 seconds prior to skill execution. Wang et al. (2020) summarise that the direction of the relationship between cognitive-processing and superior performance is unclear, but do highlight the presence of "essential neural activity" (p. 6) in the build up to execution. This is similar to the findings of Loze et al. (2001) who identified superior performance in target sports as characterised by a switch of attention (focus on external factors) to intention.

Considering further work by Christensen and colleagues (Christensen et al., 2019), there is more support for utilising an interaction of coaching tools. Christensen et al. suggest that many of our skills do not fully automate, and therefore there is an on-going requirement for declarative knowledge and representations to contribute to skill execution. For example, whilst passing in Rugby Union might be produced automatically at times, if the ball is wet or the opposing team has successfully intercepted several passes, the player might need to think more explicitly about the skill. This is practically mediated by, for example, MacPherson et al. (2009), as they explored the need for rhythm in temporally mediated skills. MacPherson et al. suggest that utilising aligning a mediated structure, or rhythm, to a skill can aid in learning, and therefore recall and execution of the skill.

2.6.2. Maybe She's Born With It?: Developing Talent

Nature versus nurture has been a debated topic for generations and, within the sporting context, like others, we are lacking a complete answer (Baker, 2007; Knechtle, 2012; Yan et al., 2016). From this lack of clarity, practitioners are faced with difficult situations as they work with coaches and parents alike, who sometimes believe in genetic destiny over the merits of hard work. Presently, there are also inconsistencies in the language used amongst commentators, journalists and performers themselves, which has begun to suggest that an individual's success may be something that is pre-determined, from a birth-right, a genetic endowed superiority or, perhaps, even the gift of a higher being, all loosely encompassed by the perhaps misleading term 'natural talent'. However, it appears that this argument fails to stand up to scientific scrutiny.

Examples of the term 'natural talent' within the media are not hard to come by (e.g., peer commentary on Twitter – former European Tour player Johnstone states "perhaps the most natural talent to ever swing a golf club" of Seve Ballesteros, former World Number 1 Golfer; 2019), and in many cases demonstrate the consequences of the misunderstood term 'natural'. An article titled 'How the 'natural talent' myth is used as a weapon against black athletes' (Lawrence, 2018) discusses athlete stereotyping based on race, and highlights that some athletes are not able to reach their true potential, as it is assumed their talents lie in specific sporting positions. For example, the historic over representation of white players at quarterback in American Football, whereas black athletes are more often seen in positions such as running back or linebacker. This is a phenomenon known as racial stacking (Eitzen & Sanford, 1975), a bias which is still seen in scouting in the modern game (Woodward, 2004). Literature has attempted to mitigate the use of the term and instead suggested 'giftedness' (Gray & Plucker, 2010; Tranckle & Cushion, 2006).

At present, a wealth of research has attempted to identify a genetic link to successful sporting performance (e.g., Bray et al., 2009). Some genetic markers, known as single nucleotide polymorphisms (SNPs; a variation of a single nucleotide in a genetic sequence which can be found in a minimum of 1% of the population), have been linked with performance (Ahmetov & Fedotovskaya, 2012), notably in aerobic capacity and strength. For example, both angiotensin-converting enzyme (ACE) and alpha-actinin-3 (ACTN3) genes are linked with performance in a number of sports such as distance running, swimming and rowing (Jacob et al., 2018), and in some cases within elite populations (Eynon et al., 2012).

Importantly, it has been concluded that no genes or SNPs have statistically significant predictive capacity for high-level physical performance (Buxens et al., 2011). Furthermore, regardless of where the significance threshold is set, elite and world-class performance is not significantly linked to genetic variance with strong effect (Pitsiladis & Wang, 2015). Indeed, from a practical perspective, Pitsiladis and Wang raise some serious concerns regarding the on-going testing for genetic abilities, in spite of the lack of scientifically significant support. They cite that, in 2015, at least 22 companies were offering genetic and DNA testing in relation to human sport and exercise performance.

Of similar concern is the number of purportedly trait-focused (i.e., relatively enduring and resistant to change; Haslam, 2007) measures currently available, developed within the sport psychology literature, all aiming to identify the dispositional determinants of sporting expertise. These range from traditional generic concepts, such as personality (16PF; Cattell et al., 1970) and anxiety (Sport Competition Anxiety; Martens, 1977), to more contentious and specific concepts, such as hardiness (Dispositional Resilience Scale; Bartone, 1995) and Mental Toughness (MTQ48; Clough et al., 2002). Indeed, even reinvestment has been measured as a dispositional trait through the branch of personality (Masters et al., 1993). In parallel to these specific measures, the trend for more generic 'sport personology' has re-

emerged through commercial products such as Insights Discovery (Beauchamp et al., 2005; Benton et al., 2008) and Spotlight (Wei Ong, 2018). Qualifications in these new instruments are proudly advertised by practitioners, despite the lack of any peer reviewed evidence for their efficacy. Despite extensive research into the validity of some of these measures, however, research exploring the link between dispositional or trait factors and high performance sport are, at best, equivocal (Fawver et al., 2015).

Finally, is the long-held belief that talent or skills can be possessed by a player, not through birth or genetics, but instead through status as a higher-order being. This type of opinion is expressed in a myriad of ways. For example, peer commentary in the press, as Billie Jean King, former World Number 1 Tennis Player, states "I feel like [Kyrgios] has these God-given talents" of Nick Kyrgios, a wild card entry to Wimbledon 2019 (para. 9, 2019). Alternatively, journalists also make comments of this nature, such as about Cristiano Ronaldo ("he's got a God given talent – and he knows it", Lewis, para 1, 2013) or comments on Jason Robinson ("that was after God had found Jason Robinson, and endowed him with the talent…" Hayward, para. 1, 2002). Of course, little of this makes its way into the peer reviewed literature but its influence is powerful and pervasive. Indeed, athletes attribute their own success to the 'powers that be'. A well-documented example of this is Usain Bolt, who stated "It gives me confidence in my God-given talent…" (cited in Cox, 2016). At present, this appears to be a sensitive view on high performance and one that lacks investigation into what, how and why athletes draw upon this perspective.

In stark contrast, the alternative view lies within another quite contentious topic, deliberate practice (DP; Ericsson et al., 1993). DP is "a structured activity with the primary goal of improving an important aspect of current performance" (Ford et al., 2009, p.65). To identify the classification of DP, Ericsson et al. (1993) suggest that these activities should include the opportunity for repetition with error detection and correction, require full

attention, with maximal effort and complete concentration. Finally, and most pertinently, DP requires immediate access to useful feedback. DP has acquired somewhat of a bad reputation in the last decade or so, with the inconclusive 10,000 hour rule misquoted and misinterpreted often (cited as "a provocative generalisation" by Ericsson (2012, p. 3) in his open letter entitled 'The danger of delegating education to journalists'), as his research was incorrectly popularised by Gladwell (2008).

Notably, Ericsson responded to this 'magic' number (Gladwell, 2008), and several papers have reported mixed findings relating to the necessary hours of DP (Ford et al., 2015). Instead, Ericsson (2003; 2007) refers to the need for DP to push performers beyond a natural plateau, inferring that some athletes instead face 'arrested development' (the state of competence some performers stay at). In order to progress beyond this, he suggests, experts will plan and engage in DP.

However, the effectiveness of DP on talent development has been criticised. A recent meta-analysis of 88 studies found that DP could only explain 18% performance variance in sports (with much lower figures for education at 4% and only slightly higher for music at 21%; Macnamara et al., 2014). Evidently, neither genetics nor practice fully explain sporting success. As such, there is a need to explore additional factors that could discriminate between novice and elite performers as well as looking to tease out what the optimum balance between these two and explore what the other factors might be.

Notably, however, many researchers suggest that the nature/nurture debate is not one worth having, and that the lack of support for either a *solely* biological or environmental deterministic approach means we must move our attention towards an interactionist approach (Davids & Baker, 2007). Whereas others, whilst remaining inherently interactionist, tip the scales in favour of nature (Georgiades et al., 2017) due to strong heritability findings from the study of twins (Klissouras, 1971).

2.6.2.1. Key implications. As a result of the assumptions formed by these absolutist views (when held in an either-or stance), there is a belief held that individuals can become successful in high performance sport due to inherent advantages. Indeed, these inherent advantages are possessed by the individuals upon entering the development pathway and appear to be maintained consistently throughout. Evidence of this can be seen in Talent Identification programmes, often recruiting athletes at 4 or 5 years old. For example, some of the top-names in the Premier League table for the 2019/20 season list their scouts' aim to recruit players from as young as Under-8s (Leicester City, 2020), Under-7s (Tottenham Hotspur, 2020) or even Under-6's (Southampton FC, 2020).

Conversely, recent literature has begun to suggest that progress on the pathway is related to 'effortful learning behaviours', and therefore success will be independent of, or at least extraneous to, any inbuilt advantage. A study into this was carried out by Taylor and Collins (2019) who explored the possible reasons for why those inherently advantaged players did not go on to achieve the success they were tipped for. The reasons cited included features such as pathway-based failures or a lacking in physical or mental skills. These findings support earlier work from Collins and colleagues (Collins & MacNamara, 2012; Collins et al., 2016a; 2016b) and suggest a need for, and application of, additional skills and characteristics along the pathway – some nurture for nature as it were.

Moreover, as exploration has continued into concepts such as DP, researchers have begun to acknowledge that ongoing success cannot be attributed solely to experience (Macnamara & Maitra, 2019). Ericsson (2004) suggests that, across a number of performance domains, promising individuals often plateau (arrested development, as stated above) as their innate talent and experience are found to be not quite enough. Instead, he states that "acquisition of expert performance requires engagement in deliberate practice and that continued deliberate practice is necessary for maintenance of many types of professional

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performance" (p. 70), within medicine, sport, chess and music domains. Neurologically, this could be explained by the recent work from Fox and Stryker (2017) as they attempted to integrate Hebbian plasticity (Hebb, 1949) and homeostatic plasticity. Hebbian plasticity explains how information is coded and stored in the brain, (i.e., the neural networks created through learning, or DP), suggesting that 'neurons that fire together, wire together'. Whereas homeostatic plasticity refers to the process of neuronal change through regulation which acts as a compensatory adjustment against excitability; in essence, a return of synaptic functions towards baseline states (Toyoizumi et al., 2014) such as pre-training function. The recent integration of these concepts would suggest that continued use of particular neural circuitry (e.g., that required to perform specific skills) will lead to strengthening, growth and diversification of those networks. Disuse will result in the return of those networks towards their pre-training baseline. Without DP, not only will skill not be improved but it will be diminished (Keck et al., 2017). Essentially, performers have to continuously engage in DP to maintain their expertise, meaning this could not just be gifted to them.

Of course, this would make sense considering the ever-changing, dynamic nature of the performance domain (e.g., Willmott & Collins, 2017). As such, athletes will need to be equipped to deal with these evolving challenges, and therefore this approach advocates the importance of this skill development. In direct contrast to a quote offered by Dreyfus and Dreyfus (1986) explored in Section 2.6.5.1. ("when things are proceeding normally, experts don't solve problems and don't make decisions; they do what normally works" p. 30), a key feature of DP is the need to have time to problem-solve. Thereby promoting development of the necessary skills for success.

2.6.3. Product of your Environment: Ecological Considerations in Skill Acquisition

The design of a spider's web, the flow of a murmuration and animal hunting patterns are all examples of complex systems (Fisher & Pruitt, 2020). Known as the science of

complexity, this concept has been applied in an attempt to explain behavioural patterns of sport performers, both individuals and teams (Duarte et al., 2012), suggesting that "human movement systems can be modelled as complex systems able to exploit surrounding constraints, allowing functional patterns of behaviour to emerge in specific performance contexts" (Davids et al., 2013, p. 22). Based on this idea, and the foundations laid by Gibson's (1979) ecological approach to perception, practitioners and coaches are now applying this budding approach to skill acquisition and execution, termed Ecological Dynamics (EcoD; e.g., Davids et al., 2012). EcoD suggests that expertise is predicated on the performer-environment relationship (Seifert & Davids, 2017) which, as factors, should not be separated. Indeed, researchers indicate that skill learning only occurs as a result of continuous performer-environment interactions (Araújo et al., 2006; van Orden et al., 2003).

Interestingly, to explain this process of skill learning, EcoD suggests that performers 'self-organise' against the instabilities they experience as a result of this reciprocal performer-environment relationship (Renshaw & Chow, 2018). So, as performers (as a complex system) encounter these fluctuations then they begin the process of pattern-formation, known as reorganisation (Rosser, 2008). As such, this self-organising process, which appears to happen without the knowledge (or, perhaps, conscious awareness?) of the performer, explains how the performer accomplishes their goal and develops superior performance in a personally unique way (Thelen et al., 1993).

Of note, however, is that the underpinning mechanism of EcoD is not entirely clear. Much like Davids et al.'s (2013) quote suggests (outlined above on page 26/27 of this thesis), a key feature is the suggestion that behaviour is *emergent*, be that the acquisition of a skill or a decision in the game. Due to the environment and performer link, what is emerging and what is processed (if anything) seems confused. For example, Seifert and Davids (2017) state that human behaviour occurs as a result of the information that *emerges* from the

environment, which guides ongoing movement. Advocates of the approach suggest the performer self-organises this information, or more accurately the response to the emergent information is self-organised (Kelso, 1995). In slight contrast, Davids et al. (2013) discuss the "emergent performance behaviours" (p. 24) that occur as a result of an information constraint. Whilst confusing, the concept of emergence seems to at best question, or at worst reject, the existence of a stored internal or mental representation of the skill (Araújo et al., 2019; Davids et al., 2015). As such, it would seem hard to identify the mechanisms through which emergent behaviour is developed then stored for subsequent extension and, as a consequence, how practices should be structured/presented to optimise the process.

Advocates of the ecological approach to understanding skill acquisition suggest EcoD fulfils many weaknesses typically seen in the 'traditional' approaches ("training is hamstrung by the decision of sport psychologists to underpin interventions with traditional cognitive and experimental psychological process-oriented perspectives"; Renshaw, Davids, Araújo et al., 2019, p. 11), such as cognitive/Information Processing (IP), which EcoD researchers argue separate the performer and the environment (Seifert & Davids, 2017). Even here, however, there are contradictions between authors from the same epistemology. For example, in the very early stages of this approach William James (1890) stated "that every representation of a movement awakens in some degree the actual movement" (p. 526) which would seem to contradict more recent, 'anti-representation' presentations. Furthermore, I suggest that the cognitive approach to skill acquisition is not as traditional as these absolutist statements suggest.

Consideration of potential mechanisms, although often left unaddressed by authors, may offer a route through this absolutist stance. For example, Gibson created the ecological approach as an alternative to 'enrichment theories' of learning, in which learning occurred through the generation and sophistication of enriched internalised processes (Jacobs &

Michaels, 2007). In contrast, traditional theories which underpin the cognitive approach have supported this internalisation of skill. For example, Schmidt's Schema Theory was a prominent theory to suggest that individuals store information in the form of recall and recognition schema (Schmidt, 1975) which hold information about the parameters and outcomes of previous skill execution, that are continuously developed and updated within a closed-loop system (similar to Adams' Closed Loop theory, 1971). Although, Schmidt would be the first to admit that although this theory explains discrete skills, it does not extend to the full picture of serial or continuous tasks. Generalised Motor Programme theory (GMP) also stipulated the existence of a stored memory of skills that allowed for reproducibility of a practiced skill (Keetch et al., 2005), although this was also hit with criticism which suggested continuous practice was required to develop a GMP for a skill which was not transferable (Breslin et al., 2010).

Expanding upon these foundations, cognitivists now suggest that skills are stored as mental or internal representations (Schack & Mechsner, 2006), created by both constant and variable practice (Czyż et al., 2019). It is argued that this mental representation is stored hierarchically in long-term memory, functionally as a combination of executed action and the intended outcome, and then eventually, through reference to the observed effect (Jeannerod, 2006). These internal representations are deemed essential, although only as generalisations or schema. Many movements that performers execute are highly complex, and the human resource limitation would likely fall short of these required calculations for execution (Schack et al., 2014).

Despite these constant and reasonable criticisms on the basis of storage capacity, centrally driven approaches are still apparent in the literature and continue to draw support. For example, Zokaei et al. (2019) identified that modulation of the pupil is controlled by cognitive factors. This was identified as they recorded pupil diameter changes according to

selective attention when the performer engaged in active imagery. These findings suggest that motor control is likely a top-down approach, at least in part, using working memory for activation which would indicate that there is an internalisation of skill. Moreover, even without prior practice of a movement, findings suggest that you can learn and develop internal representations (Kraeutner et al., 2016) through motor imagery (Salfi et al., 2019).

Take, for example, the concept of self-organisation outlined above. The absolutist approach of EcoD seems to rely on self-organisation to explain movement initiation and control. However, this could overlook an individual's ability to learn and retain skills. Learning implies that information is structured in such a way that it is accessible and repeatable. That it must therefore be 'stored' in some way. Recent neuropsychological research indicates that information is stored by forming networks in the brain in an associative manner, meaning muscles, which are activated regularly in response to a similar stimulus, will be controlled from a centralised network (Sharma & Baron, 2013). This is clear since imagery of the stimulus sufficiently activates the necessary neural structures to activate the necessary regions in the primary motor cortex (Baeck et al., 2012). As such, this would likely lead to network formation (and therefore learning) which sits in contrast to the suggestion that an individual self-organises information at every point of instability faced (in the environment, which cannot be separated from the performer).

Seemingly, imagery, a ubiquitous feature of sport psychology, is a strong argument against the total acceptance of the EcoD stance.

2.6.3.1. Key Implications. Whilst EcoD was developed as *a* theoretical approach to sports performance, for many it has become the only way. Due to the suggestion that emergent information results in emergent behaviours, practitioners suggest this information can be manipulated, or constrained, in order to produce the desirable movement. In practical terms this is known as the CLA, cited earlier, which is underpinned by Dynamical Systems

Theory (DST; Newell, 1986). DST states that all outcomes occur as a result of the interaction between the task, environment and organism, therefore CLA suggests if a coach were to constrain one of these components for their performer, this would influence the movement (Rovegno & Kirk, 1995) and therefore is a route to motor learning (Davids et al., 2008). Interestingly, there is also a lack of clarity about whether the coach should apply constraints towards a target/goal action or merely to support the emergence of a personal, idiosyncratic style. If the latter, how 'wide' should the tolerance for experimentation be set? In short, when to constrain and with what aim, is often ignored.

According to the absolutist approach, changing a constraint shapes the emergent behaviour, and when this is done repeatedly over time, behavioural change occurs (Davids et al., 2012). Although it is not clear mechanistically how this change occurs. The tricky thing for practitioners is to figure out what to constrain and when. Furthermore, whether this should be applied instead of, or in combination with, direct instruction. The latter having only recently been added to the EcoD/CLA toolbox (Correia et al., 2018). Of course, this approach views all performers as complex neurobiological systems which progress in a non-linear fashion (Chow et al., 2011). Therefore, small changes to an individual's constraints (deliberate such as information, or by-product such as an increase of strength) can have dramatic impacts on movement patterns (Renshaw et al., 2010). This stance has clear implications for how performers should practice and train for competition. In this instance, researchers have suggested practitioners deploy a discovery approach to learning which involves deploying environmental constraints to produce the flexibility required for successful performance in a dynamic sport environment (Williams et al., 1999). This premise is built upon Bernstein's (1967) 'repetition without repetition' concept, which suggests that even well learnt skills show variance in achieving the same task outcome. Indeed, there are a

number of principles that would suggest this movement variability is preferable when functional.

Interestingly, however, things are not quite so clear-cut from a more nuanced perspective, which would suggest that whilst movement variability can be important, it is not always preferable or not always the result of manipulated constraints. For example, when engaging in a period of skill refinement (perhaps post-injury) performers would benefit from reduced movement variability for the movement components targeted for change, to avoid slipping back into an old habit. Moreover, for some sports, movement variability is far from optimal, such as fine-motor control sports. Alternatively, movement variability can also serve a strategic function, such as performers adapting their play *for* different surfaces (as opposed to being constrained *by* it!). Finally, the Uncontrolled Manifold Hypothesis (UCM; Scholz & Schöner, 1999) stresses the patterning of covariance (how variance changes across different elements) with *lower* variation being a characteristic of the elements playing the *most essential* role in that particular skill. So once again, the role of variation, and the absolute dysfunctionality claimed by EcoD, is far from clear.

From a mechanistic approach, practitioners have been discussing the use of imagery to develop and enhance a mental representation. Schack et al. (2014) completed a review of motor imagery training and mental representations, in which they identify Basic Action Concepts (BACs) as sub-representation units of which a mental representation is comprised (Schack & Frank, 2020). Schack et al.'s (2014) review explores the existence of BACs in a number of sports such as tennis, gymnastics and volleyball, and the findings suggest that imagery, Motor Imagery Training based on Mental Representations to be exact, can be applied successfully for the development and promotion of expert performance. Similarly, sensorimotor training to enhance balance and body control, through a more sophisticated mental representation, is recommended in dance (Fabre et al., 2020).

2.6.4. Where's Your Head At?: Focus in Learning and Performance

Focus and attentional control is a construct which spans across both learning and performance environments. Unfortunately, it is equally unclear where this focus should be in either context! Theorists have suggested that when performing a motor skill, athletes should *always* maintain an external focus, and that an internal focus is detrimental. Wulf and colleagues proposed the Constrained Action Hypothesis as an underpinning mechanism (CAH; McNevin et al., 2003; Wulf, McNevin, et al., 2001). CAH suggests, in a way similar to reinvestment theory, that focus on one's movement mechanics (an internal focus) is detrimental to performance because it 'constrains' a performer's motor control system by disrupting the automatic self-organising executional processes. In contrast, a focus on the *effects* of movements (external focus) or distally within the environment, serves to enable the movement organisation in an automatic and more efficient manner. Or in other words, maintaining an external focus allows "the motor control system to more naturally self-organise, unconstrained by the interference caused by conscious control attempts" (Wulf, Shea et al., 2001, p. 1144). This results in more efficient learning and therefore performance, since the motor system is not constrained by the performer's conscious control (Wulf, McNevin et al., 2001). Support for the CAH, and the superiority of external focus has been identified in a myriad of contexts, such as; Tennis (Maddox et al., 1999), Golf (Wulf et al., 1999), Soccer (Wulf et al., 2002) and a leg-flexion task (Kal et al., 2013). Interestingly, each of these findings found a statistically significant difference in favour of external versus internal focus, and therefore these researchers have suggested that an external focus is always superior and preferred. In one case stating, as mentioned above, that "an external focus of attention is a *conditio sine qua non* of performance" (Wulf, 2016, p. 1293). Or for the non-Latin speakers, an external focus is the absolute 'always best' solution.

As an alternative to focussing externally on the movement effect, some researchers have suggested distraction strategies, for example utilising dual-task protocols (Gabbett & Abernathy, 2012), which aim to direct attention away from the body mechanical focus that CAH suggests is detrimental. However, Wulf and McNevin (2003) state very explicitly that simply distracting performers away from an internal focus will not be effective enough. Indeed, in completing a 15 year review of external focus and CAH research, Wulf (2013) states that the benefits of an external focus can often be seen immediately and will impact not only the performance of a skill, but also learning.

Notably, Wulf and Shea (2002) suggested the external focus is likely to prove more beneficial for complex rather than simple skills, as simple skills are already controlled at an automatic level, not because of any benefit derived from an internal focus. They also suggest, however, that complex skills are more vulnerable to the interference caused by conscious control due to the many moving parts. In this respect therefore it is interesting to note the greater use of simpler tasks in experiments by these researchers (e.g., Collins et al., 2016).

Despite the abundance of studies showing benefits, contemporary applied literature is emerging to suggest that an external focus is not *always* the answer. Instead, it would appear that different occasions require different foci, meaning whilst an external focus can be beneficial there are some occasions in which an internal focus is essential. Exploring the process of skill refinement, Carson and Collins (2011) proposed a five stage model, dubbed the Five-A Model (Analysis, Awareness, Adjustment, [Re]Automation, Assurance) in which an early Awareness stage is required to consciously de-automate the already existing and well established skill as an essential precursor to being able to introduce and then internalise a new version technique. Here, contrast drills are encouraged, which aim to *consciously* utilise an internal focus. Without an internal focus at this stage, aimed at accessing the relevant movement components within a performer's memory, it is very unlikely that long term skill

change could occur, as a study using an implicit approach has demonstrated (cf. Rendell et al., 2011). Indeed, even during the final stages of skill refinement, an internal focus on the whole movement (rather than the component being refined) can offer performance benefits, with an aim to holistically 'prime' the movement for execution in future (Collins, 2011). As such, practitioners might need to be prepared to consider the role of both internal and external foci when appropriate.

2.6.4.1. Key implications. As stated, many practitioners believe that an external focus is *always* the most advantageous for learning and performance. Gröpel and Mesagno (2019) identified several interventions (either distraction or self-focused based) with recommendations for coaches that ascribe to the principles of CAH. Dual-task conditions were found to be the most effective in performance (not during training), whilst quiet eye training and left-hand contractions were effective in all contexts. Notably, however, Gröpel and Mesagno also identified the use of acclimatisation training. This sits in contrast to the assertions of CAH, as these findings suggest performers can mitigate the negative impact of pressure and therefore would not suffer with the performance detriment of an internal focus.

Exploring professional coaching practice, however, Porter et al. (2010) identified some conflicting results. Porter et al. documented perceived benefits of an external focus of attention. When they interviewed National level track and field coaches and athletes, however, they identified that most verbal instruction employed encouraged an internal focus. Moreover, as a result of this instruction, 69% of athletes utilised this feedback, resulting in an internal focus during competition. However, Porter et al. suggested these coaches clearly lacked in education regarding motor control processes, as opposed to offering insight that could inform theory (cf. Christina, 1987). In short, just because coaches and athletes used the internal focus, this did not make it automatically the best tool for performance. Instead some empirical study was warranted.

In spite of suggestions from the absolutist approach, and notwithstanding such confounded results from Porter et al. (2010), researchers and practitioners have begun to understand that a nuanced approach is necessary. For example, Benz et al. (2016) explored the role of coaching instruction and cues for enhancing sprint performance. Their review suggested that a myriad of different instructional tools should be utilised to support the learning of such an important sports skill, although, external or neutral (e.g., 'heels to the ground', as opposed to 'push through the floor') cues were superior. Furthermore, Winkelman et al. (2017) later compared highly experienced sprinters with athletes that utilise sprinting as part of their sport (e.g., soccer players). Data showed no significant differences in performance between external focus, internal focus and control conditions, suggesting that as performers become more skilled they are not effected by direction of attention. This is supported by the work of Maurer and Munzert (2013) as they investigated the impact of familiarity on the focus of attention. The research demonstrated that internal and external focus impacted performance considerably less than the familiarity of the performance conditions. In essence, if a performer is familiar with an internal focus during motor skill execution, this focus will not have a detrimental effect on their performance, whereas an external focus would be negative as unfamiliarity would be the factor of difference, not the direction of attention. Finally, Schoenfeld (2016) explored the role of internal and external cues, concluding that an internal cue is far superior to maximise muscular development, meaning that the appropriate focus needs to be deployed based on the goal of the task. This literature would suggest that perhaps a more idiosyncratic approach to training athletes, offering them adaptable focus solutions during training as appropriate, might be the most successful attitude. At the very least, these data challenge an absolute perspective with another nuanced perspective.

2.6.5. Context is Key: Cognition in Decision Making (DM)

Whilst the roles of perception (Roca and colleagues, 2013, 2020) and anticipation (Morgan et al., 2020) in DM have been considered extensively, there is an on-going debate amongst practitioners about how cognition might affect these processes. Notably, there are two contrasting points of view which were explored in Section 2.6.3, the cognitive and the ecological approach. Expanding on the information offered in that section, the ecological and cognitive approaches both offer pertinent insights within the skill of DM and subsequent skill execution.

As an alternative view to the cognitive approach, and the absolutist view of this dichotomy, Gibson developed the ecological approach, which emphasises "the complementarity of the animal [performer] and the environment" (1979, p. 56), suggesting that a person and their environment are reciprocal and complementary. It is this complementarity that enables an individual to operate (Correia et al., 2013), since there is enough information in the environment to act without requiring additional internal processing, using a mental or internal representation as explained within cognitive approaches (e.g., Schack 2012; Schack & Frank, 2020). Instead, environmental information is perceived as an invitation for action, or an affordance (Gibson, 1979).

Expanding upon this perceptual theory, researchers introduced an interactional perspective between Gibson's (1979) direct perception and co-ordination dynamics as expressed by DST (e.g., Kelso, 1995), thereby creating EcoD (Araújo et al., 2006). Within EcoD, researchers explain the direct interaction between a person and their environment through a system known as perception-action coupling (Warren, 1988), meaning that as we act (move) we perceive (see) which in turn creates affordances, which promotes further action (and so on, as this coupling is a continuous cycle). Direct perception suggests that a

performer has epistemic contact with their environment, and operate unmediated by internal representation (Fajen et al., 2009).

Seen as an interactionist view of perception and action, the EcoD approach suggest that DM is an "emergent behaviour" (Araújo et al., 2006, p. 16), stemming from an individual's interaction with their environment, as opposed to independent mental processes or influenced by internally stored representations (Araújo et al., 2019). Notably, EcoD suggest that athletes gain more understanding of their surroundings not through visual searching and cognitive processing, but instead through a process of 'neural resonance' (Gibson, 1966). Gibson suggests that environmental information, such as the playing surface or light reflected from a ball, is not processed solely by the brain, but through a brain-body-environment system, which is 'embedded and embodied' (Teques et al., 2017). Known as perceptual attunement, ecological dynamists suggest that performers do not use cognition or understanding when experiencing affordances but rather, are adaptable in their selection for action due to task constraints or the availability of information (Fajen et al., 2009). This suggests perception is not derived from any form of mental representation, or indeed understanding of context, but only from information detected by an observer.

In contrast to this idea, cognitive theorists adopt a 'top-down' approach (e.g., Gregory, 1970; 1974). This work suggests that a performer uses contextual information, or pattern recognition, to build their understanding of the environment around them, which allows meaning to be developed for later visual inputs, as opposed to the bottom-up approach of EcoD which explains a continuous self-organisation of behaviours through a direct relationship with the environment. This cognitive approach suggests that performers store a mental representation, seen as encompassing abstract symbols (Raab & Araújo, 2019), held within the relations between a body and its goal (Pacherie, 2018). Simply put, Raab (2012) suggests that previously learnt movements influence current decisions, or an action–

perception coupling as opposed to perception–action coupling should also be considered (Carson & Collins, 2020).

The 'style' of such sense making in performers is argued to take either a Classical Decision Making (CDM; Mascarenhas & Smith, 2011) or a Naturalistic Decision Making (NDM; Klein et al., 1993) approach, both of which require a degree of cognition (further explored in team DM; Gréheigne et al., 1999). In the case of CDM, performers will typically generate and think through various options prior to making a decision, whereas NDM is seen as more of an intuitive judgement, or 'gut feel' process (Collins & Collins, 2015). However, this intuition is now proposed to be grounded in understanding developed from experience and previous reflection (Collins & Collins, 2016; Klein, 2008). As an example, the concept of Recognition Primed Decision Making (RPDM) suggests that a slowly developed sense of recognition is an important feature for DM training. Indeed, through an internal representation, this recognition supports the DM process when an individual faces a problem within their environment. In short, search strategies and subsequent actions are *primed* by anticipation, either through a RPDM process, a more carefully considered CDM-style internal reflection (cf. Collins & Collins, 2015) or both acting in tandem (Richards et al., 2017).

Of note, whilst the ecological approach is presented here as the absolutist view, as stated in section 2.6.3, EcoD was originally developed following criticisms of the cognitive approach. Researchers believed the traditional approach fell short and was both overly prescriptive and 'mechanistic', thus leading to a lack of realism and explicative power. It would be fair to state that, for some, the cognitive approach is equally absolutist, and therefore not the contrasting view of this dichotomy. Instead, I would highlight the nuanced nature of the cognitive approach apparent in other, more recent researchers and practitioners. This does not disregard the importance of the performer's interaction and relationship with the environment, but instead simply suggests that there is more to DM and control. In short,

such a perspective sees a role for both central control, including representations, and ecological elements such as direct perception. Of interest, it is worth noting that such an integrated approach receives increasing opprobrium from many in the EcoD camp, sometimes from an ontological rather than evidence-based stance.

  2.6.5.1. Key Implications. "When things are proceeding normally, experts don't solve problems and don't make decisions; they do what normally works" (Dreyfus & Dreyfus, 1986, p. 30). The confusion that exists as a result of the ecological and cognitive approaches is widespread, as is compounded by the ambiguity of this quote. To do what 'normally works' could be interpreted by cognitivists as primed information (Klein, 2008), manifesting as embodied cognition and thereby contributing to an ever growing, more easily accessible and/or activated internal representation (Raab & Araújo, 2019). One cognitive concept that is gaining traction is the role of contextual information and 'contextual priors' (Broadbent et al., 2019; Mann et al., 2014) which refers to non-kinematic knowledge obtained within and prior to a game, thereby impacting upon the players' DM process (Gredin et al., 2020). Levi and Jackson (2018) suggest that players take a number of static (pre-existing such as importance of the game) and dynamic factors (evolving with the game such as score line) into account when faced with decisions. As such, practitioners should look to build understanding of these factors. However, there is still little known about how these factors continue to impact a decision through to action. What is clear is that taking a cognitive approach would require a significant amount of practice, through an attempt, review and revision process, or "TEACH-TEST-TWEAK-REPEAT" (Collins & MacNamara, 2017, p. 4). The idea being that this process would create understanding and prime athletes to recognise decisions and DM states in the future (Klein, 2008). Fundamentally, thinking into doing.

Conversely, there are a number of impactful implications that occur as a result of the EcoD approach. One example, which contrasts with the contextual DM process above, is the pursuit of esoteric terms (e.g., attunement) whereby "the perceptual system simply extracts the [informational] invariants from the flowing array; it resonates to the invariant structure or is attuned to it" (Gibson, 1979, p. 249). Ecological psychologists believe that perception does not "occur in the brain but to arise in the retino-neuro-muscular system as an activity of the whole system" (Gibson, 1979, p. 217). Based on these assumptions, ecological practitioners are trying to develop performers to make better decisions by relying on their ability to self-organise within their environment, through perception-action coupling, and that this takes place *all* of the time.

In order to achieve this, applications of EcoD take an approach such as CLA, which I have mentioned earlier (Davids et al., 2008), with a focus on representative task design (Brunswik, 1956). It is argued by Dicks et al. (2009) that sport expertise lies in the successful ability of athletes to use predictive information to guide anticipatory responses. In action, "a decision emerged based on an athlete's perceptual attunement to key information sources" (Davids et al., 2012, p. 114). This is achieved through representative learning design, which Davids et al. suggest means that learning/practice settings must meet the following criteria; involve complex tasks, provide access to relevant sources of information, use dynamic tasks, allow for active [full visual] perception and set achievement goals. Batting against a bowling machine in cricket, for example, would not qualify as a representative learning design task, and therefore would not be expected to enhance learning or performance (Pinder et al., 2011).

EcoD suggests that instead of understanding through a cognitive approach, performers need to explore their performance environment, essentially instead of thinking into doing, they are moving and doing, as learners must move to pick up information around them (known as dynamic training; Wilson et al., 2008). Under the umbrella concept of

representative learning design, practitioners and 'pedagogues' can utilise a myriad of EcoD principles to ensure the constraints of training accurately represent the context under which they will be performed.

2.6.6. To Think or Not To Think: Role of Cognitions in Performance

Unsurprisingly, and reflecting the previous dichotomies, the role of cognition is also debated within a performance context. For clarity, I mean an executional state that attempts to stabilise an already existing and learnt technique, sometimes, but not *always*, under conditions of high competitive pressure (Schack & Bar-Eli, 2007). Notably, an ideal performance state is something performers and practitioners strive for, evidenced when the American Psychological Association noted the growth of sport psychology in top sport (Weir, 2018). Therefore, *if* fundamental differences in understanding are newly apparent, such input should be of significant importance to coaching practice to avoid performers and practitioners operating in the pursuit of the improbable.

On the absolutist side of the dichotomy is 'flow'. From an applied perspective, this term is used unsparingly within sport psychology (and especially its popularist outputs), referring to a mental state achieved by individuals during a performance and pioneered by Csikszentmihalyi (1990). Reflecting the universality of flow, a myriad of domains have been used to research the state including endurance sports (Brick et al., 2014), aquatics (Anderson et al., 2014) and team and individual collegiate sports (Chavez, 2008). Flow is defined as an immersive, harmonious and intrinsically rewarding state that is often depicted by a high skill, low effort environment with positive evaluations of performance (Kennedy et al., 2014), also referred to as the challenge/skill balance. Conceptually, Nakamura and Csikszentmihalyi (2002) describe flow using nine dimensions. They argue three of these dimensions are requirements in order to transcend to a flow state, namely; (1) challenge-skills balance, (2) clear goals, (3) unambiguous feedback. The remaining six describe the state; (4) action-

awareness merging, (5) concentration on the task at hand, (6) sense of control, (7) loss of self-consciousness, (8) time transformation and (9) autotelic experience. Flow has been linked positively to psychological benefits such as wellbeing and self-concept and, importantly for athletes and coaches, peak performance (Jackson & Roberts, 1992). Despite recognising these benefits from flow, however, understanding reliably when it occurs remains a significant challenge. Therefore, even *if* peak in nature, it is an elusive state (Aherne et al., 2011).

From a cognitive perspective, flow has been characterised as an 'unthinking' state. For example, Chavez (2008) found that athletes from a range of team and individual sports recognised having limited or no cognitive conscious thought process as the most salient feature when describing flow experiences. Reflecting this effortless mode of performance, one swimmer described:

> [Y]ou don't have to think about it because… like I said before, it all comes together. It just, it's not like you have to think of how it has to come together. Like you don't have to study like you do for a test, it just should come automatically. (p. 76)

Others supported the contention of an unthinking characteristic with similar views, such as; "It's almost like I'm blank," and "It's like autopilot" (p. 76). Accordingly, these quotes reflect an overall sense of efficiency across both the cognitive *and* motor system.

Due to the nature of flow, much of the research conducted is operationalised using self-report measures, in which performers retrospectively recall experiences of the state (e.g., Swann et al., 2016). Importantly, there is a limited understanding of how flow is achieved or indeed, how it operates in real-time (Jackson & Marsh, 1996). Consequently, practitioners are striving to achieve this rare state, as opposed to working more effectively to counter performance negatives. In fact, Hooper and Collins (1997) have suggested that, in fact, flow

is an exclusively post-hoc rationalisation of an experience, whereby a particularly satisfying achievement acquires a 'rosy glow' of perfection. Specifically, they discussed post hoc descriptions of climbing, an activity often associated with the flow state (Hardie-Bick & Bonner, 2016). The recollections miss out on the 'grunty sweaty bits' which, as any climber will attest, are an unavoidable feature of climbing at or near your limit. In short, this opens up the possibility for several successful performance states existing.

Once again, a more moderate, context-related model has emerged. Challenging the idea of one optimal performance state, the Multi-Action Plan (MAP) developed by Bortoli, Robazza and colleagues (Bortoli et al., 2012; Robazza et al., 2016) has suggested that optimal performance can also occur even when employing conscious motor processing strategies. Contradictory to flow, which depicts optimal performance as a singular unconscious execution, MAP practically identifies the need for adaptability in performance states to achieve and maintain optimal performance. This necessity to adapt results from a change in conditions (both internal and external) which is often, but not always, moderated by competitive stress, or stress from other sources. For example, conscious control may be required because the performer has not trained enough to fulfil the technical requirements of the task using automatic control, or because the anxious bodily state presents too much of a discomfort to the performer that it cannot be ignored (cf. Carson et al., 2020; Montero, 2015). Mechanistically, MAP builds on the earlier work of Hanin (1978) on emotion-focused individual zones of optimal functioning (IZOF) as a self-regulatory performance strategy. Similarly idiosyncratic in nature, MAP presents an elaborated structure consisting of four performance states comprising both emotional and action-focused strategies. From an action perspective, rather than optimal performance being characterised as an efficient state, MAP values proficiency in switching between states at the right time in order to stabilise

performance outcomes, which characterises the skilled athlete (cf. Csikszentmihalyi, 1990;

Eysenck & Calvo, 1992).

Depicted as a 2 x 2 interactional model, as shown in Figure 2.2, MAP has two

performance dimensions (optimal/suboptimal outcome and controlled/automatic

performance). Advancing Hanin's original work on the IZOF (Kamata et al., 2002), the top

right quadrant (optimal and automatic; Type 1), termed 'Plan A', explains that highly

automatic and pleasant emotional states can be successful (most closely representing the

concept of flow). However, there is another state of optimal performance that is

representative of a more controlled experience. This quadrant (Type 2) reflects the type of

control demonstrated to satisfy the need for adaptability and that optimal performance *can*

and indeed sometimes *should* include cognitive control. Pertinent to this thesis, Bortoli et al.

(2012) suggest that in novel and/or highly stressful environments the performer likely

experiences unpleasant emotional states, triggering a 'call to action' of available resources;

'Plan B'. However, Bortoli and colleagues' work continues to discuss the need for a

combination of Type 1 and Type 2 performances, and that the most skilled performers will

utilise both performance states. Crucially, the controlled state needs to consider the

idiosyncratic nature of an athlete's technique and performance. In other words, conscious

control is deemed appropriate when applied to movement components that are insufficiently

automated during unsuccessful performance *and* which are causative of poor outcomes. Due

to these movements needing to be correctly activated, they have been termed "core action

components" (Bortoli et al., 2012, p. 699).

Optimal performance

Controlled performance

Type 2
"Plan B"

Type 1
"Plan A"

Automatic performance

Type 3

Type 4

Suboptimal performance
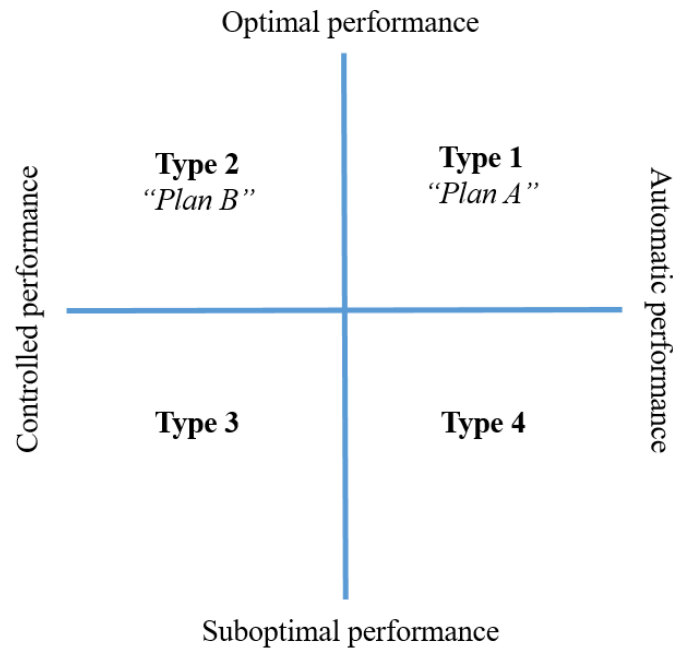
Figure 2.2. Adaptation of the MAP from Bortoli et al. (2012)

Addressing the remaining two quadrants, these states characterise suboptimal performances (Type 3 and 4). Whereas the Type 2 state explains conscious attention directed towards important but insufficiently automated action components for success, a Type 3 state explains a dysfunctional direction and use of conscious attention towards the movement. In this case, too many or irrelevant action components are focused on and the emotional experience is unpleasant. What this means is that, either way, they are not core to task success and *what* an athlete focuses on is fundamental to our interpretation of process effectiveness (see earlier comments relating to implicit learning, p. 17). Finally, Type 4 performances are equally as automatic as during flow; however, performance is suboptimal due to a lack of focus, involvement, interest, energy or effort towards the task. Type 4 performances have been explained as occurring when the skill attempted is insufficiently established in memory and usually after a period of experiencing a Type 3 state and is, therefore, equally emotionally unpleasant (Carson et al., 2020). Bortoli and colleagues' work continues to discuss the need for a combination of Type 1 and Type 2 performances, and that the most skilled performers will be able to utilise both Type 1 and 2 performance states. As

such, it is suggested that successful performance, and the optimal performance states associated with it, depend upon *what* a performer is thinking about, which can actually help to maintain and improve optimal performance, as opposed to thinking too much or about irrelevant aspects of the movement.

Extending and supporting this multi-state view of optimal performance, Swann et al. (2016) explored successful performances from tournament winning professional golfers. Specifically, during the final competitive round, participants identified two distinct performance states: Letting it happen (LIT) and Making it happen (MIT). LIT corresponded with the definition of flow or the Type 1 state, in which athletes (through a gradual build of confidence and momentum) played with a calm process focus, feeling their performance was effortless and enjoyable, which occurred early in the round. Comparatively, later on in the round when pressure increased, a MIT state shared some commonalities with LIT and therefore flow, such as enjoyment, a sense of control and absorption in the task. However, participants reported this state as "a more intense state of optimal arousal, with heightened and effortful concentration, and awareness of the situation" (p. 26), somewhat more akin to the Type 2 state. Therefore, successful performers should not be assumed to be in a single state for the full duration of performance. Reflecting both these bodies of applied literature, adaptability is understood as essential in order to achieve the correct focus needed, depending upon the performance environment.

2.6.6.1. Key Implications. Regarding flow-state literature, it is somewhat unsurprising that there is little applied literature supporting athletes and coaches in their pursuit of the state. This is due to the elusive nature of the phenomenon. Or, in the immortal song lyrics of Joni Mitchell (Big Yellow Taxi) "You don't know what you got 'til it's gone", as a flow-like state is something to be enjoyed but not something that can necessarily be created. You will only realise it occurred from reflection (Swann et al., 2015).

An applied implication of this concept is that peak performances are typically associated with unconscious (perhaps even automatic) executions. For example, a relevant statement from former international cricketer Kumar Sangakkara:

> Basically in batting, you have to be mindless. You've done all the practice, you have your muscle memory and your reflexes are more than quick to deal with any kind of delivery. You've got to let your body do all those things by itself without letting your mind take control. (Sadikot, 2014 cited in Christensen et al., 2016).

Researchers, such as Brownstein (2014) have taken quotes like this, and similar anecdotal evidence, to suggest that skill execution is completed with little conscious awareness. As result of this belief, coaches and practitioners have been encouraged to promote more automatic behaviours. To understand this from an applied perspective, information can be taken from the both ancient and yet seemingly 'new' concept of mindfulness (Gardner & Moore, 2012). The key features of mindfulness suggest individuals should be present, non-judgemental and aware, which are, in essence, contradicting the promotion of automatic control and therefore unconscious processing. A two-part study by Bernier et al. (2009) identified that mindfulness states are closely linked with optimal performance, or as they termed them flow states. Expanding this, Bernier et al. integrated mindfulness into a psychological skills programme with athletes and their results demonstrated a performance enhancement, manifesting as improved ranking scores, achievement of competition goals and increased pre-performance activation control for the intervention group, when compared to a control group. Supporting this, Carraça et al. (2018) implemented a sport specific mindfulness programme. Comparing an intervention and a control group, they identified that those in the intervention group showed increased levels of flow. Interestingly these findings identified mindfulness (i.e., a present focus) to lead to flow,

which has been reported as the non-thinking, automatic state. Perhaps, could it be possible that the study of mindfulness is instead leading to better self-regulation?

From a nuanced perspective, and reflecting the MAP model and work of Swann and colleagues (2016), it seems more pertinent for coaches and athletes to work together in an effort to identify bespoke and flexible motor processing strategies most appropriate for the athlete/context interaction. A contention supported by Robazza et al. (2004) as they identified athletes consistently reported an in/out of zone phenomenon, suggesting that self-awareness may be a more appropriate skill to equip our athletes with than a consistent strive for flow.

As stated, a key feature of this approach is the knowledge of core-action components, which are the movement components which are causative of poor outcomes, and therefore require cognitive control, manifesting in a Type 2 performance according to MAP. Holmes and Collins (2001) developed the PETTLEP model of imagery that supports the potential to identify and then train these core-action components. For example, considering the physical (P) nature of the skill, planning the task (T) being imaged and engaging in the emotion (E) that is likely linked to the performance (Wakefield & Smith, 2012). All of these would further support the self-awareness of an athlete to control these difficult core-action components. Carson et al. (2020) support this further by suggesting the consideration of how practitioners work with athletes to develop PETTLEP imagery scripts to further associate these core-action components within mental representations.

Moreover, practitioners should consider the relationship between Type 1 and Type 4 performances. Robazza et al. (2016) explore the performance-hedonic tone relationship which can result in some very pleasant (on the automatic scale) but dysfunctional performances. Reversal theory (Apter, 1989) is a comprehensive conception model, which explains how an athlete may slip from a telic (serious, goal-orientated) to a paratelic (characterised by playful and spontaneous behaviour) state of mind, but is very idiosyncratic

in nature. Kerr (1993) suggests that a contingent event, frustration or satiation, are the possible triggers of a "reversal process" (p. 403) whereby the performer switches from one state to the either. This process could be interpreted as either positive or negative by the performer from an emotional perspective, as the hedonic tone of the performance changes, however it would nearly always result in a negative performance impact. As such, Kerr suggests the importance of athletes to remain aware of their hedonic tone, and meta-motivational states in order to avoid such consequences.

A further consideration applied practitioners must be aware of is how the role of cognition might impact upon team performance. Researchers frequently point out the highly interactionist nature of team sport, suggesting a number of factors potentially impacting on the DM process, such as social values (Bouthier et al., 1995), cost–benefit considerations (Gréhaigne & Godbout, 1995) and personal motivations (Bouthier, 1993). However beyond these psychosocial factors, it is clear that within skill execution there must be a degree of thinking required in order to get a team of, for example, five basketball players pushing on defence in the final quarter working harmoniously. One such implication of this is the concept of Shared Mental Models (SMM), defined as "knowledge structure(s) held by each member of a team that enables them to form accurate explanations and expectations... and in turn, to coordinate their actions and adapt their behaviour to demands of the task and other team members" (Cannon-Bowers et al., 1993, p. 228). Operating within an effective SMM may appear flow-like to the outside world; however, key features of SMMs include an explicit understanding of common goals and strategies (Schinke et al., 1997), high role clarity (Klimoski & Mohammed, 1994) and communication strategies (Eccles & Tenenbaum, 2004); all things which would typically require a significant amount of thinking.

When it comes to in-process actions, Bourbousson et al. (2010) suggest that SMMs, or Team Mental Models, are a dynamic and probabilistic phenomenon. Space–time

movements result in dyadic combinations amongst team members to achieve the common goal. However, these in-process actions occur from verbal and non-verbal communications prior, and the development of shared knowledge in post-process actions (Eccles & Tenenbaum, 2004). In short, pre, in and post coordination mechanisms exist to conceptualise the on-pitch, field, or court performance (Filho & Tenenbaum, 2012).

2.6.7. 'Just Do It': Motoric Automaticity

Automaticity has been identified as being synonymous with optimal performance (Moors & De Houwer, 2006), characterised by little or no demand on attentional resources (Schneider et al., 1984). Logan (1988) suggested automaticity could be defined as a single-step memory recall process, indicating that automaticity across all movement components within a skill may not be uniform (i.e., conscious initiation but not ongoing control of a motor skill). From this contrast, the extent of the ambiguity that practitioners face is clear.

To put automaticity within a coach education context, Fitts and Posner's (1967) three stages of learning has been broadly accepted as *the* established theory of learning, and is presented in a linear fashion. This suggests that when we start learning a skill we are in the cognitive phase, typified by inconsistent, inefficient and fragmented performances, which require a great deal thinking. Moving forward, performers progress through to the associative stage where some parts of the movement are associated (i.e., chunked in memory) with others and specific outcomes which leads to more reliable performances. Finally, the autonomous stage is typified by accurate, consistent, smooth and efficient movements, which are controlled automatically. These characteristics suggest that the end of skill acquisition comes when the performer can repeat skills consistently with no cognitive effort.

Similarly, the work of Dreyfus and Dreyfus (1986) presents an equally progressive and linear five-stage model of skill acquisition. Their final *expert* stage is typified by a more intuitive approach to skill execution. In this stage, performers transcend their reliance on

rules, allowing for an analytical approach to be taken. One of the authors, Hubert Dreyfus, later explained this as "Masters agree that mastery is achieved only when the master ceases to base his actions on reasons and instead is absorbed into a field of attractive and repulsive forces that directly draw him to cope" (Dreyfus, 2013, p. 33). It is argued that Dreyfus and Dreyfus suggest that an individual achieves automaticity by holistic-pattern recognition (Christensen et al., 2019).

Juxtaposed to these theories of full automaticity achieved in a linear fashion, a wealth of other insights have been proposed, all highlighting many complexities currently omitted, or at least apparently neglected, within the work of Fitts and Posner (1967) and Dreyfus and Dreyfus (1986). For instance, Bargh (1994) identified four features (known as the four horseman), or tests, of performance to determine the level of automaticity; awareness, intentionality, efficiency and controllability. These criteria expand the original work of Schneider and Shiffrin's (1977) controllability criterion, by including the more subjective (intention and awareness) and performance (efficiency) components. Contrasting to the assumptions of linear skill acquisition theories, however, Bargh later suggests that not all four of these components must be present for automaticity to occur, and in fact, that automaticity had previously been assumed to be a far more uniform phenomenon than research has shown (see Melnikoff & Bargh 2018). Instead, a performer could experience only two of these and still be experiencing characteristics of automatic processing. Bargh offered some clear examples to conceptualise the nuances of automaticity. For example, typing is almost certainly intentional at some level, and controllable as the person completing the task could stop, however typing can still be autonomous and efficient and therefore have qualities of both automatic and controlled performance.

Reflecting this more nuanced approach, Milnikoff and Bargh (2018) contested a dualism approach, stating that there is a lack of any substantial evidence to support this in

relation to the four criteria for automaticity; that is, the dependency of one characteristic on another (i.e., the need for an activity to efficient, uncontrolled, autonomous and unintentional to be classed as automatic). Instead, Milnikoff and Bargh highlight the many shades of grey we must acknowledge as practitioners. Execution can be both controlled and efficient, or uncontrolled and inefficient. In short, there are more complexities than previous assumptions have allowed us to acknowledge. Interestingly, Christensen et al. (2019) argue that performers do have a performance based procedural system which is responsible for executing well-learnt skilled actions, however most complex skills do not, and should not, fully automate. Instead, these complex skills still utilise skill representations for contribution to skilled performance, however mechanistically through a more declarative system.

Accordingly, we may need to consider the idea of automaticity as a temporally dynamic construct, especially with very open-skilled sports such as invasion games or those with varying intensity levels over time. In short, automaticity in elites, or even those with experience, is not as entirely automatic as was once believed. To practically exemplify this, consider the domain of motor control. Biomechanists and motor control specialists have been interested in the process of movement for some time, and therefore have developed a number of potential theoretical perspectives. Bernstein (1967) suggested that as we develop our skills, we reduce the number of degrees of freedom (DoF) utilised in the movement, eliminating the use of any redundant DoFs until we can perform smooth actions, or 'muscle synergies' (Alnajjar et al., 2015). This view is very closely linked to the common understanding of automaticity in which we replicate the same movements without thinking. Importantly however, a more recent hypothesis challenges the idea of consistently replicated movement, known as the UCM which was cited earlier (Scholz & Schöner, 1999). UCM proposes that the central nervous system does not eliminate redundant DoFs when executing movement but rather, stores all combinations of possible DoFs and joint angles for a planned movement

outcome (Latash et al., 2007). UCM highlights that components of movements are organised differently in two types of variables. The first are performance variables, which are essential for task success, have low variability and are therefore more consistent. The other are elemental variables, which are less essential for task success and are therefore more variable. The combination of performance and elemental variables enable important movement components to remain preserved under changing conditions. Taking a UCM perspective, automaticity is clearly a far more complex system than initially thought, and instead should be seen as a more scalable or relative construct across movement components as opposed to the global movement as a whole.

    2.6.7.1. Key Implications. Taking an applied stance, an absolutist view would suggest that skills are best developed to be automatically executed with little variance. Within varying sports and across skill levels, outcomes such as accuracy and consistency are expected in automatic skill execution. This has been identified as key features by high-level performers (del Villar et al., 2007), and is further demonstrated through research which states that dual-task performances affected novice players execution but not elites' (Gray, 2004), arguably because movements are already automated and therefore immune to distraction.

    Juxtaposed to this, it appears skill execution is more nuanced. Indeed, different elements of the skill will be more or less automatic, and therefore more or less consistent in their execution. Exemplifying this, Ericsson stated "expert performers counteract automaticity by developing increasingly complex mental representations so they can attain higher levels of control of their performance and therefore remain within the cognitive/associative phase" (Ericsson, 2003, p. 64). Contradicting the process popularised by Fitts and Posner, Ericsson is suggesting that it would be preferable for players to avoid full automaticity. Specifically, automatic performances appear to represent a distinct minority of *actual* high-performance results, particularly when compared to the seemingly consistent

laboratory-based evidence. This comparison would suggest that successful skilled performances are typically not entirely subconscious, especially not when performed in real world competitive settings (see Swann et al., 2016). Indeed, Toner and Moran (2015) argue that somaesthetic awareness must be maintained for athletes to continually improve and that it may become problematic if athletes are not able to monitor their skills (e.g., bad habits slip in, fail to effectively adapt to the task demands such as a tricky competitor; Christensen et al., 2016). In essence, suggesting athletes should not want to become too automated. Instead adaptability would be preferred to deal with nuanced performance demands. Pertinently, this latter point may explain the disproportion of subconsciously controlled results in laboratory studies; in short, experimenters are asking athletes to complete (comparatively to real world competition) rather easy tasks (cf. Collins, Carson, et al., 2016)!

Of note, taking the applied stance, research within highly complex sports, such as free-style skiing and snowboarding, has further supported the suggestion to avoid full automaticity of movements. Willmott and Collins (2017) explored the progression of tricks within elite freeskiing and snowboarding and suggested that, whilst individuals vary in their trick progression journey, all require more complex manoeuvre development in the later stage of their career. Therefore, it was preferable to maintain flexibility in the prerequisite manoeuvres in order to add to this repertoire later on. Moreover, Collins et al. (2018) promote the need for coaches' consideration of the evolution of their sport, as new tricks are consistently being developed. Therefore, this late stage complex manoeuvre development appears to be an ongoing process.

2.7. Summary

Throughout this chapter, a number of emergent dichotomies have been presented. The dichotomies have come from the growth of applied research topics within the field. Importantly, however, they also appear to underpin some common problems experienced by

practitioners. Evidently, there is a clear need for a pragmatic approach in applied practice in order to better understand whether absolutist or more nuanced views can sufficiently explain elite-level performance. In the following chapters, I explore a number of real world problems which are often encountered by applied practitioners, ones which have become all too common to me. Each chapter aims to address a number, no more than four, of the dichotomies and offer some clear applied implications. Obviously, I would not be so bold as to suggest I could necessarily answer the *fundamental* questions raised from these uncertain dichotomies, but instead explore the alternative view and attempt to close the gap of understanding from an *applied* perspective.

As such, the next chapter, Chapter 3, begins this journey as the first empirical chapter of the thesis. This chapter focuses on a sport that I have a wealth of applied experience in; Motorsport. A commonly held belief, and frequently used term, in this sport is 'Natural Talent', which seems to be presented in direct contrast to the concept of effortful learning behaviours. As such, I attempt to explore the existence and veracity of this belief using sources from both peer reviewed and grey literature. This chapter address the following dichotomies: 'maybe she's born with it?', 'where's your head at?', 'to think or not to think' and 'just do it'.

Chapter 3. Born to Race?: A Critical Appraisal of Automaticity and 'Natural Talent' in Motorsport

3.1. Introduction

In Chapters 1 and 2 I outlined and explained my philosophical perspective as a pragmatic applied sport psychologist. I then presented several dichotomies that are apparent within the literature. These dichotomies are particularly meaningful from an applied perspective because they present high potential for, perhaps even current evidence of (e.g., Winter & Collins, 2015), confusion amongst practitioners regarding the best actions to take with clients. Indeed, it is, therefore, using a practice *through* theory approach that I intend to explore the extent to which these dichotomies present themselves within applied contexts that are relevant to applied sport psychology. In the current chapter, I will address four of these ('maybe she's born with it?', 'where's your head at?', 'to think or not to think' and 'just do it'; see Table 2.1) within Motorsport. Specifically, this chapter focuses on the notion of the need to develop autonomous levels of motor control and the presence of natural talent within the sport. But first, reflecting my pragmatic philosophy, I begin by providing some all-important context to this real world issue.

3.1.1. The Context

The Motorsport industry is one of the biggest within sport. On four wheels (from karting to Formula 1; F1), on two wheels and for a short period of time even 6 wheels, a vast amount of money, resource, expertise and innovation is invested in getting the vehicles right for performance, with many technological advances gradually influencing the road vehicles we see today. However, the exact process of developing a world-class driver or rider is still relatively unknown. Hassan (2011) notes the surprising lack of scientific research into the domain of Motorsport, in particular considering the financial investment made every year (~£50billion), whilst Pflugfelder states "what we might call 'Motorsport studies' exist in

fragments, as there have only been a handful of academic articles seeking to understand motor-racing culture" (2009, p. 413). Much 'evidence' of the sport, therefore, comes from non-academic sources.

Consequently, at least from a scientist's perspective, the field has gone somewhat feral. Whilst there are many individuals, talented, accredited, and otherwise, professing to support elite-level drivers, there is no clear guidance for how to achieve optimal performance, or indeed what actually characterises top-performance. As such, practitioners operating within the field are facing a constant battle against misinformed long held beliefs and misconceptions, some of which are standing in the way of achieving these long sought after victories.

3.1.2. The Problem

Maintaining the pragmatic approach that underpins this work, the present chapter addressed a practical problem experienced by practitioners which underlies many of the challenges outlined above. In particular, having operated as an applied practitioner within this domain for 6 years, it is a problem I have encountered often. Within Motorsport, it is a commonly held assumption that successful drivers are 'born, not made'. Commentators, families, and even drivers themselves profess that driving is a natural born talent, something that you either have or have not got. Therefore, as an inevitable or even unavoidable consequence, progression to and performance at the top of the sport is down to a naturally occurring skill. Indeed, some have even suggested this skill is bestowed upon a performer by some sort of higher order being, making their talent 'God-given'.

As a consequence of this assumption, significant investment is spent trying to identify those with natural talent, with a fast turnover of people who do not demonstrate this very quickly (as indeed they should be expected to, if it genuinely is completely natural). Typically, there is a very narrow pyramid of performers who go on to be successful in the

discipline, and a lack of focus on the correct development of the techniques that are most likely needed. Indeed, if the necessary skills are something you *possess* rather than *develop*, identification becomes the focus with development a rather poor second!

Notably, however, this contention is in complete contradiction to complex motor skills in other areas which emphasise a long-term practice regime (such as Deliberate Practice; DP, Ericsson et al., 1993), and some key features of the discipline which would also suggest that 'natural born talent' is likely to be nothing but ill-informed hyperbole. Indeed, Motorsport seemingly demands a high cognitive load with complicated psychomotor skills that are, more likely than not, acquired. Moreover, the 'natural born' argument is not as rife in other sports as it is in Motorsport, even individual and arguably expensive pursuits such as tennis or golf.

To test the assertion that individuals are born as good drivers, from an empirical sense, researchers would need to track hundreds of new-borns from birth until, arguably 23 years old (the age that both Sebastian Vettel and Lewis Hamilton won their first F1 titles, the youngest F1 champions in history). Of course, this would present some challenges! Moreover, there are many additional factors which can impact eventual success. For example, the most competitive children in Karting compete approximately 48 weekends out of 52 and spend ~£150,000 on one season (Haley, 2016). In other worlds, money makes the world (and wheels!) go round faster. As a consequence, genuine identification of potential would seem impossible unless, or until, developing athletes compete on a level playing field. In this case, using identical cars. Clearly, the assertion of natural born talent has major implications for applied practice and therefore, it was imperative that this was critically examined.

3.1.3. The Dichotomies

This chapter explores four of the dichotomies identified in Chapter 2 which are detailed in Table 3.1. Based on the absolutist and nuanced approaches, predictions are outlined.

Table 3.1

Dichotomy Explanations and Predictions for Chapter 3.

Dichotomy	Explanations		Predictions	
	Absolutist	**Nuanced**	**Absolutist**	**Nuanced**
Maybe she's born with it	Some lucky individuals are born with the natural talent needed to be successful.	There are some factors which are better suited to particular pursuits, but considerable deliberate practice is required to be successful/develop these factors.	Those successful in Motorsport will not display evidence of effort and deliberate practice to achieve their top performances.	Across the disciplines, we will see a clear and concerted effort at practice, rehearsal and characteristics of long-term learning.
Where's your head at?	Performance attention should *always* be directed externally and away from bodily mechanics.	Performance may not *always* be hindered by using an internal focus, instead a mix of foci would be most appropriate.	Drivers will maintain a focus on external factors throughout their performance, and a switch internally will produce a bad outcome.	A mix of internal and external focus will produce the optimum performance.
To think or not to think	Peak performance can only occur subconsciously.	Peak performance can occur under a number of conditions.	All successful performances will be characterised by flow-like experiences with minimal effort.	Successful performances will sometimes manifest in more 'out of body' experiences, but will also show signs of serious effort and concentration.
Just do it	Performers develop until automaticity is achieved which results in consistent performances, with minimal mental input.	Different skills will be more or less automatic, therefore resulting in organically occurring variance in execution.	Expert performers will produce consistent, non-variable performances.	Different elements of performance will be automatised to different levels.

3.1.4. The Objectives

Reflecting the dichotomous positions in Table 3.1, and the important applied problem addressed, I was interested to critically explore the world of Motorsport: in particular the commonly held beliefs and conceptions surrounding superior performance. Through this, I aimed to make recommendations for practitioners currently operating within the discipline.

Therefore, the objectives of this study were as follows:

1. To explore the literature, both peer review and grey, for evidence that the existence and superiority of natural talent is a true assumption. This will include seeking expert opinion.

2. Next, to address the implications of this assumption, and test them against the psychomotor literature in other areas.

3. Finally, to explore the literature, again both peer reviewed and grey, for alternative perspectives.

3.2. Is This Belief Common?

Having worked in the industry for several years, I can profess, yes! However, as stated, this is a difficult topic to study. In order to establish whether the assertion, that many people believe natural talent is the cause of success, I completed a literature search. This search took guidance from previous work in this field that has utilised documentary analysis tools (cf. Matthews & Pike, 2016), and reflected previous methodologies deployed in archival reviews, in which a number of sources are explored to gain a clearer picture of an event or phenomena (Ventresca & Mohr, 2002). Initially using the following search terms, "Natural Talent" OR "Motor Control" OR "God-given" AND "Motorsport", on EBSCO, SPORTDiscus and Google Scholar Databases. Following this, I explored the grey literature using similar search terms in the archives of key discipline specific publications and broadcasts, for example Autosport Magazine and BBC Sport. I felt that the use of grey literature was justified as it proved a more accurate portrayal of the mores within the sport

(Hughes & Coakley, 1991). Moreover, industries such as Public Health have identified grey literature make important contributions to various case studies, whilst still allowing literature searches to be replicable (Adams et al., 2016). In order to obtain purposeful data, I also searched these terms with the names of the following drivers, selected because of either their notable record (multiple world championships) and/or their early success in the sport: Michael Schumacher, Aryton Senna, Nicki Lauda, Lewis Hamilton, Sebastian Vettel and Max Verstappen. Finally, I sought the opinion from industry experts operating within the highest echelons of the sport with particular expertise in talent development.

Having completed the review of peer-reviewed literature, no relevant or suitable articles were found. The only published scientific work appears to relate to the technical development of driver ability, albeit that this surely inherently ignores the natural talent position. However, the grey literature was more fruitful. Some of the comments made by those in the field are more tacit in their implications of other-worldly talent. Such as Christian Horner, Team Principal at Aston Martin Red Bull Racing stating in the very first episode of the popular TV Programme 'F1: Drive to Survive' that "these guys have a fighter pilot mentality, and that is what separates them from mere-mortals" (Horner, in Gay-Rees et al., 2020). However, other sources are very explicit in their belief that talent is either 'God-given', "He had God-given talent to match the very greatest natural drivers" said of Stirling Moss (McEvoy, 2019, para 13) or professing the existence of natural talent, such as this statement from Eddie Jordan, owner of Jordan Grand Prix who ran many of the greats in F1, discussing Michael Schumacher (who of course needs no introduction), "Schumacher possessed 'unbelievable natural talent', close to Senna's levels" (George, 2020, para. 4). Speaking of Senna, I was spoilt for choice when it came to journalistic comments about his natural talent, so here are just a few; "Is there a Formula One list that doesn't include the most naturally talented driver in history?" (The Telegraph, 2017, para 1), "A natural talent with a lust for speed" (Botsford, 1994), and from Williams-Smith for Motorsport Magazine:

It was a natural talent visible to all, whether he was threading his McLaren inch-

perfectly through the Monaco barriers, walking on water at Donington, or pouring his

soul into a home victory in São Paulo, before a jubilant Brazilian public chanting his

name. Each moment was one of sheer supremacy, born of the ability of a true great.

Possibly the greatest. (2020, para. 2)

More recently, Lewis Hamilton (currently seven times Formula 1 World Champion)

stated to the popular Motorsport magazine, Autosport, that his driving skill was a gift: "I put

it down to talent. It's no secret. It was a gift from God" (Straw, 2014, para 3). In a similar

fashion, Motorsport Magazine (2014) published a feature article on every British F1 World

Champion since Mike Hawthorn became the first in 1958. The term 'natural' is used

unsparingly throughout. Indeed, one lens often used for identifying a natural driver is by

measuring their success around the notorious Monaco Grand Prix circuit:

A circuit that demands precise driving, a ridiculous number of gear changes with each

one of them a chance to blow up a fragile '60s racing engine. If there is a track that

requires natural skill it is surely Monaco. Look at the others who have won many

times there: Senna with the most victories of anyone with six. Schumacher with five.

Prost with four. Stewart and Moss with three each. Do I have to point out the obvious

common denominator? Correct, they're all rightly considered naturals. (Motorsport

Magazine, 2012)

In fact, this quote offers a useful overview of what might be commonly understood by the

term; in short, the *social* construct of natural talent (Keaton & Bodie, 2011). This was

confirmed by the Training Manager of the FIA (Féderation Internionale de l'Automobile) and

ex-competitor pathway manager of the British National Governing Body for Motorsport,

Motorsport UK. Importantly for the scope of this chapter, the training manager is involved with all types of Motorsport, from karting through to cars and rally. He states:

> The concept of being born with 'natural' talent is the general belief of the Motorsport community when it comes to how drivers are able to do what they do. It is a historic trait that is still prevalent today. As a talent development professional and Motorsport expert who managed the UK NGB competitor development pathway and coaching structure, it is an ongoing struggle to promote facilitated learning due to this belief. Unfortunately, the vast proportion of individuals within the sport believe that you were either born with 'it' or you were not. (G. Symes, personal communication, March 23, 2018).

This was further supported by a World Rally Champion co-driver, former Performance Director of Motorsport UK, and Vice Chairman of the FIA Rally Commission, stating:

> It's been a long held, and worryingly common, belief within Motorsport, at all levels and throughout all disciplines, that there are some drivers whom appear to possess a more advanced level of skill, or more accurately, instinct. Most pertinently, whilst clearly everyone realises that these skills or instincts improve with practice, the more damaging belief is that individuals are born with these skills. Essentially, this suggestion indicates that if a driver does not have these necessary precursors or skill set, they won't make it. (R. Reid, personal communication, May 31, 2018).

Frankly, I would say it is quite clear that the term natural talent is used in a widespread manner. This is encompassing precision and consistency in execution, technical expertise in the act of driving, an adaptable approach to meeting environmental challenges and high-level subject knowledge of, or perhaps even feel for, the equipment involved, including its'

limitations and consequent requirements. As such, there is enough out there to perpetuate this belief.

3.3. If This Belief is True…

Considering the widespread support for the concept of natural talent, I believe it is important to understand how this would work if it did exist. Throughout Chapter 2, the reader might have noticed a wealth of psychomotoric literature which demonstrates that psychomotor behaviour is not naturally occurring to elite levels. Perhaps, under certain circumstances, some skills might be produced under automatic control (Christensen et al., 2016), but this is certainly not an inevitably. I would suggest things are just not that black and white. However, if someone was operating at these levels through natural control what would we see?

A good place to start would be to explore other skills which have undoubtedly become automated (at least most of the time!) and thus, *could* be perceived as natural, for example walking. Several processes are required in order to walk, such as postural control, muscular strength, perceptual guidance and interlimb coordination, not forgetting the intent to walk (Adolph & Robinson, 2013)! But it is well known that learning to walk takes a lot of experience, and of course several failures (Adolph et al., 2003). Once achieved, however, it is argued that walking becomes a heavily automated and practiced motor task, in which rhythmicity and regularity is reached at mid-adolescence (Hagmann-von Arx et al., 2015): notably, once growth rate has stabilised and the individual is presented with a consistent control challenge.

Now, say for example that walking was a natural talent, we would expect to see no change in our ability to execute this skill, regardless of the circumstance. For example, should a dual-task condition be employed, there should be no change as the natural skill of walking would not require cognitive capacity. However, several researchers have identified that adults' gait patterns are altered when performing cognitive tasks whilst walking (Ko et al.,

2018; Yogev et al., 2005). Indeed, Möhring et al. (2020) explored three different cognitive functions (inhibition, switching and updating), finding that participants walked slower with more variability when solving these cognitive tasks. Updating and switching had the biggest impact. These findings indicate that walking under untrained conditions does indeed require conscious control.

Additionally, if this natural skill all of a sudden had a higher perceived consequence (e.g., walking by the edge of a busy road), again, we would not expect a change in execution, when studies have shown this not to be the case. Collins et al. (2001) added perceived consequence to walking by placing participants, trained British Army soldiers, 20m up on scaffolding. With this added anxiety, participants not familiar or comfortable with walking at this height (all but one participant) showed more consistent, rigid or locked, movement patterns when compared to walking at ground level. Finally, were the control parameters of the system 'perturbed', by knee surgery for example, no detriment to or re-learning of action would be observed. However, the widespread application of movement 're-education' through physiotherapy following such structural changes suggests that at least some modification to the skills is necessitated.

Essentially, walking is evidently not a naturally occurring skill if it can be impacted upon and altered in these ways; even though it is arguably the most over-learnt skill within the human repertoire. In short, walking displays none of the criteria to suggest that it is a naturally occurring movement. This is further supported when exploring research into walking reflexes. Consider the feeling of running up the stairs only to realise you have anticipated one too many steps. van der Linden and colleagues (2007) recreated this feeling through the use of occlusion glasses and an unexpected change of walking surface height, reporting trigger response muscle synergies appropriate for either the unexpected step up or down. Indeed, these findings suggest that, due to the short latency of this response, subcortical (possibly cerebellar) pathways are responsible for the production of walking.

Moreover, an individual who suffers an incomplete spinal cord injury (for whom conventional therapies are not effective) can see improvements in their walking reflexes (such as gait symmetry and speed) through the use of operant conditioning (Thompson & Wolpaw, 2015). These findings suggest that walking is a stored skill and re-establishing the plasticity of pathways (if severed) can develop and modify the skill if lost. As such, this would suggest, walking is not naturally occurring.

Relating this to driving, and on-track performance, if this is a naturally occurring skill then performers would remain consistent regardless of distractions or demands on cognitive capacity. Should the consequence, perceived or otherwise, change then again performance would not be impacted. To identify this, I explored on-track performance. Notably, it would be likely that the performances would be automatic, flow-like in nature and not requiring high cognitive loads or an internal focus. To explore this, I looked at driver's reports post-performance. Finally, if the skill of driving was naturally occurring, or gifted to the righteous, drivers would not need to engage in activities to support their knowledge or ability. To understand this, I explored information regarding the driver's training habits.

3.4. Is This Belief True?

Once again, I reviewed the literature, peer-reviewed and grey, to explore the findings of researchers who have looked at driving-type tasks. Using the same outlets, the search terms included "driving", "automated" and "Motor Control", yielding a number of interesting findings. Across these sources there were indications that would suggest perhaps things are somewhat more nuanced than they seem.

3.4.1. On-Track Performance

Exploring the peer-reviewed literature, a lot of sources pointed towards the process by which athletes learn skills, which is much debated. Positively, all the established theories pertaining to the process see automaticity as the final goal (Fitts & Posner, 1967; Gentile, 1972). Generally, there is a perspective that, at the highest level of competition, levels of

attention toward the movement execution process are low and very global in direction (Toner et al., 2016). Pertinently, these theories share one other major feature in common; namely, progression. All are based on a clear progression of learning (cf. Hristovski et al., 2006), be it referenced to cognition and/or co-ordination, indicating that skills are *developed*, not natural or innate.

To demonstrate this process (although certainly *not* the same as a racing context), a study by Charlton and Starkey (2011) showed that civilian car drivers reported increased ease when learning to drive a set route over 20 sessions. Additional measures showed a reduction in variability for both speed and car position, an increase in specific vehicle detection probability and distance, and increased reliance on environmental perceptual information to regulate speed when entering a tunnel. In short, becoming more autonomous was characterised by reduced effort, increased consistency and greater use of perceptual monitoring processes. Thus, while the process may be accelerated or facilitated by previous experiences (e.g., positive transfer; Clements & Guillo, 1984; Lehrer et al., 1988), it is still a finite progression rather than an instantaneous, gestalt-like leap. Automaticity and performance in driving is gained, not gifted.

Within the grey literature, several authors have looked to the early F1 years of one of the most successful drivers in the sports history, and largely renowned natural drivers Lewis Hamilton. Spackman (cited in Williams, 2007) makes very pertinent and astute observations of the process by which Hamilton achieved such success:

Was he simply born with the ability to go fast? Spackman does not believe so. 'What he has is what Michael Schumacher had. It's a structure and a process for how they learn and how they improve. Schumacher had a filing system in his mind, and every experience was a learning experience. It wasn't like a load of random things happening to him. That enabled him to improve every day. The same is true of Lewis. He obviously has talent, but he's a vastly superior driver now because he's learnt how to

learn, which most drivers don't do. Every experience has a way of being analysed, understood and filed away. He doesn't just pound around a race track, repeating the same old habits.' (Williams, 2007, para. 9).

Spackman, a neuroscientist credited with working with Hamilton on the McLaren race simulator, articulates clearly the learning process and deliberate execution of skill required in this complex task. In short, the natural talent seems to be a consequence of lots of well-structured DP (Ericsson et al., 1993), even *if* Hamilton thinks otherwise!

Regardless of the source, when this final stage of learning is achieved, it has previously been linked to a 'subconscious' state, a quiet mind or comparative non-thinking (e.g., Dreyfus, 2002). Even older concepts such as flow are typified by smooth, effortless performances, akin to out of body experiences (Jackson & Csikszentmihalyi, 1999). However, practical examples indicate that even drivers at the most elite level are limited in their ability to process additional task-relevant information when performing at their peak. This perhaps suggests that consciousness and automaticity are more dynamic concepts which an elite athlete can switch between dependent upon task difficulty (Bortoli et al., 2012; Swann et al., 2016), or perhaps even the consequential nature of the task (i.e., risk level, as explored above with the impact of perceived consequence on gait).

Within the grey literature, most recently for example, during F1 races, two elite level drivers (both previous World Champions) expressed frustration at receiving information during their performances at the point of complex, high attention tasks. For example, Lewis Hamilton at the 2015 Malaysian Grand Prix reporting on the team radio, "Don't try and talk to me through the corners! I nearly went off" (Johnson, 2015a, para. 8). Or Jenson Button at the 2015 Brazil Grand Prix, "Stop talking to me in the breaking zone! If you've got to speak to me you've got the whole straight to do it!" (Johnson, 2015b, para 4). In fact, a third example from Sergio Perez at the 2017 Monaco Grand Prix, though not a world champion,

suggests that to drive the circuit well relies heavily on conscious awareness of the task in a way that is far from feeling natural at all, "Guys, you really want me to crash huh? Stop ******* around, I need 200% focus" (Whisper Films, 2017). Quotes of this nature are a common occurrence throughout the echelons of Motorsport, from newcomers such as Lando Norris in Monza, "Stop f***ing talking to me when I'm trying to race" (Whisper Films, 2019), through to the big names such as Kimi Räikkönen, who has his own Top 10 compilation videos of fuming at the engineers!

To explain this, results from the peer-review search also suggest that there are increases in conscious control during the braking zones and cornering across several different classifications of Motorsport (i.e., Formula 3, Formula 3 Open, Formula 3000, Lamborghini Super Series, Maserati World Series Championship, and Porsche GT3 Cup Challenge; Filho et al., 2015). Notably, foci in this study were idiosyncratic across drivers, stressing the modulation of braking and acceleration dynamics through, for instance, altered seated posture. Indeed, team radio from the 2015 F1 season from Button and Hamilton previously mentioned also seems to suggest the importance of focus during this point. Finally, reflecting the findings by Charlton and Starkey (2011), drivers showed significant regression in automaticity and perceptual measures, demonstrating more implementation control focus (see Figure 2.1), when faced with a novel or challenging situation while driving.

Accordingly, it seems that practitioners may need to consider the idea of automaticity as a temporally dynamic construct, at least within tasks like Motorsport, very open-skilled sports such as team games, or those with varying intensity levels over time. In short, automaticity in elites, or even those with experience, is not as entirely automatic as was once believed.

Progressing from the motoric perspective, successful demonstration of automaticity in Motorsport requires spatiotemporal consideration; knowing what to focus on and when. It has already been established through reviewing the processes of learning, and characteristics of

elite performance, that automaticity is often considered a feature of performance, is related to non-thinking, and therefore could be viewed as natural. However, in every category of Motorsport, from karting to F1, there is variation in the type of technical and mental skill required. This also occurs when comparing the different demands, for instance, of qualifying versus a race. When executing skills in a qualifying session the drivers are attempting to achieve the fastest lap possible, once having found clear air (i.e., an opportunity to drive the track without encountering another car); an environment which could encourage the more naturalistic driving style. In a race, by contrast, drivers are not only attending to the core components of driving, but also tactics, enforced safety procedures, track evolution, tyre conservation, and, in some classifications, fuel consumption.

Consequently, there is a clear indication that drivers *can* and *do* adjust their performances, often to within 10^{ths} of a second per lap (e.g., when attempting to maintain a lead whilst still conserving fuel to make the end of a race) in response to uncertain and/or novel circumstances. This can be seen in pretty much any race; for example, in the epic rivalry between Red Bull Racing teammates Verstappen and Ricciardo in the 2018 F1 season in which both drivers were set the same pace (slower than a qualifying time) at the beginning of each race to avoid driver conflict (Gay-Rees et al., 2020). How can it be then that automatic, natural performance should require no thinking and unconscious control? If a driver was not consciously aware of how intricacies felt, both motorically and in relation to different tactical decisions, the occurrence of this high-level performance would be considerably less reliable (Toner & Moran, 2015). This further supports the contention that it is not 'no thinking' which is preferable, but instead what this thinking is directed towards (Carson & Collins, 2016). Moreover, how effectively this thinking is deployed under pressure. Wegner (1994) states "the intention to concentrate creates conditions under which mental load enhances monitoring of irrelevancies" (p. 7). Should such concentration occur naturally, how can we be sure it is directed toward the relevant information? Consider this in

terms of a wet racetrack which is beginning to dry, and therefore racing conditions are changing resulting in equivocal performance from the car (e.g., tyre grip). If concentration is occurring naturally, much of the important information which is pivotal to driver safety, as well as performance, would likely be missed and not relayed back to the pit-wall.

3.4.2. Post-Track Evaluations

Researchers have recently begun to investigate the physical characteristics that could indicate success in a driver (Backman et al., 2005; Raschner et al., 2013). Notably, however, minimal research has been carried out into the psychological or psychophysiological factors that underpin successful performance. Consequently, through the discourse, I was unable to uncover any peer-reviewed evidence of how drivers might evaluate their performance after the fact. However, anecdotally, many Motorsport athletes and drivers have reported experiences of being 'in the zone' (or perhaps as Lewis Hamilton refers to it 'Hammer time' Saunders, 2014, para 1). Flow is the term which is used in several sports in association with the peak performance characteristics of elite 'naturals'. As stated in Chapter 2, similar to being 'in the zone', flow is an immersive, harmonious, and intrinsically rewarding experience that is often depicted by a high skill, low effort environment whereby one possesses positive evaluations of one's own performance (Kennedy et al., 2014), also referred to as the challenge/skill balance.

Interestingly, the multiple factors required to achieve flow could be derived from a quality learning process, or at the very least through well-structured preparation (Swann et al., 2012), and are addressed by many cognitive skills taught by psychologists, including; imagery, attentional control and goal setting. An example of this can be seen in MotoGP. Valentino Rossi, known as 'The Doctor' for his cold and clinical riding style, completed what was known as the greatest last lap in MotoGP history when he overtook Lorenzo in the final corners as the commentators scream "Rossi's invented something in the final corner, he's overtaken where no one can overtake". When interviewed in the pen after the race Rossi

credits the move to his extensive use of imagery saying "I dreamt that move before the weekend" (Moore, 2009). Achieving a state whereby a performer's perceived skill level outweighs, or at least balances with, the perceived challenge, supports the view that an individual is not born with such skills but rather, must develop them through learning, training and adapting (which includes making errors; cf. Guadagnoli & Lee, 2004).

Interestingly, however, contrasting research has emerged which suggests that positive outcomes are often remembered fondly, with a spurious omission of the actual graft that they required (Hardie-Bick & Bonner, 2016; Hooper & Collins, 1997). Returning to one of the previous quotes about Senna which stated "It was a natural talent visible to all… pouring his soul into a home victory in São Paulo, before a jubilant Brazilian public chanting his name" (Williams-Smith, 2020, para 2). This quote also mentions "born of the ability". This seems curious, as this victory in São Paulo was far from simple, because Senna had to battle to finish the race as his gearbox deteriorated meaning he was stuck in 6th gear for the final 7 laps. Famously, Senna was barely able to lift his trophy afterwards, stating that "I also had muscle spasms and cramps in my shoulders and neck, because the seatbelt was too tight, but also because of all the emotion… It wasn't the greatest win in my life, but it was the hardest-fought one" (Globo, 1991).

Additional examples of battles or gritty races of this nature came in abundance through my searches of the grey literature. For example, Kimi Räikkönen, 'The Ice Man', who delivered an emphatic performance at Suzuka in 2005. This saw him pick off his opponents one-by-one from P17 to 2nd place and overtake Giancarlo Fisichella in the final lap, thus winning the race. In the post-race press conference, he states "I was lucky with that final move" (Duncanson, 2005). Or Michael Schumacher at Spa in 1995 when he qualified 16th and made the decision to go out on slicks in the wet, and managed to secure the win, or at the Spanish GP in 1994 where Schumacher maintained 2nd place despite being stuck in 5th gear for the majority of the race. Similarly Jenson Button took home the victory coming from

dead last to take the lead of the final lap at the 2011 Canadian Grand Prix, which was rife with issues such as safety cars due to the heavy rain, mechanical issues and crashes. Post-race Button stated "The most action I've had in a Grand Prix, probably, and come away with a win… I would say this race is the best one I've had in my career." (Duncanson, 2011). Finally, Hamilton. He scored an emphatic victory in 2008 at his home GP in Silverstone, which also secured the title, but it was by no means an easy feat. Post-race he stated "It is by far the best victory I've ever had. It was one of the toughest races I've ever done and as I was driving I was thinking if I win this, this will definitely go down as the best race I've ever won" (Duncanson, 2008). He goes on to discuss how the race was a real "mental challenge", "extreme out there", and states "I was just praying, praying and praying: keep it on the track, just finish".

Reviewing these findings, it is very difficult to support the natural talent belief, and indeed any suggestion that a non-thinking performance is superior. Instead, this strongly indicates that some of the most well-known and indeed sought-after victories are won by drivers that are giving everything they have!

3.4.3. Training Behaviours

Finally, to better understand whether the belief of natural talent was true, I explored the training behaviours of drivers. Whilst still not overrun with articles, this search did prove somewhat more fruitful. Of course, the physical demands of Motorsport have become quite well documented (Backman et al., 2005; Jacobs & Olvey, 2000; Watkins, 2006), so information pertaining to the physical training aspects of the discipline are starting to emerge (Potkanowicz & Mendel, 2013). Although, a deeper dive has indicated that current work in the field might not match the true requirements of the sport (cf. Hoyes & Collins, 2018). However, the natural talent belief has always surrounded cognitive or psychological factors. Interestingly, one very specific article emerged from this source.

Lappi (2018) completed a qualitative document analysis to understand both the skills required within Motorsport, and how they were being developed with an expert group. Analysing 27 training manuals, assessing these against four criteria of DP (Structured, Goal, Feedback and Repetition), this study identified several training methods that are utilised to develop driver expertise. A number of these would counter conventional wisdom held within coaching generally, and Motorsport specifically. For example, within structured DP, Lappi (2018) discusses the process of practising difficult corners, in which drivers are suggested to slow right down before a corner in order to clip the apex correctly. Over-slowing is known as "a major error in technique" (p. 7) and is anecdotally linked with novices ("he's driving like an absolute novice out there" said of Perez by Brundle, 2018) but is presented within Lappi's research as a DP drill to practice a component part of a skill.

Another example sits with the structured and feedback elements of DP, performance cues. Cues are often used by drivers to both remember circuits and promote the style of driving they wish to execute. However, several internal cues were discovered as part of Lappi's (2018) explorations, such as 'squeeze' referring to the braking action, 'widescreen' referring to the drivers' peripheral vision, and finally 'smooth' and 'gentle' in relation to how they managed the car. Research has suggested external focus is preferred and that an internal focus is almost certain to lead to performance decrement (Wulf, 2013), but this is clearly not apparent in Motorsport. Instead, drivers are making effortful considerations to direct their attention internally. Once again, not promoting the concept of a naturally gifted automatic driver.

Finally, we have the concept of repetition, the importance of doing something "over and over again" (p. 11). In this instance Lappi (2018) is referring to dedicating significant seat time (the precious time in the car) to work on something that does not aim to realise maximal performance, but instead focuses improvement on a specific skill or knowledge.

Exploring the grey literature, I identified a great number of training behaviours that fit within the DP categories outlined by Lappi (2018), indeed several more. Brolin (2020) wrote a review of some of the top drivers' mental strategies for success, titled 'All in the Mind' for F1's website. Visualisation and imagery was a hot contender, as Brolin says of Vettel "Sebastian Vettel can be found sitting in his stationary car with his eyes shut most Saturday lunchtimes" (para 40). Leclerc, Vettel's teammate at the time of writing, also discusses how he has benefitted from mental skills training following problems with his temperament in his early racing career, "When I'm not in the car this imagery helps me hugely to be fully concentrated and readapt to the car quicker" (Leclerc in Brolin, 2020, para 52). Similarly, Klarica (2001) also reports on their work within F1, exploring the use of track maps to further embed this knowledge.

Several drivers also speak of their adoption of meditation or mindfulness techniques. World champion Nico Rosberg states "I really ramped it up in 2016 and found a way of working intensely with a mental trainer. My focus was on meditation. The word is often misinterpreted but in my case it was about concentration practice and learning to control your mind." (Rosberg, in Brolin, 2020, para 35).

Of course, alongside the mental skills, drivers are trying to recreate performance conditions through the use of simulators. Whilst all F1 teams are reported to have their own simulators which are utilised for driver development as well as testing aspects such as car set up, there are many companies across the globe that look to support drivers from Karters upwards through this technology (my own journey in Motorsport started with iZone Driver Performance - https://www.izoneperformance.com/). Research conducted into aviation simulators has identified that they can be great for novice learners and have quasi-transference for intermediate and expert pilots (de Winter et al., 2012). However, we are still in the dark about the effectiveness of simulator training in Motorsport.

As the last element in this section, we have the training habits that drivers carry out during a race weekend. A key event for nearly every driver is the track walk. The aim of the track walk is to support the driver in learning the circuit (track conditions, camber, complex turns), which of course in and of itself would suggest that there is a clear learning component to the skill, with a particular focus on explicit knowledge. Interestingly, Hamilton states that he completed track walks for the vast majority of his career, "all the way through Formula Three, GP2 and my first four years in F1. Then it got to a point when I wasn't gaining anything from it" (BBC Sport, 2013, para 17). Of course, the seven-time world champion has a wealth of experience at every event. However, he does cite them as a great opportunity to discuss the strategy and setup for the race with the engineer, which he now just prefers to do in an air conditioned office. Indeed these conversations alone also suggest a need for clarity and explicit knowledge for performance. What is particularly interesting is that, whilst Hamilton no longer sees value in track walks, he does indeed still need a process for learning the circuit and embedding this information. When discussing Baku, the newest circuit on the F1 timetable with the addition of the Azerbaijan Grand Prix, which of course he had not yet driven, Hamilton stated "I will go around tomorrow, and that first lap is like you're taking pictures with your mind, and you're learning as you go around" (Hamilton, cited in Cooper, 2016, para 10).

3.5. Discussion

3.5.1. Contextual Discussion

Natural talent… To be frank, I think the evidence is overwhelming against its existence. This chapter had three clear aims relating to the concept of natural talent. First of all, establishing if the belief exists. Through the peer-reviewed literature there was minimal support for this statement, as Motorsport is already an under-researched discipline. However, quotes from the grey literature and expert statements strongly evidenced that this is a belief with which practitioners are currently confronted. Next, considering the evident existence of

this belief, the chapter aimed to explore what performance would look like if the belief was true. Finally, the chapter aimed to examine those contentions. Throughout this review, a multitude of different sources indicated that drivers are far from born with, or gifted, their ability to be successful. Instead, there are a number of skills and behaviours which appear to be developed over time and through a significant amount of effort.

Of course, what remains unclear is the origin of this contentious and even potentially dangerous belief, or perhaps now we could refer to it as a myth. If practitioners are going to counter this claim then an understanding of where the myth stems from, and indeed why, is crucial. Of course, this could be because the sport appears independent in nature to other sports that practitioners and the public alike might see as more traditional, mainstream, or 'sporty' if you will. This is, however, quite curious as one of the performers featured heavily here, Lewis Hamilton, was awarded Sports Personality of the Year in the year prior to thesis' completion. Regardless of the underpinning reason, as explored in this chapter, drivers at the highest echelons of the sport are carefully deploying the time and effort required to be successful, whilst in the same breath attributing success to external or unstable factors.

3.5.1. Dichotomous Discussion

Drivers are clearly committing time, effort and resource to achieve the level of skill required to be successful. This effort appears to manifest both on track and away from a race weekend. Away from the competitive environment, drivers appear to be exhibiting effortful learning behaviours (such as the Psychological Characteristics of Developing Excellence; PCDEs), which are often developed as a result of the highs and lows that high performers experience (MacNamara et al., 2010a; 2010b). Many features of the tools and techniques used align closely with the characteristics of DP, as outlined by Ericsson et al. (1993).

On track, whilst drivers do anecdotally consider their drives to be performed in a flow-like state, this review suggests that many of the performances, indeed the ones drivers classify as career bests, are actually much more akin to the 'making it happen' classification

(Swann et al., 2016). A key feature of this also lies within the driver's ability to utilise both an internal and external focus. Of note are the use of cues, plotted with track maps, some of which are aimed at technical execution, and some of which support self-awareness and regulation for the driver (Winkelman et al., 2017). This is in direct contrast to some recommendations which suggest that any internal focus is detrimental to performance (Wulf, 2013).

Finally, throughout this review there has been a significant debate surrounding the role of automaticity. Interestingly, key elements of being successful in Motorsport, such as managing lap times, suggest that skill execution is far from automatic, and instead take a significant amount of conscious control (Toner & Moran, 2015). Reflecting these considerations, it appears that the clarity of the findings would align with the nuanced approach expectations. Accordingly, Table 3.2 suggests the strength of these findings using a green line to act as a guiding visual representation.

Table 3.2

Dichotomy Predictions for Chapter 3 and Visual Representation of Strengths of Findings

Dichotomy	Absolutist Predictions	Nuanced Predictions
Maybe she's born with it	Those successful in Motorsport will not display evidence of effort and deliberate practice to achieve their top performances.	Across the disciplines, we will see a clear and concerted effort at practice, rehearsal and characteristics of long-term learning.
Where's your head at?	Drivers will maintain a focus on external factors throughout their performance, and a switch internally will produce a bad outcome.	A mix of internal and external focus will produce the optimum performance.
To think or not to think	Successful performances will be characterised by a flow-like experiences with minimal effort.	Successful performances will sometimes manifest in more 'out of body' experiences, but will also show signs of serious effort and concentration.
Just do it	Expert performers will produce consistent, non-variable performances.	Different elements of performance will be automatised to different levels.

3.6. Summary and Implications

Indubitably, there are some things that help people be successful in Motorsport. Some of these are psychomotor, for example they have got good coordination. Some are psychosocial, for example having the contacts or the funds to be in a position to be competitive. Some are the psychobehavioural concepts, some of which interestingly *could* be natural but support the driver's ability to engage in DP effectively. As such, it is imperative for practitioners to continue to dispel the myth of natural talent in order to appropriately support drivers in their strive for success. Practitioners working with drivers in this way must also consider the key, or more common, characteristics and concomitants of high-level performance. Often athletes and their support networks are misinformed in regards to the nature of the performance for which they are striving. These data suggest that more often

drivers require a degree of cognition in their performances, adapting their focus as required on the track.

Moving forward, the next chapter, Chapter 4, empirically explores the execution of skills, in this case in the context of golf putting. Reflecting the pragmatic approach adopted within this thesis, the chapter investigates a strategy to the task that is currently underexplored by research and occasionally employed by players. As such, there is a need to understand in further detail in order to inform coaches' future decision making on its use. Specifically, using this relatively closed skill, data were collected on two different putting aiming styles to identify which produced superior performance, and of course, why; namely, ball and target focused aiming. This chapter explores the following dichotomies: 'where's your head at?' and 'to think or not to think?'.

Chapter 4. Promoting Performance in Golf: EEG Concomitants of Differing Putting Styles

4.1. Introduction

It could be argued that understanding the world of Motorsport is realistically challenging to research, given its unpredictability, and social and political exclusiveness. However, you would be mistaken if you believed that the simpler, more accessible and hugely researched domain of golf putting could conjure up any consistency. In fact, despite the common utility of this task (putting) within research, it is surprising that something as seemingly simple as where to look, for instance, still presents a conundrum to researchers (see Wilson et al., 2016). In this chapter, I examine a relatively new visual strategy being employed by some top level Tour players. Importantly, however, rather than monitoring eye movements as has been done previously, I wanted to look deeper along the visual pathway into the occipital cortex to further and more objectively probe the role of visual attention. To optimally inform coaching practice, I also took a more detailed approach to the results, looking at what can be learnt from when executions do not work as well as between conditions of normal and modified putting styles. As with the previous chapter, I now provide some context to the skill and the problem faced.

4.1.1. The Context

Undoubtedly, golf is considered a cerebral game. Many researchers have investigated golf and the psychological impact on performance, including mental skills (Finn, 2009) and motor control processes (Evans & Tuttle, 2015). One aspect of golf that could be argued to be the most cerebral is putting. Not only is this due to the fine executional control required and additional extraneous variables such as green reading, but it is often thought of as the most important moment within the sport. As such, these conditions can easily induce symptoms of pressure (e.g., Baumeister, 1984). Indeed, Bobby Locke, a renowned golfer with 73

professional wins, is thought to have coined the phrase "you drive for show, but you putt for dough" (Ajlouny, 2016, p. 24). Moreover, putting makes up a significant proportion of a round of golf. Indeed, the top 10 players on the PGA Tour are currently taking an average of 22.9 putts per round, which would be nearly a third of the shots on a par 72 course (PGA Tour, 2020).

Reflecting this backdrop, significant investment is made to improve putting performance through technique. One such approach, outlined by Moffat et al. (2017) is the use of Target Focused Aiming (TFA; "golfers putt while orienting their head, neck, and visual field toward the target location during execution", p. 36) instead of the more common and traditional Ball Focused Aiming (BFA; "keep your eyes over the ball during execution" p. 36) technique. Historically TFA was associated with finding a cure for the dreaded yips, a motor phenomenon which results in involuntary moments, Smith et al. (2003) have stated that the causes lie somewhere on a spectrum of a neurological disorder such as dystonia to a psychological disorder such as choking. Nowadays household name professionals such as Jordan Spieth and Louis Oosthuizen have used TFA as a real tool for performance, even during Major championship performances which they have subsequently won. However, an understanding of the mechanism behind this technique is still lacking, which is surely essential if it is to be used most effectively.

4.1.2. The Problem

Once again, reflecting my pragmatic approach outlined in Chapter 2, this study addressed another practical problem which practitioners and performers often face in real world contexts. The phrase 'because we've always done it that way' is the red tape response anyone aiming for behaviour change dreads to hear. Until recently, however, BFA was essentially the only method taught by coaches. Given the rise in awareness of TFA, it seemed important for me to explore the effectiveness and operation of TFA versus BFA in order to inform its best use. At first sight, the concept of TFA intuitively suggests that by focussing on

your target (i.e., the hole), attention is diverted away from thoughts regarding a negative outcome of the shot, or overly technical attentive foci (cf. Wulf, 2013). Anecdotally however, performers report BFA to *support* important skill judgements such as timing of the swing phases. This would, therefore, contradict the aim to remove or limit processes by employing TFA. As such, there is a clear cognitive component underpinning both techniques that needs exploring. At present, there are very few studies exploring TFA and none of these have probed the cognitive or visual mechanisms underpinning the technique (Moffat et al., 2017). Interestingly, a recent study by Moffat et al. (2018) found no performance difference between the two techniques but did not probe the mechanisms for why this was so. To achieve this more detailed understanding and advance practitioner knowledge for *when*, *how* and *why* to use TFA instead of BFA, I needed to find a relatively non-intrusive measure for the nature of cognitive activity. Based on my investigative reading, I decided on the use of electroencephalography (EEG).

EEG has been widely used in much similar research (e.g., Collins et al., 1990, 1991; Cremades, 2014; Ji et al., 2019). More specifically, occipital EEG alpha power (8–12 Hz) can be used to reflect the degree and timing of visual attention toward external stimuli. Whilst insights to spatial specialisation are comparatively poor, EEG is noted for its ability to inform the temporal patterning of activity; in this case, the allocation of visual attention to external stimuli or a lack of/switching from this modality. Research shows that an increase in occipital EEG alpha power reflects a reduction in visual attention use (i.e., an inverse relationship; Kononen & Partanen, 1993). Therefore, higher occipital EEG alpha power would suggest that visual information processing has reduced. Notably, several occipital EEG investigations have used closed and self-paced skills similar to golf putting, notably during the pre-shot process of archery, rifle and pistol shooting. These show an increase in EEG alpha power in the epochs prior to shot execution (trigger release; Hatfield et al., 1984; Loze et al*.,* 2001) which is particularly apparent when comparing experts to novices (Haufler et al., 2000;

Janelle et al., 2000), for best versus worst shots (Loze et al., 2001) and for more, as compared to less, difficult tasks (Crews & Landers, 1993). In other words, data suggest that visual attention is most necessary and engaged early on in the preparation of the task, when the performer establishes their aim, but is then required to a much lesser degree when it comes to the final moments of shot execution. On the basis of these data, it seems that performance in target focused sports may be enhanced by a switch in focus from *attention* to external factors to a state of *intention* (i.e., an internal focus) on task movement execution (cf. Loze et al., 2001). Such data do, at least, provide a sound and methodologically accepted basis on which to explore the novel use of TFA in golf putting.

4.1.3. The Dichotomies

This chapter explores two of the dichotomies identified in Chapter 2; 'where's your head at?' and 'to think or not think'. Table 4.1 details the predictions of this study from each dichotomy perspective, both the absolutist and nuanced view.

4.1.4. The Objectives

Reflecting the dichotomous positions in Table 4.1, I was interested in the focus and timing of visual processing as indicated by the levels of occipital alpha power associated with both putting techniques. Answering this question would, in turn, provide insight into the engagement with environmental information by highly skilled performers *and* the nature/degree of cognitive activity during a representative task.

Therefore, the objectives of this study were as follows:

1. To explore visual engagement under both TFA and BFA to better understand the dichotomies outlined, in striving for peak performance.

2. To compare visual engagement during effective and suboptimal performance (i.e., missed putts).

Table 4.1

Dichotomy Explanations and Predictions for Chapter 4.

Dichotomy	Explanations		Predictions	
	Absolutist	**Nuanced**	**Absolutist**	**Nuanced**
Where's your head at?	Performance attention should *always* be directed externally and away from bodily mechanics.	Performance may not be *always* be hindered by using a combination of internal and external focus.	Uniformly low levels of occipital alpha throughout the trials and for both techniques. The visual cortex should always be active because the visual focus will always be external.	Occipital alpha power may change according to the task requirements and/or phase of execution.
To think or not to think	Peak performance can only occur subconsciously.	Peak performance can occur under a number of conditions.	Little evidence of active processing involvement leading to high alpha power. A loss of active processing would be solely associated with superior performance.	Task-specific conscious and unconscious states both associated with good performance.

4.2. Method

4.2.1. Participants

Twelve high-level male amateur golfers, all right-handed ($M_{age} = 36.09$ years, $SD = 18.56$, $M_{handicap} = 3.72$, $SD = 1.60$, $M_{experience} = 22.00$ years, $SD = 13.45$) were recruited for this study via purposive sampling. One participant was removed (adjusted $N = 11$) due to poor EEG data as a result of the equipment being inappropriate for the participants head size. Inclusion criteria required participants to be (a) an amateur golfer with a current single figure

handicap of 5 or better, (b) have normal or effectively corrected vision and (c) have no

previous experience using TFA as determined by self-report. Ethical approval was obtained

from the University Ethics Committee prior to conducting the study; all participants provided

written informed consent prior to their participation.

4.2.2. Methodological Considerations

EEG was selected as the preferred tool for this research. As stated, occipital alpha

power reflects the engagement, or lack thereof, of visual attention and has been used in a

number of relevant research studies previously. Of note, a key finding of EEG research with

self-paced skill has found that an increase in alpha activity is indicative of neural

reorganisation associated with efficient motor processes (Nunez & Srinivasan, 2006). In

essence, EEG offers insight into a performer's mental focus. However, there are a number of

methodological considerations required when utilising EEG in this scenario.

One consideration is the appropriate electrode montage for measurement. Existing

research into the sport of golf identified that alpha power is higher in occipital regions than

frontal and temporal regions for expert golfers during movement preparation (Gallicchio et

al., 2017), therefore this region is already identified as important within execution of this

skill. This, coupled with the specific focus on visual attention during putting (similar to Loze

et al.'s aims for shooting; 2001) makes the occipital regions of greatest interest for this

research, therefore sites O1 and O2 were selected to understand alpha levels at these specific

visual sites. Additionally, the settings of the EEG recordings are of equal importance. An

electrical reference is required, which in this study was located between AFz and Fz

electrodes, with a ground placed between the Pz and Oz electrodes (Del Percio et al., 2019).

Finally, psychophysiology research of this nature must be aware of the small signals

they aim to collect, and the sensitivity of these signals. Therefore, the use of EEG must

consider the impact of eye movement and blinks, known as artifact (Croft & Barry, 2002),

and what the presence or absence of this might mean. Of course, deliberately trying to inhibit

eye movement and blinks can distort brain activity (Verleger, 1991) and the normal pattern of skill execution, so it was important participants were able to go about their routine freely. Instead, to account for artifact, researchers are encouraged to engage in a correction procedure. A regression analysis has been favoured as the main tool for correction of ocular artifact, by which propagation factors are calculated, which estimate the relation between Electroculography (EOG; the corneo-retinal standing between the front and the back of the eye) channels and the selected EEG channels. This allows correction of the raw EEG data based on the subtraction of the EOG factors. However, recent research suggests this is vulnerable to error and assumptions. Instead the more time and resource heavy process of Independent Component Analysis (ICA) will produce more 'perfect' corrections (Hoffmann & Falkenstein, 2008). Through ICA the researcher identifies and removes blink-like components and, depending on the purpose of the research, engages in a back-projection of the remaining EEG channel (Akhtar et al., 2012). Fortunately, for this study only specific incidents were of relevance and therefore ICA could be utilised for the relevant time period (Comon, 1994).

Moreover, a lack of eye movement has historically been attributed to an intense focus (see Quiet Eye literature; Lebeau et al., 2016). However, a fixation of gaze could also indicate daydreaming (Antrobus et al., 1964) or disengagement which is a cognitive recall tool (Doherty-Sneddon et al., 2002). For example, the latter is exemplified by a shift of gaze when someone is asked for directions. The direction of gaze and lack of eye movement is suggested to reflect the consideration of an internal map. As such, a clear duration of analysis prior to motor skill execution can allow for this to be monitored. In this instance, up to 6 seconds prior to executing the putt, broken down into 2 second epochs as per the norm in sport-related studies (Wang et al., 2020).

4.2.3. Procedure

In order to maintain ecological validity, this study took place in real world conditions. Two holes on the practice green were selected at a Cheshire golf club, based on the breaks and slopes which reflected similar on-course conditions. Data collection took place over 2 days. On both days, green speed was typical of championship conditions, registering 9.5 on the Stimpmeter (Stimp is the measure of green speed and is determined by rolling a ball with an initial speed of 6 ft. s−1 from an elevated grooved track and measuring how far it rolls on a flat portion of the putting surface). On these two holes, eight shots were set up, one at 8ft. and the other at 15ft. distance from the hole (see Figure 4.1), identified by a tee sitting just above the grass surface. The eight shots on each hole were spaced equidistantly apart, providing a variety of challenging putts (including breaking right-to-left and left-to-right, uphill and downhill). These determined the points from which participants should place their ball in order to complete a pre-putt routine and complete the shot.
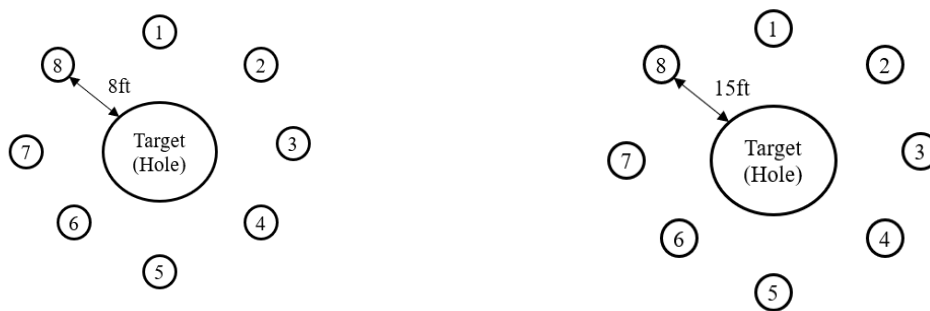
Figure 4.1. A schematic representation of the putting layout for 8ft. and 15ft. trials.

The putting distances of 8ft. and 15ft. and location of each putt (eight different locations for each test hole) were carefully selected (Karlsen et al., 2008). According to Pelz (1999), during competitive play both represent meaningful distances for a 1-putt, converted approximately 44% of the time at 8ft. and 23% of the time for 15ft. by leading US tour

professional golfers (PGATour, 2019). Participants used their own putters and all putts were performed with new unmarked and legally conforming golf balls provided (Titleist Pro V1).

This self-paced putting task was designed to recreate pressured conditions experienced during competition, furthered through the use of financial incentives (Baumeister & Showers, 1986). Participants were told they would be individually evaluated based on the number of successful putts holed and a cash prize of £50 would be awarded to the highest scoring participant. A competitive ranking structure was promulgated to all participants over the 2 days of trials (c.f. Baumeister, 1984; Beilock & Carr, 2001). All participants expressed that they were highly motivated to perform at their best, primarily because of their competitive nature but also because they wanted to top the leader board which just so happened to be stationed next to the club house.

Following the fitting of the EEG cap (see equipment details below), participants were allowed time to familiarise themselves with the equipment and pace of the greens, using non-trial holes on the same putting surface. Participants were then briefed on the process and asked to complete their normal pre-putt routine for all putts, but to utilise TFA for the specified trials. The TFA condition required them to fix their gaze on the target (either entry point of the hole for straight putts or the breaking point for sloped putts) for a minimum period of 2 s prior to stroke initiation and to leave the eyes fixed on this position throughout the putting stroke (c.f. Binsch et al., 2009). Once the trials had begun, the participant was not disturbed by the research team and was therefore allowed to putt as they would in a real competition. Inclusive of all setup, familiarisation and testing procedures, the time taken for 32 putts ranged from 55–60 minutes per participant.

4.2.4. Performance Measures

The number of holed putts out of 32 was recorded in the trials. All putts were scored as holed or missed. For the missed putts, two-performance error measures were taken; radial (cm) and length (cm), measured using a purpose-built grid system (2m × 2m divided into 10

cm^2 sections). Missed putts were marked on the green and, following each block, were allocated to the nearest grid section with the grid positioned on the green with the centre originating at the centre of the hole. In this way, we were able to determine the extent of errors. Putts finishing outside of the grid were marked as so.

4.2.5. EEG Measures

EEG data were collected using electrodes housed within a stretchable lycra cap (waveguard) and ultra-mobile EEG unit (Ant Neuro B. V., The Netherlands). EEG data were recorded across two regions of interest (ROIs), the left and right occipital (O1 and O2), referenced to a ground placed between the Pz and Oz electrodes in accordance with standards of the international 10:20 System (Jasper, 1958). Analog EEG data were subjected to a 0.5 Hz high-pass and 70 Hz low-pass filter, together with a notch filter at 50 Hz. EEG activity was sampled at 140 Hz, with a gain of 30,000 applied to the signal. Electrode impedance was ensured as below 5KΩ before the start of each putting trial and EEG data were captured throughout the putting trial. A priori impedance testing ensured a sufficient signal to noise ratio.

To time-lock EEG data capture with initiation of the putting stroke, a laptop computer keyboard was used to manually code the number of each putt onto the EEG data file. This enabled cross-referencing of EEG data with the sequence of putts and subsequent results of putts holed or missed.

At the end of the trials, selected data were subsequently reduced to a 6 s pre-putt period and divided into three 2 s epochs. Epochs were extracted from −6, −4, and −2 s relative to the moment of putt initiation. Displays of digitally converted EEG data were then inspected visually by a qualified EEG technician to identify and remove from further analysis any pre-putt epochs with artifact, such as eye blinks and/or visible muscle activity, although this artifact was noted against the performance measures. For each participant, the EEG technician examined 32×6 s epochs from when the participant addressed the putt and set up

his putting stance in position to putt. These data and rejections were subsequently checked and confirmed through off-line application of ICA-based algorithms to the same inspected epochs (Akhtaer et al., 2012). This showed a rejection/retention accuracy of over 95% so the original decisions were accepted.

Finally, data were analysed using spectral analysis incorporating a Fast Fourier Transform (FFT) with a raised cosine window, yielding absolute power values for the EEG data alpha frequency range (8−13 Hz) for each of the three pre-putt epochs for the 32 putts. All procedures and processes followed previously published EEG studies, such as Loze et al. (2001).

4.2.6. Data Analysis

Differences in EEG alpha power were examined using a $2 \times 2 \times 2 \times 3$ (Distance $\times$ Mode $\times$ Site $\times$ Time) ANOVA with repeated measures on all factors. This provided an 'omnibus test' controlling Type 1 error rates across the study. Subsequently, and if significant findings were apparent, a further two $2 \times 2 \times 3$ (Mode $\times$ Site $\times$ Time) ANOVAs were conducted, one for the 8ft. putts and one for the 15ft. putts. As detailed below, a separate set of analyses were completed on missed putt data. Effect sizes are reported as η_p^2 and interpreted as per Cohen's *d* (Cohen, 1992).

4.3. Results

4.3.1. Putt Outcome

There was no significant difference in outcome for putts made between TFA and BFA. Analysis by Friedman's two-way analysis by ranks yielded a *p*-value of 0.731.

4.3.2. EEG Putts Made

EEG data were analysed separately based on outcome, initially looking at putts made. To control the experiment-wise chance of a Type 1 error at 5%, initially all permutations of the data were tested using a $2 \times 2 \times 2 \times 3$ (*Distance $\times$ Mode $\times$ Site $\times$ Time*) ANOVA with repeated measures on all factors. This 'omnibus Test' revealed a number of significant

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effects, including some associated with *Mode*, due to higher values of alpha power for the 15ft. putts.

As the next 'follow up' stage, two $2 \times 2 \times 3$ (*Mode* $\times$ *Site* $\times$ *Time*) ANOVAs were completed, one for the 8ft. putts and one for the 15ft. putts, the outputs of which formed the basis for discussion. These outcomes are shown in Tables 4.2 and 4.3, with the data presented pictorially in Figure 4.2. As shown, the clearest effect was the significant *Time* effect, with alpha power increasing towards the moment of ball contact.

As shown, there was a consistent increase in alpha power approaching the moment of the putt, which was universal across sites O1 and O2. Furthermore, that increase seems to be greater with TFA than BFA across both distances of 8ft. and 15ft. respectively as shown by the significant main effects of Mode. In summary, there is this tendency for higher alpha power changes eventuating in the final epoch in TFA compared to BFA.

Table 4.2

ANOVA Outcomes for 8ft. Putts Made

Measure	F (1, 10)	η_P^2 (Size as per Cohen's d)
Mode	8.80*	.46 (M)
Site	0.04	.004
Time	5742.16***	.99 (L)
Mode $\times$ Site	0.29*	.43 (M)
Mode $\times$ Time	4.77 AS	.32 (S)
Site $\times$ Time	0.35	.03 (S)
Mode $\times$ Site $\times$ Time	0.17	.01

*Note: * = p< .05, ** = p< .01, *** = p< .001, AS = Approaching significance*

Table 4.3

ANOVA Outcomes for 15ft. Putts Made

Measure	F (1, 10)	η_p^2 (Size as per Cohen's d)
Mode	2.98	.23 (S)
Site	10.85**	.52 (M)
Time	1653.57***	.99 (L)
Mode × Site	13.95**	.58 (M)
Mode × Time	4.85*	.32 (S)
Site × Time	4.70*	.32 (S)
Mode × Site × Time	6.61*	.39 (S)

*Note: * = p< .05, ** = p< .01, *** = p< .001*
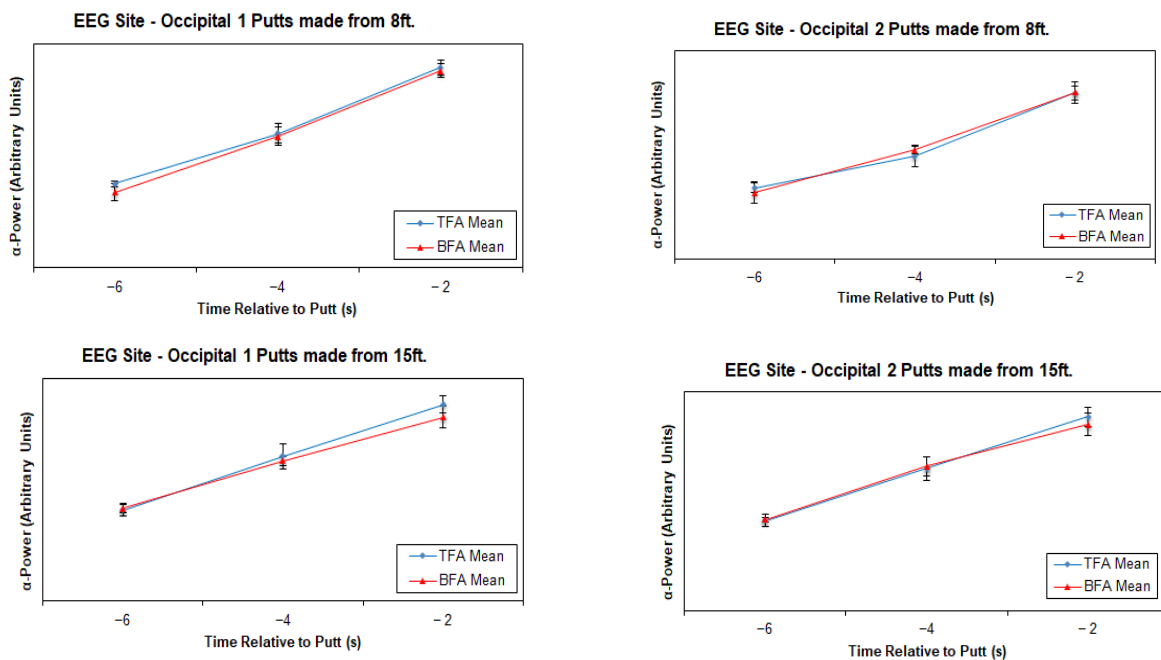
Figure 4.2. EEG data for occipital sites at O1, O2 for 8ft. and 15ft. in putts made

4.3.3. EEG Putts Missed

For a variety of reasons, not least the large differences in number of data values returned for individual participants for putts missed, these putts were treated as a separate analysis. A similar sequential process was applied, starting with a $2 \times 2 \times 2 \times 3$ (*Distance $\times$ Mode $\times$ Site $\times$ Time*) ANOVA with repeated measures on all factors. These findings are presented pictorially in Figure 4.3.

It is also worth noting the number of data points rejected for each putting mode due to eye blink and movement artifact. These categorical data were again examined by use of Friedman's two-way analysis by ranks, demonstrating a significant difference across the variables. Inspection shows this was due to higher rejection of BFA (means of 3.3 and 4 for each distance) as opposed to TFA (means of 1.6 and 1.3 for 8ft. and 15ft. respectively) trials. In short, participants tended to have more eye movement in BFA than TFA trials which resulted in missed putts.

Whilst putts missed show lower levels of significance and effect than putts made, the *Time* effect is still apparent. The magnitude of that difference (although significant in most cases) in alpha power is smaller in putts missed than in putts made, the closer to the moment of the putt. Also, there is a tendency for alpha power to be greater in longer distances.

With putts missed, however, the findings from the FFT analysis are actually supplemented by the amount of muscle and eye movement artifact in the two modes. In other words whatever the distance, it seems that when putts are missed they are often missed because of visual activity – externally the eyes are moving or blinking, or internally, the EEG increase (alpha power) associated with success is not occurring. Furthermore, the results demonstrate that, with putts missed, there is twice as much artifact and eye blink with the BFA Mode than the TFA Mode. Finally, post hoc analysis revealed that, for each site, both Modes exhibited significantly greater FFT levels at 15ft. than at 8ft. The magnitude of difference between the Modes was greater with putts made than with putts missed.
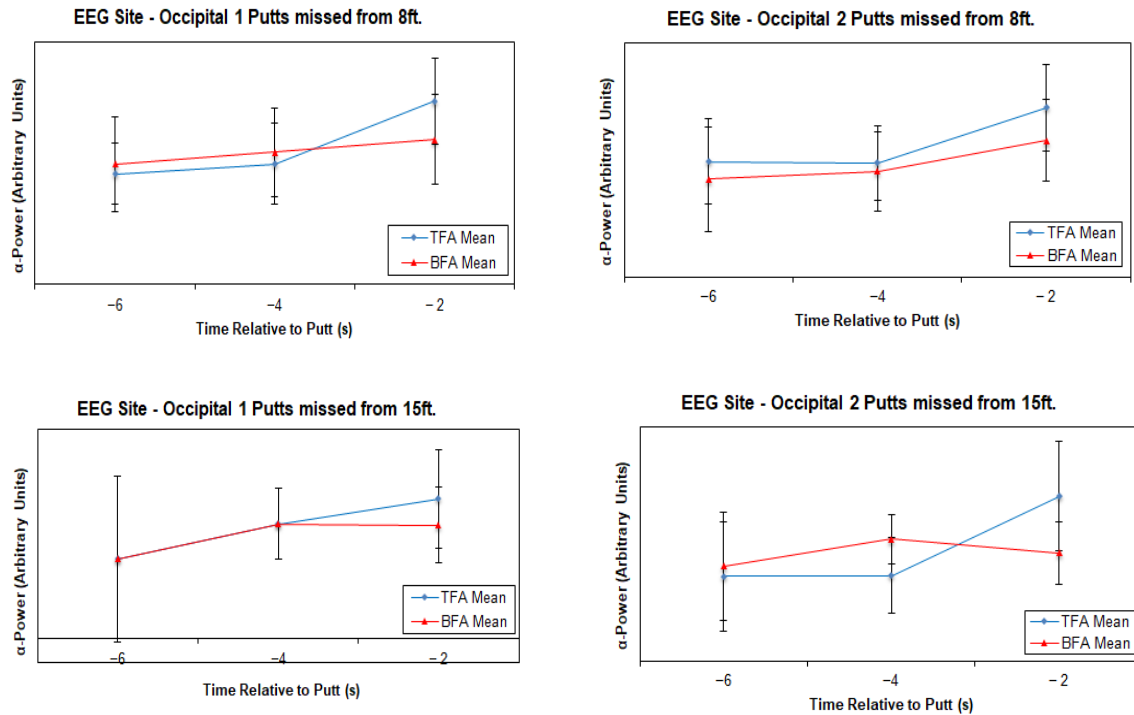
Figure 4.3. EEG data for occipital sites at O1, O2 for 8ft. and 15ft. in putts missed

4.4. Discussion

4.4.1. Contextual Discussion

This chapter aimed to explore two key objectives. Firstly, to understand the visual engagement and mental activity under both the TFA and BFA putting techniques. Specifically, I was interested to look for changes in alpha power in the build up to putt execution. Secondly, I aimed to explore what happened when the participants failed to perform.

Exploring both aims concurrently, the EEG differences for the putts made in comparison to the putts missed demonstrates the positive association between high level alpha power (i.e., low levels of visual processing) and performance. Whilst both putts missed and putts made showed an increase in alpha power levels at both sites closer to the moment of execution, the magnitude was far greater for successful putts. This supports a wealth of literature, both within golf (Campbell et al., 2019) and within other sports (Hatfield et al., 1984; Haufler et al., 2000; Loze et al., 2001) that increased alpha power levels are associated with successful performances. Reflecting earlier contentions, I see this pattern as indicative of

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greater performance by switching to an 'intention' (internal) focus, as the participants

appeared to reduce attention to external stimuli and instead directing this internally prior to

performance. In essence, mechanistically, without external visual information to attend to

(such as back swing to adjust the pace of a putt, or commitment to the line of a putt)

participants were able to focus on other aspects of their performance. It certainly appears that

these would much more likely be internal elements, such as the temporally mediated rhythm

of putt execution (MacPherson et al., 2009; Richardson et al., 2018). Moreover, supporting

this, putts missed were typically associated with higher levels of eye movements, under both

conditions.

Interestingly, these alpha levels were also subject to other variables, for example the

technique, and the distance. The latter variable showed that alpha levels were generally

higher for the 15ft putts. As stated, 8ft. and 15ft. were selected as the distances based on Golf

Data Lab (PGATour, 2019) information from professional players currently playing at Tour

standard. 15ft putts are more difficult and, therefore, this high alpha power could be

accounted for due to the intensity of focus the participants gave to this more difficult task

(i.e., the movement is less automatic). The larger effects observed for the 15ft. putts are

worthy of note, with these findings related to *Distance* and *Time* matching other studies

completed on EEG in golf putting (e.g., Crews & Landers, 1993). This is noteworthy as

players and coaches should consider this need for higher alpha levels in more complex tasks,

and therefore aim to implement tools to support this. A clear explanation for this lies with

Meshed Control Theory (Christensen et al., 2019) which stipulates the different styles of

control which are necessary to be successful. Whilst smooth control skills, such as putting,

can often be produced without the need for cognitive control, as the task demands change

(such as a more complex longer distance putt), a different style of control, such as effortful, is

required.

However, returning to the main focus, the putting technique (TFA/BFA) also made a notable difference with alpha power levels; TFA generating higher alpha levels than BFA. These effects match what has been shown in previous studies of aiming tasks (Hatfield et al., 1984; Loze et al., 2001). The similarity of change associated with the putting tasks in this study lend validity to these findings. Indeed, if coaches and psychologists are trying to encourage higher alpha levels, in essence creating, or heightening, concentration in their performers, this would be a possible intervention/change to consider. Of course, the findings also showed that TFA produced less visual processing than BFA, perhaps as a result of lowered distraction. This would indicate that TFA may actually function primarily by removing a performance *inhibitor*, as opposed to promoting performance *success*. In order to truly support this contention, it is of paramount importance to understand the underpinning mechanisms of TFA.

When exploring the secondary objective of this chapter, one of the most interesting findings of this study was actually something that to many other researchers would have been a disappointment – artifact! Of more relevance here, is the condition under which the majority of data were lost, as significantly more data were lost under BFA in comparison to TFA (twice as many). Artifact arises from too much movement, in the present case blinking or eye movement, indicating that within BFA, participants were much more likely to continue to engage with an external visual focus. Alternatively, the missed putts could be further explained by the absence of the increase in alpha power at the occipital sites which was associated with the success of the putts made.

Essentially, when the participants did not successfully complete the putts it appeared as though they were still attending to an external visual stimulus, paying *attention* as opposed to focusing on the smooth control required to execute the motor skill, *intention.* Indeed, even microsaccades of the eyes have been shown to discern when someone is merely 'looking' versus 'seeing' (Krueger et al., 2019). Specifically, microsaccade rates are shown to decrease

with increased mental task demand and increase with growing visual task difficulty. Such findings imply that there are fundamental differences in microsaccadic activity between visual and nonvisual tasks. This supports findings of previous studies, such as Loze et al. (2001), and suggests that when striving for peak performance, TFA, and similar strategies, are effective at avoiding these visual distractions in the moments before execution. In essence, TFA may not help create optimal performances, but it can stop hindrances of it.

4.4.2. Dichotomous Discussion

Two dichotomies where explored in this chapter, 'where's your head at?' and 'to think or not to think', the findings of which enabled me to better understand the veracities of each and implications for applied practice. Within this research it was clear that when participants were successful (putt made) there was an increase in alpha power levels at the occipital sites in the moments prior to execution. This was more prevalent for the TFA condition, especially for the 15ft. putts. Moreover, when participants were unsuccessful (putts missed) there was considerably more eye movement which suggests that attention directed exclusively externally was not always supportive of better performances (cf. Wulf, 2013).

Instead, it would appear that successful performances were typified by an external, and then, prior to execution, an internal focus. As such, these findings do suggest that taking one exclusive approach, external *or* internal, is not characteristic of successful behaviour (cf. Collins et al., 2016; Vu et al., 2017), at least in this task. Essentially, an external focus was still employed during a successful putt, however in the final 2 s prior to execution an internal focus was optimal. As such, this is not an either/or answer. Instead, both types of focus play a valid and important role.

Finally, in further support of an adaptable approach using external and internal foci, as stated there was increased eye movement with BFA putts in comparison to TFA. An interpretation of this finding would suggest that BFA can 'enable' distraction by conscious tracking of, or distraction by, the club head, both of which lead to this eye movement. As

such, the function of TFA may be effective at removing a distraction which is countering a

performance negative, as opposed to necessarily promoting performance.

Reflecting these important implications, the clarity of the findings would align with

the nuanced approach expectations. Accordingly, Table 4.5 suggests the strength of these

findings using a red line to act as a guiding visual representation.

Table 4.5

Dichotomy Predictions for Chapter 4 and Visual Representation of Strengths of Findings

Dichotomy	Absolutist Predictions	Nuanced Predictions
Where's your head at?	Uniformly low levels of occipital alpha throughout the trials and for both techniques. The visual cortex should always be active because the visual cortex is always engaged to prevent a focus on movement mechanics.	Occipital alpha power may change according to the task requirements and/or phase of execution.
To think or not to think	Little evidence of active processing involved. A loss of active processing would be associated with superior performance.	Task-specific conscious and unconscious states.

4.5. Summary and Implications

Having explored the visual engagement through occipital activity of two contrasting

putting techniques, it must be remembered that neither one produced significantly better

performance results. Therefore, it could be suggested the putting styles should be based on

personal preference. Similarly, it appears clear that successful, optimal performances can be

produced under varying mindsets, thereby supporting theories such as MAP (Bortoli et al.,

2012; Robazza et al., 2016) and generally promoting the need for adaptability from

performers. This notwithstanding, techniques such as TFA can be effective at avoiding the distractions that could often occur with an external focus, counteracting suggestions made by CAH (Wulf et al., 2001). It is also worth noting that all participants in this study had used BFA for many years and literally thousands of repetitions. In this case it is quite surprising that the imposition of TFA seemed to offer no detriment to their performance. Reflecting this, across both dichotomies this chapter examined, it is clear that practitioners should avoid absolutist recommendations and instead consider the more nuanced approach. Evidently, peak performance can occur across more than one mindset, and benefits from a switch of external to internal focus at the appropriate moment.

As such, applied practitioners and coaches must be mindful of this, working with performers to be adaptable in their approach. Techniques such as TFA could be coached to develop a robust skillset against varying performance environments, and to be deployed in the event of ongoing visual distraction. Further investigation should look to explore further the mechanisms underpinning TFA, to explore the switch from attention to intention more clearly.

Moving forward, having now investigated the training and execution of motor skills, I wanted to tackle another practical problem I have experienced, whilst also exploring a more complex skill and environment. Equally, the next chapter seeks to understand a different concomitant of expert performance; the important skill of decision making. In doing so, the following chapter, Chapter 5, explores the role of cognition, understanding and knowledge in high-level decision making in the context of Rugby Union. Referring back to Table 2.1, this chapter explored the following dichotomies: 'pay attention in class', 'context is key', 'to think or not to think' and 'just do it'.

Chapter 5. "Muscular collision chess": Examining the role of cognition, understanding and knowledge in high-level decision making

5.1. Introduction

Of course, some might perceive the skill of golf putting as a reasonably closed skill and wonder how the dichotomies being explored in this thesis might manifest in a more 'chaotic environment' (Aicinena, 2013). Reflecting this, in the present chapter I chose to explore the considerably more complex skill of decision making (DM) in a sport which is well known for its fast-paced, phasic nature, Rugby Union. Notably, I aimed to extend conventionally held wisdom to understand the opinions and knowledge held by high-level performers not just in the execution of the skill, but more importantly if and how this extends into live play. Finally, in an effort to inform current practitioner practice, I attempted to understand how this skill has been developed, and therefore offer appropriate implications for practice. These objectives together address four dichotomies: 'pay attention in class', 'context is key', 'to think or not to think' and 'just do it'.

5.1.1. The Context

Invasion games have been a key focus for practitioners and researchers alike for many years. From individual performance through to team success, coaches and practitioners aim to better understand the complex and chaotic environments on the pitch, field or court. Within elite sport, accurate anticipation of 'what happens next' is an important factor for success (Williams et al., in press). Terms such as 'game intelligence', or 'skilled anticipation', are often used to describe those players who are able to predict not only the opposition's next move, but also what their own team's behaviour should be, both reactively and proactively (Singer & Janelle, 1999; Singer et al., 1996).

One such construct that has received significant attention is DM (Davids et al., 2013; Gréhaigne et al., 2001; Gréhaigne et al., 2005). Whilst initially a lot of research explored

coaches' DM (e.g., Vergeer & Lyle, 2007, 2009), more researchers are looking to explore

players DM, and the different factors which might impact this, such as DM style (Richards et

al., 2017) and attention (Vallerand, 1983). Rugby Union is a suitable domain for research of

this nature due to the use of stoppage time (in which referee can stop the clock at their

discretion), as well as the stop-start nature of the game, which occurs as a result of dead-ball

scenarios, such as lineouts, scrums and penalties (World Rugby, 2020).

5.1.2. The Problem

Whilst our understanding of performers' DM in team sports is growing, a lack of

clarity into exactly how DM works, and therefore how we might act to optimally develop it,

exists due to two conflicting approaches; ecological and cognitive approach. These

approaches were explored within Chapter 2, during the 'context is key' and 'product of your

environment' dichotomies, whereby cognitivists would suggest that DM is primed through

careful reflection via Classical Decision Making (CDM; Mascarenhas & Smith, 2011) and/or

Recognition Primed Decision Making (RPDM; Klein, 2008), as performers develop an

internal representation of the skills they are executing. Juxtaposed to this, and highlighting

the contrast with the cognitive perspective, "…in ecological dynamics, there is no internal

knowledge structure or central pattern generator inside the organism responsible for

controlling action" (Araújo et al., 2019, p. 10). Indeed, Gibson (1966) suggests perception is

not derived from *any* form of mental representation (which is a key pillar of the cognitive

approach: Frank et al., 2013; Schack & Meschsner, 2006), but *only* from information detected

by an observer.

The contrasts between these two theoretical perspectives clearly offers a conundrum

for psychologists and coaches on how best to develop DM skills. Notably, and as an

additional consideration, until recently there has been very little attempt to consider the

situations in which these decisions take place and, therefore, the influence of the context upon

decision makers. However, researchers are beginning to address this gap (Cañal-Bruland &

Mann, 2015) with recent research beginning to explore the role of contextual information (from non-kinematic sources) in shaping anticipation and DM behaviour (Loffing & Cañal-Bruland, 2017). Such knowledge which informs action has been termed 'contextual priors' and continues to be explored in sport with promising implications for professional practice (Broadbent et al., 2019; Mann et al., 2014). Foundations in understanding this were laid by Levi and Jackson (2018) as they concluded that it is imperative to consider the influence of context upon decisions. In their exploration, Levi and Jackson interviewed elite development soccer players in an effort to understand which factors impacted their DM. However further research is needed to understand how contextual factors combine to influence decisions and, *if* these factors are present during the DM process, how they transfer to action. Also, if found to be important, what mechanisms underlie this and, therefore, what the implications are for development.

Finally, and extending this point, there is a dearth of consideration as to how key decision makers develop these skills and abilities, cognitive or otherwise. Whilst ecological theorists consider this a bottom-up process of becoming more attuned, and cognitive psychologists suggest a top-down deliberate process employing representations of prior action, neither have sufficiently explored how to improve and develop the skills of DM.

5.1.3 The Dichotomies

Chapter 5 explored four of the dichotomies identified in Chapter 2; 'pay attention in class', 'context is key', 'to think or not to think' and 'just do it'. The predictions for this study representing both the absolutist and nuanced perspective can be seen in Table 5.1.

Table 5.1

Dichotomy Explanations and Predictions for Chapter 5.

Dichotomy	Explanations		Predictions	
	Absolutist	**Nuanced**	**Absolutist**	**Nuanced**
Pay attention in class	Performers should learn implicitly as to avoid skill breakdown under pressure through reinvestment.	Explicit knowledge in learning can be essential for peak performance in varying conditions. In essence, cognition would be scalable in practice.	No explicit information is held about skills, regardless of the complexity. Additionally, if explicit knowledge did exist, a breakdown of that skill whilst executing the decision in-action would occur.	Deliberate learning tools aim to enhance explicit understanding of the tactics and techniques deployed, with little evidence of negative impact due to interference from cognitions.
Context is key	Decisions are made without command from the brain, and instead through direct perception with the environment.	A scalable process, with lower level decisions made subconsciously, but higher order tasks using the contextual information available.	Most effective DM takes place in the absence of cognition, whereby action emerges from the environment without conscious consideration by the performer.	DM consciously utilises contextual factors, and identifies information through priming, which continues into action
To think or not to think	Successful performances occur automatically, in a non-thinking flow like state.	Optimal performances can occur across a spectrum of different performance states, which often require cognitive input.	Subconscious executions, whereby performers have deliberately attempted to remove control over their movements.	A broad spectrum of mental states exists within performances, some of which require significant effort and control, and others which occur more intuitively.
Just do it	Having the autonomous stage of learning performers execute their skills automatically which means consistency.	Motoric automaticity is nuanced, and skills vary in the degree to which they can be fully automated.	Skills will be performed consistently across every performance, with no variance regardless of environment or context	The execution of skills will be varied.

5.1.4. The Objectives

Within this chapter, and reflecting the dichotomies addressed in Table 5.1, I was interested to explore the role of cognition, understanding and knowledge in DM in high-level Rugby Union. Through exploring this topic, I hoped that further knowledge would be garnered pertaining to the best practice techniques for training this skill, if indeed, it can be trained. Reflecting this, the following objectives were outlined:

1. To examine contextual priors in high-level Rugby Union. Specifically, to identify the macro, meso and micro factors considered when a ball is out of play. Do these prime subsequent decisions, focus and action?

2. To examine whether those factors then carry through as foci for attention once the game recommenced. Does this priming subsequently operate?

3. To see if those factors were selected and developed through training. If they exist, where do these priming ideas come from?

5.2 Method

5.2.1. Participants

Nine male premiership professional Rugby Union players ($M_{age} = 32.4$ years, $SD = 5.6$) were recruited for this study. Purposive sampling (Lavrakas, 2008) was used to recruit participants due to the specific sample criteria required (i.e., key decision makers with high-level experience). Participants approached were known to the researchers, and they then expressed an interest in partaking. Following this, participants received an information sheet about the research. All participants played in positions heavily reliant on their DM abilities (centres and fly-halves) as these players have the most touches of the ball in positions in which they can dictate what comes next, in particular where additional options are still available (World Rugby, 2020). All had experience playing at top tier level ($M = 10.6$ years, $SD = 3.2$), with five having been capped at international level. Two participants were retired from professional Rugby Union and were now coaching at premiership clubs (see Table 5.2,

details are restricted to help protect anonymity). Notably, and reflecting the pragmatic

approach of this research, to avoid a heavy influence of club coaching practice and therefore

identify common features of expertise within the sport, participants were recruited from four

different professional clubs. This study received approval from the University's Ethical

Committee and all participants provided signed informed consent prior to taking part.

Table 5.2

Participant Playing Characteristics and Experience

Participant	Primary Position	Years playing at Top Tier (senior)	International Caps	Years coaching at Premiership
1	Centre	>5 years	>30	>5
2	Centre	>10 years	–	–
3	Fly-half	>10 years	>3	–
4	Centre	>10 years	–	–
5	Fly-half	>5years	–	>5
6	Centre	>10 years	>20	–
7	Fly-half	>10 years	–	–
8	Fly-half	>10 years	>20	–
9	Fly-half	>15 years	>50	–

5.2.2. Research Design and Interview Guide

Building on the work of Levi and Jackson (2018), this research looked to obtain a rich

picture of participants' personal experiences. As such, a qualitative research approach was

employed, since this allowed for participants' experience and expertise to be probed and

discussed. Semi-structured interviews were selected (DiCicco-Bloom & Crabtree, 2006) to

flexibly engage the participants in the planned topic. Furthermore, semi-structured interviews

have been praised for the development of reciprocity between researcher and participants

(Galletta, 2012).

A pilot study was completed with League 2 level participants to enhance the reliability of this study and confirm the development of the semi-structured interview questions within the guide (Kallio et al., 2016). Feedback from pilot participants indicated that the interview guide was appropriate and had a coherent flow. Consequently, we confirmed the choice to explore the study purposes above by asking participants about their experience in stoppage time, through to live play as opposed to dead ball situations (World Rugby, 2020). This was deemed most appropriate as these scenarios require performers to review options, make a decision and commence action in a short period of time as the game is still in flow. This differs to dead ball situations which are typically longer in duration and generate less pressured situations. The pilot study indicated that an example scenario would help to contextualise participants' thinking, therefore a line out was offered as an example scenario because this break in play allows the majority of the team (eight forwards) to be isolated from the game. Consequently, the backs, in particular 10 and 12, can either attack or play for territory with the greatest available space.

5.2.3. Data Collection

Due to national travel restrictions at the time of the research (due to global health pandemic), all interviews were conducted over video calls, and recorded with the participants' permission. A semi-structured interview guide (see Appendix for full interview guide) was utilised to guide the investigation; however, due to the flexible nature of this method each interview was idiosyncratic. Participants were able to explore their thoughts at leisure, and I only offered occasional prompts or clarifying questions. Interviews lasted between 45–123 minutes ($M = 57.4$, $SD = 11$), and were concluded once the participants felt they had nothing additional to contribute.

5.2.4. Data Analysis

Demonstrating the emphasis on pragmatism to understanding this topic, and extending the six-step thematic analysis process as outlined by Braun and Clarke (2006), this

analysis used a deliberate 'reflexive' approach (Braun et al., 2018). This means that, in contrast to analysis being purely inductive or deductive (against already existing theory/findings), data were coded using both inductive (i.e., new insights) and deductive approaches; the latter informed by both the researchers' applied experiences and literature-derived knowledge or theoretical knowingness (Braun et al., 2016). As such, each interview was transcribed verbatim, participants were given pseudonyms, and all identifiable information offered, such as clubs the participants had played at, were removed. Transcripts were read through and raw data codes were highlighted using appropriate terms, taking a 'revise, retest, revise' approach (cf. Taylor et al., 2020), whereby the participant's intended meaning was critically considered against the knowingness of two of the researchers. In this way, data were meaningfully analysed through reflexive, thoughtful, transparent engagement, thus working towards a "richer more nuanced reading of the data" (Braun & Clark, 2019, p. 594). According to Braun and Clark (2019), codes do not and should not *passively* emerge. Instead, they are created by the researchers in an attempt to develop an interpretive story of the data. As such, the two researchers (myself and a member of my supervisory team) conducting this stage of the analysis purposefully took time to reflect upon the selected raw data codes and assessed these against our own theoretical assumptions before constructing a complete structure. A small number of adjustments were made that served to clarify the link between the raw data code name and the intended meaning by the participants; in other words, the coding process was internally scrutinised (Braun & Clarke, 2019).

Reflecting these qualitative innovations by Braun and colleagues, the raw data codes were compiled in order to identify similar patterns with shared meaning (addressed as shared meaning units (SMU) previously thought of as 'lower-order' themes), then hierarchical central organising concepts (previously thought of as 'higher-order' themes) were generated to unite these meaning units. At this stage all researchers reviewed this structure to confirm the collaboratively constructed central organizing concepts (henceforth referred to COC;

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Braun et al., 2018). Through this process, COCs were named and defined, and the write up of data commenced using a selection of the most pertinent and appropriate quotes in order to exemplify these. All data analysis was conducted with the use of NVivo v12 software.

5.2.5. Trustworthiness

In addition to the steps outlined above I sought to ensure maximal trustworthiness of these data, to both ensure best practice but also to accurately reflect the participant's real world experiences, thereby further supporting the pragmatic philosophy. As stated by Smith and McGannon (2018), historically used processes such as member checking and inter-rater reliability are no longer recommended on the basis that "theory-free knowledge is unachievable and that realities are subjective, multiple, changing, and mind-dependent" (p. 112). Most notably participants and researchers are not able to extract themselves from their own experiences, and therefore biases (Denzin, 2017).

As such, once analysis was completed, member reflection was utilised. Member reflection is the process of sharing ideas and findings with the participants, not for verification of results, but to more fully explore the topic of interest (cf. Smith & McGannon, 2018). Instead of aiming to *remove* contradictions in the data, as is the aim of member checking, this process aims to highlight and understand these contradictions to inform data interpretation (Schinke et al., 2013). For example, reflecting my decision to recruit across multiple professional clubs, variation within these data could be further explained as a result of specific practices/cultures of training within each club. Drawing upon Harvey's (2015) dialogic approach, I shared the generated raw data codes, and COCs with participants for their comments and additional thoughts in order to co-construct and understand the findings. To ensure accurate recall, and therefore an effective member reflection process, this took place no more than 3 weeks post-interview. Following this, all participants responded, confirming that their views were effectively represented and that the generated codes were an accurate depiction of their views.

5.3. Results

During the interview and data analysis process it became clear that study objectives one and two were inextricably linked, and the generated results would serve both objectives. Therefore, I present the findings that answer these objectives and discuss them together, exploring the most pertinent generated COCs and underpinning data (see Table 5.3). Following this, I employ the same process for objective three (see Table 5.4).

5.3.1. Objectives 1 and 2: Considered Factors, Contextual Priors and Priming

Against the first two study objectives, namely, the macro, meso and micro factors that might impact decisions and how these factors are carried through into skill execution, four COCs were generated, underpinned by twelve SMUs, all of which are displayed in Table 5.3 with supporting exemplar quotes. These demonstrate the nuanced process that performers experienced when making and processing decisions.

I direct the reader's attention to the breadth of raw data codes which were generated, from micro (pitch conditions) to macro (score line) in nature, as the participants highlighted that they had to be constantly aware of and assessing all these through the evolution of the game. As Participant 3 explained, "you're in constant communication with people, and that allows you to build a structure of the game". Some of these factors were pre-determined, which contributed to a primed effect (explored later), but others (see Table 5.3) developed as the players engaged in the game. Participant 8 summarised these as "points and pressure", referring to the constant consideration of context required.

Notably, the results show that the impact of these factors also extended to subsequent skill execution, as demonstrated by quotes in Table 5.3 under the 'Primed DM' COC. This suggests that there is a genuine and impactful 'priming' of DM created by overtly led consideration and cognition, which can be seen in the raw data codes that compromise the COC 'Contextual Priors' (Table 5.3); for example, advanced knowledge of the opposing team. As Participant 6 identified with regards to one opponent: "As soon as he does that, as

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soon as he starts to get high, that's when you can throw the pass". Moreover, context impacted the motoric automaticity of skill execution, as participants reported needing to be consistently aware of their environment. For example, weather or pitch quality, and adjust the execution of even the most basic skills accordingly. Participant 7 stated: "yeah, I don't think of it always, but if he's out on the wing and it's a tough day, weather wise, I have to put more behind it [the pass]".

In addition to 'Contextual Priors', three other COCs emerged which should be of interest in relation to objectives 1 and 2. Players suggested that they were also thinking, plotting, and planning against a variety of different factors, *during* skill execution; for example, knowledge of the opposition team, which was mentioned by all participants (Table 5.3). The 'Cognition' and 'Considered Factors' COCs suggest that participants were becoming more aware of their opposition as information became available to them. Further demonstrated here:

> They've overcommitted to a breakdown, so there's three in the breakdown, I'm already at seven. They've got two in the backfield which I know they have, that gets me to nine and then suddenly I've gone 'I've got half a pitch to go here, I know it's on', like it's just simple maths (Participant 9)

Interestingly, the 'Cognition' COC indicates that these thoughts were ever-present, but were reported to narrow in focus or, as Participant 9 suggested, become more "bespoke", going on to state "it becomes narrower on the task at hand and what you've got do".

Importantly, through the change into this active phase, participants were overtly considering what to do, but also what *not* to do, against the emerging picture. For example, "the defence has tightened up for whatever reason, let's play around them or they're wide and we can play through them" (Participant 6). In short, players were thinking *as* they played as well as before the game restarted. This was also the case from a motoric perspective of skill

execution, and I draw readers' attention to raw data codes such as 'thinking about the task' and 'decision against action'. This was further demonstrated by participant 4 who stated: "I've been passing, throwing, tackling my whole life. But sometimes, I have to decide if it's right. Do I need to adjust my movement based on what they've shown me?"

5.3.2. Objective 3: Developing the Skill

Of course, if DM and skill execution *do* rely on underpinning cognition, this must be developed in some way. This led to my final objective, which produced one main COC, underpinned by four SMUs (Table 5.4). As already identified, several players spoke initially about DM processes as "instinct", but went on to exemplify this instinct, explicitly seen as anticipation and game sense (e.g., "Rugby is second nature, but it's safe to say that knowledge is something I've been building" – Participant 7), had been developed through many hours of reflection and discussion, led by overt coaching. I draw the reader's attention to a plethora of quotes in Table 5.4, in particular under the 'Coaching Tools' SMU, and in further examples such as Participant 8 who stated, "I think the best players think very instinctively in the moment… they have trained these moments probably a lot in their own head but they've also trained them in training". Furthermore, these findings showed that explicit, motoric coaching across a spectrum of skills was used, for example: "sometimes we'll have a session where we really focus on the quality of passing, catching et cetera. Bad habits can creep in so it's essential" (Participant 1). The quotes also suggest that participants (and perhaps the literature?) may be overusing the 'instinctive' terminology!

Regarding the contextual factors, it appeared that many decisions are primed through extensive performance analysis and scenario-based training. Utilising these coaching tools developed participants to better understand and consider their teams' approach to different circumstances. For example, as Participant 4 described, "they'll tell me 'you're down by two points, two minutes left', and then I have to bring the huddle in and we have to decide". These SMUs often interacted, as players found themselves constantly exploring and

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understanding plans specifically related to their next competition. This was eloquently described by Participant 1 when they stated, "you spend all week learning theories and then Saturday is just about putting them into practice".

Within the 'better comprehension of DM' SMU, players identified that key coaches had an impact on their DM, by better explaining what the players should be looking for. Moreover, eight of the nine participants discussed the impact of explaining, or coaching, DM to junior players as a key turning point for their own skill. For example, Participant 6 stated:

> when I'm coaching them I'm like 'no stand here, stand a few meters back, what are you looking at? are you looking at him? are you looking at that area of the pitch? are you looking at the depth?' and they're like 'no not at all'. I'm like 'OK' so these sort of things are just constantly going on in my head.

Finally, readers should note that participants' expressed the importance of the evolution of Rugby and their own background within this sport, noting that this growth was essential to their effective DM processes. For example, Participant 6 stated, "I'd say if I knew even half the knowledge I have now when I was 21 in my 3rd year of professional Rugby I'd love it". As such, these data are supportive of a significant role for cognition, which is constantly developed as players 'study' the game.

Table 5.3

Thematic Analysis Pertaining to Research Objectives 1 and 2

Exemplar Quotes	Raw Data Codes (*N* participants)	Shared Meaning Units	Central Organising Concepts
We know everyone on the pitch what you're about as players… I'll know every other player what they're about.	Consideration of own team (9)	Pre-known/determined Factors	Contextual Priors
The factors that are probably affecting the conditions of the game so you talk about a 4G pitch whether it's raining whether it's windy um definitely have a massive effect on um what decision you make.	Weather/Environment (9)		
If you're having a bad day at home of course it's gonna effect your main decision in a highly stressed job.	Extraneous pressures (6)		
It's just knowing how I can move, which direction I can go quickest in.	Skillset/Ability (6)		
Where is the opportunity to apply pressure on the opposition? And where are the opposition's weaknesses so even psychologically where are the opposition's weaknesses under pressure? … their hooker's struggling to throw in so it doesn't matter if we kick the ball out we'll get into their lineout?	Knowledge of the opposition (9)		
You're trying to make a decision on is this the right time to go again?' is the referee pinging for penalties... Very, 50/50?.	Officiating (5)	Evolving Factors	
So you know um if you're going into the last 5 minutes of the game and you're losing and you need to score you need to score a try… you know the factors around you that have a big impact on the decisions that you make.	Scoreline (8)		
So the scoreboard and the clock, we talk about points and pressure.	Time on the clock (9)		
We're all on the same page and we're all understanding that we're doing it for the right reasons… that's when you need to kind of be in control of your internal plan as a group.	SMM Strategy (9)	'Feel' Factors	

Exemplar Quotes	Raw Data Codes (*N* participants)	Shared Meaning Units	Central Organising Concepts
I think it's sort of an awareness, it's an awareness of that momentum and those building blocks.	Momentum (8)		
You've got to have an understanding of how the game feels... you have a feeling for how the game is maturing or how the game is playing out.	Knowledge of the game so far (7)		
You're assessing well right it's a poor kick by the opposition I've run onto the ball, it's a fragmented defensive line in front of me that I have I have my support players working back and giving me width, the opposition are a bit condensed so then they're processing that quickly…I think the best players think very instinctively in the moment, they have trained these moments probably trained them a lot in their own head but they've also trained them in training.	Developed Instinct (6)	Developed Instinct	Primed DM
People look on and go 'bloody hell how are they making that decision?' but… we do it day after day after day like it becomes quite simple… it does feel fast but it is years and years of knowing it.	Embeddedness (8)		
What our players are saying to me, where they feel that space is, the more information I can garner, the better it is for me.	Communication from team mates (9)	Thinking in Action	
As a player and a leader you know that they're not gonna win this line out, the opposition's all over them so let's go to the other plan.	Context in the game (8)		
The more you know about someone the more you're likely to pre-empt what's gonna happen.	Anticipation (5)		
He can read a picture and be a maverick, his best element of his career is he drills this system day in and day out and you have to be a metre if you're a metre out of position you're in the wrong position and he drills it, so when he's sees it, he knows it on.	Recognition (8)	Visual Information	
Probably 95% of the time I've been in the position before… used up knowledge I've had in the past or stuff I've done wrong or right in the past.	Experience in similar situations (5)		
When you look and you see people's body language… where they're propelling their energy to, are they sinking in on one person in particular how quick can you then go to that other	Understanding visual cues (7)		

Exemplar Quotes	Raw Data Codes (*N* participants)	Shared Meaning Units	Central Organising Concepts
option and that reading of body language which is a split second is basically probably one of the factors why you can be successful, but only because you understand what the those picture are now.			
It's an understanding of your options. You're almost primed to know that those options are available to you.	Priming (6)	Priming	
Training may look brilliant and they might run it brilliantly, but if they haven't experienced this chaotic side of the game um then how can we expect them to have the ability to deal with it whenever they play on a match day.	Preparation (9)		
People weren't going to the space inside him, and once you actually coaxed him to come towards you, we can exploit him. So that was just through analysis throughout the week. So we know that he, the individual does that, so then we can pick him off.	Performance analysis (9)		
So that vision that you have off the ball is very key for guys that you see make breaks and then obviously that physical element helps if you're a bit stronger and a bit quicker that you can push through those half breaks and things like that.	Physiological Factors (7)	Physiological	Considered Factors
You might get the call on from the coaches to kick the balls because they want more territory, but you might make a call on the pitch that you feel we haven't played enough with the ball in hand.	Adaptability (5)	Psych Factors - Developed	
I do a lot of like visualisation and imagery. I'm trying to imagine the ground. I'm trying to imagine a grass, it's fake, it's real, wind, rain, whatever… Imagery, a lot on my defence around my tackling. That's the biggest thing I work on and call it X-Factor stuff so, things that I might do once every ten games. I try and do that every week in my head.	Mental Tools (4)		
…and good players play makers will make the right call 9 times out of 10 instead of 6 times out of 10, so having those other elements are big factors to the decisions on the ball um but I think that's a bit of the game where having confidence, trusting your training pays off.	Confidence (9)	Psychosocial	

Exemplar Quotes	Raw Data Codes (*N* participants)	Shared Meaning Units	Central Organising Concepts
One thing that's important to note as well that when you're playing with somebody who's making similar decisions well we're all making decisions together.	Values/Culture (8)		
My attention is on my role within that um so you know that decision may be that we're going to push the ball to win because there's an opportunity on the outside so what is my role?	Role clarity (8)		
There's programmed predetermined decisions in the sense that you've just got a selection and it's just trying to figure out which is the best one.	Options (9)	Weighing up action	Cognition
When that picture doesn't present itself you might panic and try to show a pass which isn't on. Where I've learnt you're just going to have to cut your losses and just carry the ball in, and be patient, and eventually something will present itself.	Decision against action (4)		
I'm actually quite frustrating to coaches, I reckon. I'm very inquisitive, so I'd always ask, 'well, why are we doing that?' And it got me into a bit of trouble in the past because sometimes I think an insecure coach would feel like you're questioning him, I just want to know why.	Explicit knowledge/understanding (8)	Explicit Understanding	
Well I think it [thinking] becomes a bit more bespoke, it becomes narrower on the task at hand and what you've got do so. Yeah. It's not that you're forgetting everything. It's just you sort of compartmentalise… you're just purely focussing on what the action is and then stay very much in the moment and the present.	Thinking about the task (7)		

Table 5.4

Thematic Analysis Pertaining to Research Objective 3

Exemplar Quotes	Raw Data Codes (*N* participants)	Shared Meaning Units	Central Organising Concepts
Watching and doing I think really. So watching a lot of film, as you call it, and learning the triggers of very good players and people making good decisions… You've gone from trying it, to learning it, to copying it, to understanding it, to then actually being able to articulate and tell other people why you understand.	Process of learning DM (9)	Learning DM	Training DM
Yeah, decision making can definitely be developed and taught. It's through work.	Belief that DM can be learned (8)		
Explaining stuff to academy boys and sitting down and going through clips, that was a huge help for me to understand what I should be looking at.	Coaching others (9)	Better comprehension of DM	
I found a coach who was number 10 who can really critique my decision making… my game has gone to a whole new level based on one coach who can really help my decision making in game.	Coaches explaining DM (8)		
If you've got that in the locker already which you would hope a professional Rugby player would have the ability pass under pressure and kick under pressure and run the right lines that when you add into a drill where you don't have to worry about that it then becomes more decision making based because already those fundamentals of passing kicking and that stuff then that's the bit that you rep and that's the bit that you're constantly adding to.	Drills (4)	Coaching Tools	
it probably goes back to the training weeks in the months before and getting to know working in you know very high stress situations when you're over fatigued in training or you're mentally challenged during really hostile situations in training.	Training under pressure (2)		

Exemplar Quotes	Raw Data Codes (*N* participants)	Shared Meaning Units	Central Organising Concepts
I suppose we do scenarios in training we'll do like scenario base drills where like right lads you've got 1 ½ minutes left on the clock you've got 3 points left on the scoreboard you're in this part of the field, what do you do?	Scenarios (6)		
Again, this is all been a process throughout the years so if I'm looking at my own individual situation, whereas when I was younger, I might go into a game and I might only probably look for like two or three areas. I would have been very individualistic in terms of what defender is weak so I can beat them. Whereas now I'll probably less look for individual defenders as an individual for myself.	Background in sport (5)	Development of DM	
So you might not have a quick ball then but then someone might bust a tackle and you're suddenly 30 metres down the pitch so the context's changed so what will he do now so that's a really good way of looking at it as well what is the context of that moment.	Evolving game (5)		

5.4 Discussion

5.4.1. Contextual Discussion

Interestingly, one key COC supports the findings from Levi and Jackson (2018), as there were several contextual factors which participants were considering both during stoppage time and when the game restarted. Whilst Levi and Jackson identified static and dynamic factors which were considered prior to a decision, my research identified the following: pre-determined, evolving, and 'feel' factors. Pertinently, this research also extended Levi and Jackson's work, as it became clear that these factors, or 'Contextual Priors' as they were dubbed (Mann et al., 2014) carried on as in-action thoughts through to skill execution.

As suggested by Broadbent et al. (2019), 'Contextual Priors' inform active play, providing an alpha plan of actions. This knowledge allowed players to anticipate opposition behaviours, since they were primed to search for and recognise these and act accordingly (Klein, 2008; Segaert, in press). This RPDM style suggests that athletes were viewing the 'pictures' presenting themselves in the evolving game but utilising cognition, likely stored as a mental representation, to execute the skill (cf. Raab & Araújo, 2019).

Relating to the in-action thoughts, interestingly, these cognitions were ever-present, but were reported to narrow in focus as the game restarted. These findings support cognitive theories, such as the previously mentioned Meshed Control theory (Christensen et al., 2016), which suggest that skilled performers' thinking is not uniform depending on the nature of the task. Automated movement control allowed athletes to attend to higher implementation components, such as strategy (cf. Carson & Collins, 2020), whilst executing lower level skills 'instinctively'. Of course, not forgetting that this aforementioned instinct has been careful curated.

However, and of particular concern for the ongoing debate of cognitive versus ecological, through the change into this active phase, participants were overtly considering what

to do, but also what *not* to do, against the emerging picture. As the exemplar quotes for the 'weighing up action' SMU suggest. Seemingly whilst a player might observe an opportunity for action, or an affordance (Gibson, 1979), they also based their decision on the context and understanding of the game as well. This thinking is still high level, and does not extend to such well-rehearsed actions as 'how and when do I pass'. Unsurprisingly, these lower level actions are seemingly controlled unconsciously and could *perhaps* be explained by the EcoD approach. Importantly, however, our data could be explained equally well by the implementation control element of the more cognitive meshed approach, as previously mentioned (Christensen et al., 2016).

Clearly, there is no doubt that cognition is the primary driver as understanding of the information participants perceived was still necessary. Reflecting this, the results suggest that the process of coaching conscious DM is of particular importance. It would appear that these findings seemingly both support and contrast currently held wisdom within DM coaching literature. Exploring the evolution of DM coaching, Light et al. (2014) suggest that mechanistic, technique-focused coaching simply will not cut the mustard anymore, and instead we should *exclusively* utilise a holistic, "player-centered, inquiry-based approach" (p. 272). Comparatively, our findings would suggest that a breadth of different coaching tools, from drills to games, still have relevance in this process, as is evident from the exemplar quotes offered to support the 'recognition' and 'drills' raw data codes.

Finally, as shown in the Table 5.4 quotes underpinning a 'better comprehension of DM', this study highlights the importance of athletes sharing their knowledge and experiences with other players. Perhaps formally known as mentoring, which has received some attention in coach development (Bloom et al., 1998) but little in peer development (Hoffmann et al., 2017), my findings demonstrate further that understanding can be developed through explaining the DM process to others. Both teammates and more junior players offer advantages as the targets of

such interactions. For example, developing one's own comprehension against developing SMMs in slower time

5.4.2. Dichotomous Discussion

Against the three dichotomies explored within the chapter, a number of pertinent points arose. My findings indicate that DM abilities have been, and continue to be, developed. Moreover, this development typically came from explicit understanding and reflecting upon experience, and therefore was both conscious and effortful as opposed to a more automatic phenomenon such as attunement to the performance environment. A number of particular coaching tools, such as scenario-based learning and drills were utilised to enhance this DM ability. Of note, understanding of the process was particularly stressed by the participants (as demonstrated by the SMU 'better comprehension of DM' seen in Table 5.4), which, as shown in the results, was commonly developed by coaching younger players. Reflecting this, it is clear that participants developed their skills through a number of explicit processes, which were later embedded for a more automated, or primed, performance (whereby priming is the repeated presentation of a stimulus, which leads to the facilitated processing of this stimulus; Segaert, in press). Moreover, the findings failed to identify any performance breakdowns as a result of this explicit knowledge in either technique or tactics, perhaps because they were so well embedded. These findings, therefore, appear to reject many contentions stipulated by Reinvestment Theory (Masters & Maxwell, 2008). Therefore, the findings certainly reflect the nuanced approach predictions more accurately.

This self-perceived 'instinctive' execution was discussed by two thirds of participants. Initially, some participants suggested this was a natural instinct, almost from ethereal talent (c.f. 'God-given' talent in Chapter 3). After further exploration, however, it became clear that their instinct was, in fact, developed, through the aforementioned tools. Reflecting contentions suggested by Christensen et al., (2016), these findings support a hierarchical structure of skill

execution, whereby the lower level skills (technique) were more automated allowing for more cognitive attention on the higher order challenges (tactics and strategy). Of note, this cognitive attention was typically directed towards 'Contextual Priors' in which participants were considering pre-determined, evolving and 'feel' factors. These findings indicated that these contextual priors were of paramount importance, and contributed heavily to the DM process. Notably, these were present as active cognition prior to the game restart, and more embodied cognition (internal representations; Raab & Araújo, 2019) once in-action. Once again, these findings typify the nuanced expectations.

Additionally, research identified the performance states in which participants experienced their superior DM and, consequently, superior performances. Once again participants drew on their experiences of naturalistic, almost automated, performances, but through further exploration, the importance of 'knowing' underpins these. For example, even the most maverick of performances had been drilled and practiced significantly, leading them to be produced through RPDM (Klein, 2008). Of particular note is the importance of effort and control which was required to create these performances. This can be seen across several of the SMUs, such as 'developed psychological factors', 'weighing up action' and 'thinking in action'. Thus, whilst some performances might appear to the audience to be occurring almost miraculously, they instead required significant communication amongst the team (both overt and a priori – cf. Richards et al., 2017), consideration of options and alpha plans of action, or at the very least they were primed through a significant amount of hard work. This certainly supports the MAP approach to performance (Bortoli et al., 2012; Robazza et al., 2016) over flow (Csikszentmihalyi, 1990).

Mechanistically, these findings do suggest that successful skill execution is more complex than the dated theories of acquisition might have led us to believe (Fitts & Posner, 1967). Previously held contentions of automaticity do not align with the performances that

participants reported, and instead skill execution fits more closely with the four horseman of automaticity outlined by Bargh (1994).

The findings of this study aligned more closely with the expectations from the nuanced perspective. A blue line is drawn in Table 5.5 to demonstrate the subjective clarity of the findings against the spectrum of these two approaches.

Table 5.5

Dichotomy Predictions for Chapter 5

Dichotomy	Absolutist Predictions	Nuanced Predictions
Pay attention in class	No explicit information is held about skills, regardless of the complexity. Additionally if explicit knowledge existed a breakdown of that skill whilst executing the decision in-action would occur.	Deliberate learning tools aimed to enhance explicit understanding of the tactics and techniques deployed, without significant reinvestment.
Context is key	Most effective DM takes place in the absence of cognition, whereby action emerges from the environment without consideration by the performer.	DM utilises contextual factors, and identify information through priming, which continues into action
To think or not to think	Subconscious executions, whereby performers have deliberately attempted to remove control over their movements.	A broad spectrum of mental states exist within performances, some of which require significant effort and control, and others which occur more intuitively.
Just do it	Skills will be performed consistently across every performance, with no variance regardless of environment or context	The execution of skills will be varied.

5.5. Summary and Implications

In presenting this study, I believe both approaches can add to the understanding of DM in high-level sport. In the context of the chapter, the cognitive approach appears to offer the most parsimonious explanation of the data. However, with further investigation, the EcoD perspective could offer an explanation for execution of the more seemingly automated skills. It is possible that protagonists of either perspective may question the interpretations, through the use of esoteric terms such as 'attunement', or (and rightly so) request further mechanistic explanations of the EcoD approach. However, having sought clarity of the findings, and at my level as a pracademic I would suggested that the explanations offered are both the most parsimonious *and* most reflective of participants' views. In essence, athletes train and are coached to achieve *understanding* of their performance environment. Thereby, they are considering contextual factors, sometimes extensively, before action, utilise recognition priming in order to execute these decisions and, finally, continue to consider all this whilst in-action.

The implications of this research are impactful for coaches and practitioners alike. As presented, the role of understanding is often neglected within research and practice. Therefore, coaches and practitioners should make a concerted effort to encourage this during player development (cf. Price et al., 2019). Moreover, whilst we suggest there is a mechanistic split between technique (e.g., how/when to pass, or how to tackle) and tactics (e.g., who to pass to or when to tackle), clearly both must be tightly integrated (Carson & Collins, 2020). It would appear there is merit in developing these separately *and* together (cf. Richards et al., 2017). However, the findings here show a strong and direct relationship between what players say they do and what they actually do do! Notably, active and involved cognition was a consistent feature of all players as their play appeared to be a form of "muscular collision chess" (Participant 6).

Of course, a common feature of the sports explored in this and the two preceding chapters (Motorsport, Golf and Rugby Union) is that they all present well-established participant

development routes. As a result of this, each sport can be typified (for serious participants) by a formal coaching environment, and therefore by extension the athletes are also subjected to this influence. Taking a novel approach to this convention, it seemed appropriate to explore a sport which likely has an absence of such formal influence, certainly it is not utilised within motor control/sport psychology research. Therefore, Chapter 6 investigated the learning processes of performers in skateboarding. This chapter explored the following dichotomies: 'pay attention in class', 'maybe she's born with it', 'product of your environment' and 'where's your head at?'.

Chapter 6. Show me, Tell me: An investigation into the learning process within an informal coaching environment

6.1. Introduction

So far in this thesis I have presented a pragmatic perspective towards sport psychology both as an academic pursuing a translational research agenda and as an applied practitioner experiencing the confusion on one hand and uncritical acceptance on the other, of fellow professionals when attempting to utilise the formal evidence base to guide the practice decisions (Chapter 2). Through the previous three chapters I used mixed-methods to explore various concomitants of expertise, namely, the role of practice during talent development (Chapter 3), the utility of visual information during closed-skill execution (Chapter 4) and the role of cognition and understanding during high-pressure DM (Chapter 5). Notably, all of the domains have been high-investment sports, either at the age at which performers start and/or the level of support required through coaching and technology to develop skills. It is, therefore, possible that the way athletes have learnt their skills simply reflects a journey 'tainted' by those influencing the development of coaching and the opportunities they provide, to whatever extent they can be correctly informed. One way to test this notion is to enter a motor skill learning environment that is not influenced by such structures and explore the processes taking place; a more natural laboratory if you will. As such, this final study explored the learning behaviours of skateboarders with an aim to understand how these performers develop skills in the absence of formal coaching.

6.1.1. The Context

Skateboarding is global sport (World Skate, 2020). More importantly, it is also a very accessible sport with low equipment costs and few precursors required to be successful (SkateboardGB, 2020). In essence, you can arrive at a local park with a board and simply 'have a go'! However, skateboarding has recently become considerably more mainstream since it was

added to the Tokyo 2020 (2021…!) Olympics. Of most relevance however is that, as with many other action sports, skateboarding is currently largely still coach-free. In other words, actions of the riders within the sport are most likely to exist because they are shared amongst, and learnt from, peers, or because it simply works for them. Notably, not because a coach said they should.

Skateboarding now joins the likes of freeskiing and freestyle snowboarding as a young sport in the mainstream, something which is certainly not without its challenges. Willmott and colleagues (Collins et al., 2018; Willmott & Collins, 2017) highlight these difficulties by suggesting that any coaches within the environment, formal or otherwise, are often left somewhat floundering, either copying the pathway of other successful athletes or "overly influenced by the waves of new but unspecific sport science support now available" (Willmott & Collins, 2017, p. 2). At present, the only scientific research conducted within these action sports explore injury incidence and prevention (Forsman & Eriksson, 2001; Fountain & Meyers, 1996). In short, skateboarding presently does what works best for the performers, but as they get thrust into the mainstream, things will quickly change!

6.1.2. The Problem

Through formal (peer-review, conferences) and informal (social media and best practice forums) sources, there is a wealth of advice available to coaches on the best techniques. A notable example of this can be seen in the growth of podcasts available since much of the world was placed into a lockdown, such as (to name a few) the Coaching Discourse Podcast (2020; 695 twitter followers), the Perception-Action Journal Club (2020; 1180 subscribers) or the Talent Equation Podcast (2020; currently offering 147 episodes). Interestingly, as explained in Chapter 2, much of this advice appears to take an 'either or' stance, based on the cognitive or EcoD approach. Rather than being contextualised, however, a wealth of this information typically seems to be at best, epistemologically biased and, at worst, evangelical. Rarely is this information presented with an empirical rationale. A confounding variable to this is the nature of

coaching qualifications, which often fail to teach the skills needed to be a critical consumer of the information around them. Indeed, this has led to some sports sitting firmly within one camp, for example Hockey's penchant for CLA (Newcombe et al., 2019; Renshaw, Davids, Newcombe et al., 2019).

As such, whilst historically other research has attempted to explore which approach is more successful within environments which are already endeared towards them, this research had the rare opportunity to operate without such biases.

6.1.3. The Dichotomies

This chapter explores four of the dichotomies identified in Chapter 2; 'pay attention in class', 'maybe she's born with it', 'product of your environment' and 'where's your head at?'. Table 6.1 details the predictions of this study from each dichotomy perspective, both the absolutist and nuanced approach.

6.1.4. The Objectives

Reflecting the dichotomous positions in Table 6.1, I was interested to explore the nature of learning and development in an informally coached environment to better understand which tools were used, how performers developed and how these tools were deployed. Furthermore, if there was a difference between the top performers' approaches with those less 'talented'. In exploring this, I aimed to garner further information pertaining to the focus of the performers during skill execution. Therefore, the objectives of this study were as follows:

1. To explore how skateboarders learn new skills in the absence of formal coaching.

2. To identify how and/or why 'top-enders' were more successful performers.

Of note, whilst working with this sample, other research questions were addressed. These, however, do not form part of the work which is covered in this thesis.

Table 6.1

Dichotomy Explanations and Predictions for Chapter 6.

Dichotomy	Explanations		Predictions	
	Absolutist	**Nuanced**	**Absolutist**	**Nuanced**
Pay attention in class	Absolutist views suggest that possessing explicit knowledge of a skill can lead to skill breakdown, and therefore encourage performers to learn implicitly.	Different types of knowledge can support athletes in different performance scenarios, therefore both styles of learning are relevant.	Participants will report no explicit knowledge of skills while learning.	Participants will report using a mix of implicit and explicit knowledge of the skill to learn.
Maybe she's born with it	Individuals enter the development pathway and go on to be successful due to a genetic endowment or natural gift.	Progress along the development pathway is driven by effortful learning behaviours.	Little evidence of deliberate practice, particularly for top end performers. Instead they will rely on natural benefits.	Participants will engage in a wealth of deliberate practice in order to achieve successful performance.
Product of your environment	Learning should occur through the performer's interaction with the environment, thereby identifying affordances resulting in attunement.	A mix of learning tools is essential, which results in an internal representation of the skills acquired.	Performers will report exclusive use of tools such as constraints to immerse in the environment to develop emergent skill.	Performers will report a mix of tools which develop an understanding and internal representation of the acquired skill.
Where's your head at?	Coaches should always direct performers attention externally, as an internal focus will result in skill breakdown.	A mix of internal and external focus can be beneficial and that performers should learn how to switch between the two types of attention.	Skill execution will take place strictly with an external focus, any internal focus will prove detrimental to skill execution.	A mix of both internal and external focus will be reported as appropriate by the participants.

6.2. Method

6.2.1. Participants

One hundred and two performers were approached across 7 skateparks in the UK and New Zealand, who appeared to fit the age criteria (16 years or older) and who were confirmed by a gatekeeper for that site as a regular boarder. Of these, 8 were younger than the target age and 3 declined to participate, resulting in a final group of 91 (82 males, 9 females; M_{age} = 17.3 years, SD =1.1; $M_{years\ training}$ = 4.2 years, SD = 1.8) participants. This 'by eye then check' sampling method resulted in approaches to around 65% of those in the park at the time of visit. In other words, even though the age stipulation prevented me, and the research team, from questioning around a third of the available participants, the sample still generated meaningful results. This perception was confirmed by the gatekeepers as 'external verifiers'.

6.2.2. Instrumentation

As indicated in the introduction, and the literature which underpins this study in Chapter 2, there are clearly a number of quite varied questions which I felt needed addressing with respect to skill acquisition, refinement and practice. As such, I wanted to maximise the impact of the work with this specific group of athletes. Accordingly, I firstly considered major issues which could be addressed effectively within the constraints of the study environment. This led to the development of a first draft instrument which was initially piloted with six riders drawn from two skate parks not involved in the main study. A process of cognitive interviewing followed this pilot and led to three changes that offered greater clarity against issues raised. Within the final list, questions asked were as follows:

1. Consider difficult tricks or sequences you learnt recently or are learning.

    a. How are you learning/did you learn them?

    b. What did you use to help?

    c. What else would have helped you?

d. What do you do if/when you make a mistake?

2. Where have you picked up ideas on how to get better?

3. Who is/are the best performers in this park? (used to identify the 'top-end' performers)

6.2.3. Procedure

As outlined when discussing the participants, a member of the research team originally approached the management of each skate park to seek permission to undertake this research and approach riders. This approach was made in association with a park-specific and previously identified gatekeeper who had been recruited through personal contact. Gatekeepers were uniformly over 21 and experienced riders themselves. Most importantly, they were regular attendees at that particular skate park and were well known to the other athletes at that venue.

Following approval from skate park management, one member of the research team (two researchers collected data across the countries) attended the park with the gatekeeper, approaching individuals together, to invite them to take part. Individuals were only approached if they were recognised by the respective gatekeeper as being regulars at that particular park. A key and early part of this approach was an explanation of our purposes, provision by the researcher of photo identification and an explanation as to how the study would work from an ethics point of view. In brief, and as approved by the University Ethics Committee, participants were guaranteed anonymity. Indeed, the research team deliberately did not record their names but only took age for the purposes of post-hoc analysis.

In this study, we were interested in securing participant's views on the topics addressed in the questions. As such, no post-hoc interpretative analysis was intended. Rather, we focused on accurately recorded and individually confirmed viewpoints. Accordingly, questions were asked by the investigator whenever the participant's statement was unclear or could be misconstrued. Importantly, however, probes were not used to avoid any tendency to leading the participant. This approach resulted in a conversation, with the interviewer reporting back what

had been heard and asking for the participant's confirmation whenever things were not clear. This process received further clarification by the gatekeeper, especially when technical skateboarding terms were used. This process was my best attempt to avoid any issues caused by the lack of member reflections. I did, however, utilise input from independent subject matter experts (SMEs) as well, to endorse the trustworthiness of the data. These approaches are detailed below.

On completion of the interview, the researcher handed each participant an information sheet. This provided written details which had already been explained to the participant, inviting them to reflect on the conditions themselves and, if under 18, check these with their parents or guardians at the earliest opportunity. On this sheet, the lead researcher invited phone or email contact if either participant or parent/guardian did not wish them or their data to be included in the study. Importantly, no such calls were received although I did receive 10 inquiries about the study with interest in the results. Importantly, this information sheet also provided details of the University complaints procedure in case parents/guardians or participants had concerns about the process. Once again, no such calls were received.

6.2.4. Design

To some extent, these data can be considered as inductively analysed because the researchers held no expectations or structures (skateboarding specific knowledge) prior to the investigation. Importantly however, and from a trustworthiness perspective, as stated the researcher always immediately 'repeated back' to each participant an overview summary of what they had heard for clarity, resulting in a few cases (numerically seven) where the participants suggested a change. Furthermore, accuracy of recorded information was confirmed by the relevant gatekeeper who was always present.

With changes to reflect the context and style of this investigation, I was once again influenced by the approaches used in a previous chapter, Chapter 5, which explored DM in

Rugby Union. Once again, and reflecting qualitative innovations by Braun and colleagues (e.g., Braun & Clarke, 2019), raw data codes were compiled in order to identify similar/shared meanings, then hierarchical COCs (Braun et al., 2019) were generated to unite these meaning units. This was a comparatively straightforward process since responses had already been clarified/confirmed by participants. For the first question asked of the participants, COCs are presented together with a percentage respondent score to illustrate how often the COC was mentioned. Reflecting the ideas presented by various qualitative researchers, I did not intend that these percentages are taken as indicators of importance but rather just as indices of commonality. For the remaining two questions, data are presented and explored within the descriptions offered. In all cases, participant quotes are used to expand and clarify the COCs.

6.2.5. Trustworthiness

In addition to the steps outlined above, I again sought to ensure maximal trustworthiness of these data in order to further support my pragmatic philosophy. I was especially aware that researchers are not able to extract themselves from their own experiences, and therefore biases (Denzin, 2017). Accordingly, interactions were almost entirely participant driven, with the investigator completing 'real-time' member reflection by listing back responses to each participant. As stated above, the comparative simplicity and straightforward nature of these responses was a major factor in deciding on this approach.

In contrast to Chapter 5, but still in pursuit of the same epistemological ideals, responses were subject to two 'external' checks. Firstly, a digest of the data was shared with each gatekeeper, asking for their opinions as to the veracity of the data. In short, whether anything that they had heard, or that I reported, sounded odd or out of the ordinary. No such opinions were expressed, with gatekeepers 'endorsing' the results as representative of their own experiences, knowledge and actions in skateboarding.

As a further and final check, the chapter was shared with two experienced international action sport coaches (one from the UK and one from NZ, both with over 15 years' experience as full time coaches) who were asked the same questions; that is, whether anything struck them as surprising or different to their experience, together with their observations of the messages within the data. Although not skateboarding coaches (one was a free skier whilst the other coached snowboarding) both were very in touch with the action sports scene and familiar with skateboarding through their work with their own athletes. Once again, the results were endorsed as presenting a true and accurate picture of the milieu by both SMEs. One of these SMEs, Sean Thompson, the Head Snowboard Coach for New Zealand, offered the following insight:

> Being a lifelong action sports enthusiast, I have dedicated decades of time both learning and coaching board sports such as surfing, skateboarding and snowboarding. My current role as the Olympic Slopestyle and Big Air snowboard coach puts me in the frontline of working closely with an array of athletes in a similar demographic to that studied in this paper. All findings and correspondence from the riders within the paper are what I would expect to be the norm from that age group in that sport.

Both coaches were happy for their names to be reported. The other was Pat Sharples, Head Coach of Snowsports GB.

6.3. Results

Results are presented in three sections, reflecting the major research objectives identified in the introduction, but also the questions asked of the participants. In the first category, a summary table is provided to offer an overview of data in that section, followed by a more detailed breakdown including quotes from participants. All following sections are presented with exemplar quotes.

6.3.1. How They Learnt

Reported learning methods are summarised in Table 6.2, with exemplar quotes from

participants used to offer detail presented under the different subheadings.

Table 6.2

Participants Reported Use of Learning Tools

Central Organising Concept	Reported by	Exemplar quotes
Analogy, feel and internal representations	44 (48%)	To help me get the rhythm I'll often see a picture in my head that makes me feel like I want it to look. For example, lots of the time I'm seeing myself surfing a wave. I might see someone interviewed on [skateboarding website]. He will be talking about something else he's done that helps him get the move right. 'Whipping cream' when riding a bowl is one that's helped me a lot.
Attention	78 (85%)	Lots of time I'll pay attention to what I look like. After all that's a big motivation for being here. Every so often I'll work on what the move feels like. I'll stay inside my head and get the feel before I do it.
Demonstration	80 (88%)	I always take the chance to watch someone perform. I learn so much from it… I look 'specially when the good guys are riding, I'll take a sneaky peek!
Error usage	45 (49%)	I'll watch a run several times. I want to see what I'm doing wrong so I can correct it. I like to talk over mistakes with my mates, I want to see what they think I should do.
Explanation	78 (85%)	I find it really useful to talk things through with other riders. They often highlight things I haven't thought of. I love it when someone agrees to talk me through how they're doing something.
Imagery/Mental Practice	85 (93%)	I'll lie awake in bed running through a trick – what it will feel like and, to be honest, how good I'll look! When I get the chance to watch someone doing a target trick, I'll watch then try and feel how it would be for me. I'll do that loads of times till I think I've got the idea.
Practice	90 (99%)	This is all about practice…repetitions till I look smooth and effortless. My aim in practice is to look consistent and smooth…I want to flow.
Planning and Preparation	80 (88%)	I usually think about what I will do on the way to the park…set myself some challenges or whether I'll just ride depending on how I feel. I take a competition schedule and work out what I need, when I need it.

6.3.1.1. Analogy, Feel and Internal Representations. As later sections will demonstrate, participants used a variety of both explicit and implicit approaches. From an analogy point of view, several examples were apparent. Unsurprisingly perhaps, pictures and thoughts of surfing were particularly common. As expressed by this rider, "I love to ride round a bowl and picture myself cutting up and down a wave", or from this experienced rider: "to keep my balance I will often imagine a piece of string pulling up from the top of my head".

Another finding of interest related to the deep understanding of tricks or sequences which many participants found really important for their learning, such as "I don't only want to know what it looks like or what it feels like when I do it well. I also want to understand how it works from a kick flick upwards". Another more experienced 19-year-old rider explained:

> I guess as the older dude around the park I get a lot of young guys asking my advice. I always want to make suggestions to them that develop their understanding of what they're trying to achieve. I use words, symbols, stories [probing suggested this to be metaphors] or pictures to develop this.

As reemphasised in the later section on imagery, almost all participants made some use of internal representations. Notably, however, these were often driven by a mixture of internal and external constructs. For example: "I really want to know how a sequence will run before I do it. I'll store and practice that usually as a combination… imagining it and what it looked like against the 'list' of moves.", "I run through a list of moves in my head and the rhythm…often I'll get the rhythm of the moves from a favourite piece of music. You mentioned 'Eat, Sleep, Rave, Repeat'. I use it!", or from this 17-year-old: "I've actually set up a run list at home with video cuts for each move. I've been using that to put together an ideal run or sequence…putting things together as I can physically do them."

6.3.1.2. Attention. Although not strictly a learning aid (i.e. it may not be interpreted as a deployable tool), the large volume of research on the overwhelming advantages of an external focus made this a factor of interest in this naturalistic learning environment. There were clearly a number of participants who thought about what they attended to and when. External focus was commonly used and often facilitated by use of video. "I'm worried about what I look like doing the run, how smooth it looks and what impression it's going to make." There were notable situations, however, in which participants reported using an internal focus. "As I'm watching someone do a trick, I'm trying to imagine how that will feel…I watch out then think in." Or this 18-year-old: "I often run through the rhythm and feel of the sequence just before I do it to get me ready."

Interestingly however, there was some evidence for a switching of attention, often in a 'whole-part-whole' approach. For example, "I always find it important to think through the whole run and what it looks like before going inside my head to check the feel of the difficult dismount or bit in the middle." Or this 16-year-old: "what we've been talking about, inside my head or watching myself or focusing on what the thing will look like; I use them all…it depends!" In summary, a mix of external and internal foci were apparent in this sample.

6.3.1.3. Imagery/Mental Practice. Participants reported a range of methods which were used to aid their learning and execution. Use of imagery was very prevalent. Around 90% of participants reported using imagery in some shape or form, although two broad categories were apparent. Firstly, mental run-throughs at home or away from the park venue. Content seemed to include elements of mental rehearsal and 'ideal performance' motivation; sometimes in combination. For example, one participant recalled:

When I first went for a 'Crooked Grind' [a slide along a rail on the front of the board] I fell and broke my nose. After that, I would watch a demo vid on [website], seeing myself do the trick, then feeling how it would be if that were me.

The second category related to imagery at the park, which was reported as both preparatory (mental rehearsal) and as a combination with action observation (see later sections on Demonstrations and Explanations). For example, as this participant reported, "So when I was working on improving my Nollie Flip [jump up as board rotates under you then land] I would watch a vid on my phone, then run through how it would feel. So watch, feel, then do." This combination of mental run-throughs in combination with some form of 'instruction' (either watching video, receiving instruction or watching someone else) was extremely common. Of those who responded to the follow up question on imagery perspective, 8 used internal alone, 14 external alone and 47 both.

6.3.1.4. Demonstrations. Across participants, demonstrations played a big role. Almost all used others as formal (show me how) or informal (covert watching) models. Loss of credibility seemed to be the only block, as explained by this participant: "**** it wouldn't be cool if I was walking round staring at all the other skaters!". Subsequent to watching, either overtly or covertly, participants would try to work out what they would have to do to accomplish what they had seen. In this form, demonstrations were used in a juxtaposed fashion through combinations of imagery and observational learning. Examples from participants include: "I'll pick a star performer and watch how he does a sequence then go and try it myself, trying to reproduce what I saw with what I'll feel", or:

> I'll often ask for advice or if someone minds me hanging with him. Often, I'll approach them and say 'hey that was sick…how do you do that' and they'll usually show me and offer a quick talk through. I find I learnt an awful lot from listening but don't tell my Mum!

6.3.1.5. Error usage. Getting data on the use of this tool was notable in that almost all participants provided lots of information but, almost always, only after probing. Several spoke of

the need to be accepting of errors, such as this from one rider: "You're never gonna be any ****ing good at this if you don't have lots of **** ups" or this,

> you've got to accept that you're going to take more than a few falls…it isn't great in
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> front of your mates but to be honest the hardcore boys in here just accept it and even
>
> encourage you to have another go.

One big feature of the groups' learning strategies described below, was how participants used their peers, together with video feedback, to help them correct errors. For example, "My mates are great. They notice differences or problems, point them out and suggest changes", "If I do a run, especially if I'm trying for something in competition, I rely on my teammates to help me look at the run [critically] and work out where I can make improvements." or finally from another participant:

> I think it's crucial to use your **** ups positively. I want to work out what I've done
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> wrong and how to correct it. To do that, I use as many different inputs as I
>
> can…teammates, video, how it felt, the whole lot.

Error correction and the tools to do it were seen as particularly important for competition, as shown by this participant quote:

> I might be in something at the park where I've got the best of three runs. If land the first
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> one that's great. If I **** up, I need my mates and the video to help me get it right next
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> time.

6.3.1.6. Explanations. Although not strictly explanations, verbal input from other riders was extremely common across our sample, for example something American research has termed vibing (Buterbaugh, 2017), was a common feature. This involved small symbiotic

relationships across riders. These 'mutual interest groupings' (cf. Communities of Practice; Culver & Trudel, 2008) then used video and stills, usually from phone cameras or similar, as the basis for after-action debriefs on what had happened and to identify areas for improvement. As one boarder put it, "yeah, it's really important to get a perspective from my mate on how I've done", or another, "we'll usually work in the evenings, usually on social media especially at the moment, debrief on progress and set some targets for what I need to change".

It was interesting that, in the absence of formally appointed or employed coaches, our participants established surrogate coaches through peer learning and teaching. Even more interesting was the extent to which, although they should be termed informal, the impact of these relationships were so powerful as to give them an almost formal feel. In fact, participants with experience of other sports drew this analogy themselves, for example "I would probably pay as much attention…hey, perhaps even more, to my friends at the skate park as I would to the stuff I get from my football coach". Alternatively this participant highlighted "I've had a lot of coaches in the activities I've done up to now. I have to say that working with my friends is far more effective because they have a real understanding and feel for our mutual activity".

6.3.1.7. Practice. Unsurprisingly, practice was mentioned by almost every participant. Unsurprising because, for many, practising and refining their skills represented the whole joy of the activity in this aesthetically-driven sport. Drilling, repeating moves over and over again, was a major feature. "I have to get my moves straight. I keep going and going 'til I just know I can do that move wherever I am." Or this 16-year-old who seemed to be using a form of overlearning: "I have to have the basics…I have to be able to ollie [a jump up or on to a feature with the board] wherever I am." Interestingly, this desire for skill transfer did mean that participants would try out the same skills in a number of different sites, either within the same park or on trips to others. Importantly however, especially against ideas like repetition without repetition, they would usually get this mastered in one situation before trying it elsewhere.

"When I started, I hammered the stance-push-stop basics at home. Only then did I feel comfortable to go out to the park…to ride in public!"

Participants reported several different features common in other skill acquisition scenarios and also seemed to draw on ideas from other action sports. For example, as previously highlighted, whole-part-whole seemed important for those getting a sequence of moves down. "I'll plan a run across the park then use that as the base for practice. I might do the whole run, then work the rail in the middle, then put it together and then go again." At a higher, session level, athletes were very aware of setting up a theme or target for the day; some in advance but some in a more ad hoc fashion (see the planning section below). Interestingly the idea of push-drill-play recently discussed in free skiing and snowboarding (Collins et al., 2018) seemed to resonate with participants even though they'd never heard of the original idea. "Some days I'll get to the park and it's having it…I'm there on a mission. Other times I'll just go hammer one or two moves. Other times I'm just going to **** about with the guys."

Finally, as a small but distinct subcategory, there were several athletes who just preferred to go on their own. These 'solo performers' seemed to understand the sense in their peers using others, but it was just their personal preference to practice alone. For example, one 18 year old states:

> I've never been one for the crowd, especially when I'm putting new stuff together. Even when I started, however, I'd much rather go away on my own and get things sorted. It was almost like people being around were a distraction…or a challenge to what I was trying to achieve.

6.3.1.8. Programming and Planning. I have already mentioned participants' habits around making decisions on what they would do at each visit. Clearly, and in the absence of any formal designated coach, no written structures were apparent. Interestingly, however, athletes

themselves imposed structures mostly at micro or session level, as well as a meso (monthly) and macro (yearly) level. From a micro perspective I would reiterate that, with certain exceptions, riders would usually arrive at the park with a predetermined plan; albeit that this might have been arranged on the bus journey to the park. One participant stated "I don't just like to turn up. Course it ain't like school but I want to know what I'm gonna get from being there, what I'm gonna do, even who I'm going to meet."

At the meso level, many participants used both vibing and prior discussion to develop at least plans of intent; an outline of what they wanted to achieve over the next few weeks. "I watch a lot of video and visit a lot of skateboarding websites and that gets me interested. It gets my juices flowing about what I want to try and achieve next." Or this 16-year-old: "I watch videos and websites but that's the sort of an external pressure of course. I also want to keep up with the leaders at [name of park]."

Macro level planning seemed to be apparent only in those with a regular competition schedule or the view of getting involved in competing. "I know what comps I'm going for…it determines where I am when and what I'm doing." Or this 18-year-old:

I've really got into competing at skateboarding. I'd say that has taken over as my main motivation. I want to do well…I want to establish a reputation for myself and start getting some of my videos on Instagram or YouTube. I can see a genuine career in this.

6.3.2. Where They Learnt about Learning

Many other action sports already have a culture of formal coaching, albeit that the coaches in that sport have usually received a training in another, more traditional sport, then transferred these skills into the new activity, supplementing it with books and internet-based knowledge. As stated earlier, my interest in this particular participant group was the almost complete absence of formally appointed or explicitly recognised coaches. As the sections above

demonstrate, however, there was clearly coaching going on and this process was both acknowledged and valued by our participants. Once I had explored early responses on how to get better, which initially were mostly related to technical aspects, I then managed to get to the heart of why participants were practising in the way they were and where this might have come from.

Perhaps unsurprisingly, there were lots of responses which fell into the tacit category. For example, this 16-year-old: "It felt comfortable watching and copying…I feel like I have done that my whole life". For these sorts of responses, participants seemed unaware of where the techniques had come from or unable to offer any rationale as to their use. Answers of the 'it just does, so I use it' category were the most common with 58 participants (64%) responding in this way.

In addition to these, however, there were number of perhaps more thoughtful participants who offered a greater depth of response. For many of those participants, ideas and approaches were transferred from their experiences of skill learning and practice in other environments. For example: "I guess I just think about the way we do it at school. It makes sense so I use it in the park." Or from this 16-year-old: "I used to go to both gymnastics and judo clubs and I guess how I practice here has been quite influenced by the stuff we did there." We obtained similar responses from 17 participants (19%).

Other participants reported gleaning techniques from websites, mostly in skateboarding but also notably in other similar action sports. "I've watched several vids on [skateboarding site] which have interviewed top riders. They all talked about imagery or visualisation as a technique. I tried it and it works." Or from a 16-year-old: "I've seen even the stars trying and failing a number of times, looks like they go away and hammer the practice, if it's good for them it'll work for me." Websites were mentioned by 16 from this sample (17%).

Finally, a small number of participants had actually sought out help from books, social media and websites specifically on the pedagogic principles. "I got this book for Christmas that

talked about coaching and pretty much that became my Bible." Or "I get great ideas from social media sites and blogs on coaching…I try them and if they work, I add them to the mix". This more 'academic' approach was apparent in 12 of this sample (13%). As should be clear from the totals, some responded in more than one category.

6.3.3 Top-enders

Finally, I was able to interview nine individuals of the 11 top-enders identified. Results were extremely similar to the other participants, with one or two notable exceptions. Firstly, 100% were keen and consistent consumers of external sources (social and other media) on skateboarding. "I need to look at the sites at least twice a week to stay up to speed…it's where I get my edge", "I want to see what others are doing – the ideas help me to improve and also direct my practice".

As a second difference, top-enders seemed almost 'error seeking' in their exploration of new alternatives. "If I can do it this way then why can't I do it that way…if someone else is doing it like this then why can't I do it like that." or "I'm always looking to do the new and peculiar especially when it comes to putting moves together."

Finally, these performers seemed a lot more self-driven and experimental in their activity. For example, "I tend to set myself some clear targets, but these are based on what I want to achieve… it's all about me!", "When I come to the park, I tend to play with purpose…to just **** around to see what I can come up with." Or this 21 year old (one of the elder statesmen) "Things have changed as I've got older; I used to watch the others all the time; picking out a guy or a trick that I wanted to copy; but not now".

6.4. Discussion

6.4.1. Contextual Discussion

It is important to acknowledge the patterns of learning behaviour in this 'uncoached' environment and see where they match or deviate from current wisdom. For example, how

participants saw positives in the integrated use of both explicit *and* analogy type images to facilitate their learning and performance (cf. Chatzopoulos et al., 2020). As another, the use of an internal 'what should it feel like' focus to learn from others. The use of the internal focus seems to contradict recent doctrine by Wulf and others (e.g., Wulf, 2013) that an external focus is the only way. An important qualifier is seen in the work of Sakurada and colleagues (2015) which relates advantage from the use of internal or external focus to imagery skill. Clearly this study did not take any measures from participants. However, it might be that, since the vast majority were primarily motivated by what they could do, a kinaesthetic imagery/internal focus was the socially encouraged mode.

The almost ubiquitous use of drilling, many repetitions of the same skills (repetition without repetition but with the intention of *with* repetition to groove?), seem to support a more traditional learning perspective. Of course, I acknowledge that movements involve a lot of variability, and I am sure that the various tricks being practiced here were no different. In short, there was clearly some 'repetition without repetition' (Bernstein, 1967) although this was never expressed as a particular consideration by any participant. As far as they were concerned, 'consistent and effortless looking tricks' were the main aim. This element notwithstanding, however, participant behaviour does seem to contradict the Dynamical Systems ideas which are increasingly common, such as differential learning (e.g., Savelsbergh et al., 2010).

Participants' use of imagery offers another interesting lock to the literature. The common use of watch then image as a method is very similar to ideas suggested by Smith et al. (1997) and recently examined empirically by Romano-Smith et al. (2019). The combined use of alternated observation and imagery was commonly reported as offering a means to 'internalise' what was being watched (cf. Fournier et al., 2008; Hall et al., 1998). I did not probe on the modality mix of this, feeling that the explanation of constructs would have been too leading.

Notably, however, observation of several participants (watch – look away – watch – repeat) was highly suggestive of the external visual *then* internal kinaesthetic suggested by Smith et al.

Personal preferences for practice, for example collaborative versus solo, also find similarities in the literature. As suggested by Nokes-Malach et al. (2015), self-identified solo learners seemed to suggest that others 'got in the way' or made them 'feel too busy'! Once again, this finding supports the need to fine tune practice to optimally fit with individual needs. Across the whole sample, there is sufficient variety to negate black and white, absolutist stances and support a nuanced perspective.

With regards to where these learning strategies came from, perhaps unsurprisingly, prior experiences in other physical pursuits were the major source of ideas for learning strategy. As with more controlled studies in similar motor tasks (e.g., learning dance sequences; Bläsing et al., 2018), participants felt most comfortable with observation of demonstrations, but in this case clearly much less formally. Of interest is the extent to which participants continued to avail themselves of demonstration-based information, even after the original learning stages had taken place. Also of interest was the ongoing solicitation of verbal input, especially from peers, although it would be hard to discriminate this from the social context data obtained from question one.

Additionally, it is worth considering the similarities and differences apparent in the top-end learners. It would be wrong to define these individuals as experts. We applied no performance criteria and their 'appointment' to this status was clearly context specific and based on group perception. That said, there were several differences in the practice behaviours of these individuals which, whether causative of or associated with their status, seem worthy of note. The interplay of DP/drilling and more exploratory, almost error-seeking behaviours was seen as the way in which these individuals could maintain or further their status (cf. Carson & Collins, 2020). Original ideas were usually sourced from other environments whilst only a few were

genuinely creative in focus. Data are similar in this regard to work by Shimizu and Okada (2018) in breakdancing, another action sport which is showing signs of movement to the mainstream. Notably, however, participants at all levels, and particularly in these local leaders, were committed 'students' of their sport. In short, both physical and mental drive were important. In this regard, it is worth considering the further comments offered by one of the SMEs. Thompson expressed:

> The language used in responses from the skateboarders was of interest to me, phrases such as 'I want to understand' and 'I really want to know'. This got me thinking about curiosity and the role it plays within the learning process. In particular, how curiosity can drive progression and therefore the risks of coaching not nurturing ones natural level of curiosity.

It seems clear that Thompson, an experienced coach in a pursuit not dissimilar from skateboarding, expresses the importance of understanding as part of the skill acquisition and developmental process. He went on to explain that a key feature of this understanding exists due to the nature of the physical pursuit.

> I see this on a daily basis working with my current athletes. The more curious an athlete is about an area of performance the more they are willing to delve into it to seek performance gains. This becomes even more apparent when the level of risk is high, especially in progressive sports like skateboarding and snowboarding. Once the curiosity is there, the 'whatever it takes' mindset kicks in and the reward of landing a new trick out values the risk of injury. (S Thompson, personal communication, 28th November 2020).

As a final point, I should clarify the 'level' of commitment, in case a reader was to consider the findings of this chapter, due to its focus on, exclusively applicable to participation or recreation athletes, as opposed to performance. Instead, the investment level of the participants demonstrate their commitment to be that of performance athletes, or at least performance development athletes who typically work at this age within academies. Seasonal variations of weather notwithstanding, participants reported an average of 3.1 visits to the park a week (SD = 1.2), each lasting an average of 78 minutes (SD = 18). It seems that these participants were very committed, even in the absence of coaches or other adult supervision; a finding which should be noted by those who question the 'younger generation' and their willingness to adhere to activities. Indeed, whilst it has been reported that 'Generation Z' (Gen Z; those born since the year 2000) are less invested in sport and physical activity (Biber et al., 2013; Smith et al., 2005), the present findings would suggest this generation might have been somewhat misrepresented. Notably, much of the existing research draws this conclusion from the increase in obesity that has been seen within Gen Z (Ogden et al., 2010). However, it seems clear that Gen Z participants have the ability to invest in their pursuit in abundance. Perhaps it is coaches and physical educators that need to consider re-evaluating their approach?

6.4.2. Dichotomous Discussion

Four dichotomies were explored in this chapter, in an effort to see if these findings support either the absolutist or the nuanced approach. A key focus of this research was the learning process in an informal environment. Participants discussed, in no uncertain terms, the importance of *understanding* in the development of moves. Indeed, their suggestions are in direct contrast to the assumption of reinvestment theory (Masters & Maxwell, 2008), as the participants used tools such as explanation from peers and consideration of errors to better understand the moves they were striving for. Indeed, this was a key feature of the top-enders who were proactively searching for these errors to better understand their skill execution.

These findings linked closely with another dichotomy discussed, 'product of your environment'. A consistent feature of the results of this study supported the existence of an internal, or mental, representation. The use of imagery and visual rehearsal was discussed in detail (Tong, 2013), as well as participants using kinesthetic feel. Of particular note, however, is the use of demonstration. Current findings have proved equivocal when determining where demonstration is an effective tool for skill acquisition (Williams & Hodges, 2005). Importantly, however, these findings support the contention that the performers' learner history impacts the effectiveness of this technique and that, therefore, tools of this nature should be employed adaptably and as appropriate (Hodges & Franks, 2002).

Expanding beyond the learning concepts, the study explored performance and skill refinement as well, exploring the optimal focus of attention. Of note, in this research both an internal and external focus of attention proved beneficial at different times. A number of the learning tools deployed by the performers were representative of contrast drills, which would aim to understand the movement and then internalise it (Carson & Collins, 2011). For example the use of errors. Within the 'attention' learning tool it was clear that the performers aimed to sometimes focus on the skill production (i.e. what the movement looked like), and then switch internally (i.e., what the movement felt like). Interestingly, several ideas shared by the participants matches work currently being undertaken with international free skiers and snowboarders, using a template run of 'stuck together' tricks which is gradually replaced by sequences of two or more of the tricks as the athlete achieves them physically (Collins et al., 2018).

Finally, the age-old debate of nature versus nurture. This dichotomy was addressed in a number of ways throughout this chapter. Clearly, as addressed above, the number of learning tools employed certainly fit within the definitions of DP (Ericsson et al., 2003). Particularly pertinent was the process through which the participants learnt about how to learn. Participants

were proactively seeking sources of information, from their own discipline and others, as well as transferring skills from other relevant outlets. These effortful learning behaviours demonstrate the commitment required for success, thereby refuting the suggestion that talent could be gifted or born.

In summary, it appears that the clarity of the findings align more with the nuanced approach predictions. Accordingly, Table 6.3 suggests the strength of these findings using a purple line to act as a guiding visual representation.

Table 6.3

Dichotomy Predictions for Chapter 6 and Visual Representation of Strength of Findings

Dichotomy	Absolutist Predictions	Nuanced Predictions
Pay attention in class	Participants will report no explicit knowledge of skills while learning.	Participants will report using a mix of implicit and explicit knowledge of the skill to learn.
Maybe she's born with it	Little evidence of deliberate practice, particularly for top end performers. Instead they will rely on natural benefits.	Participants will engage in a wealth of deliberate practice in order to achieve successful performance.
Product of your environment	Performers will report exclusive use of tools such as constraints to immerse in environment to develop emergent skill.	Performers will report a mix of tools which develop an understanding and internal representation of the acquired skill.
Where's your head at?	Skill execution will take place strictly with an external focus, any internal focus will prove detrimental to skill execution.	A mix of both internal and external focus will be reported as appropriate by the participants.

6.6. Summary and Implications

This study was designed as an open look at a modern youth phenomenon; namely, unstructured and non-directed play in an informally/socially judged activity. The main purpose was to see how young people learnt skills in an activity when it was 'coach-free'. These findings offer an important perspective on a number of current debates in the literature. There are clearly lots of different and often contrasting ideas out there, however perhaps the clearest idea to emerge is the necessity for coach DM to be contextually driven and focused on both the needs and preferences of the learners (cf. Vinson & Parker, 2019). There are some interesting findings in terms of the choices about and applications of different learning strategies in this group of coach-free athletes. In this environment, participants predominantly make use of traditional or cognitively based learning systems, supporting a nuanced approach. However, of course, some other sources might suggest this as representative of a constraints-led approach (e.g., FTN, 2020). My position is clear, but I leave it to the reader to take a dispassionate and open view on the data set provided. Moving forward, applied practitioners must consider the individual needs of the athlete when making recommendations for learning, performance and refinement.

This chapter marks the end of my empirical investigations that I believe have addressed a range of important and practically meaningful topics. In doing so, I wanted to provide insights towards the challenges and potential solutions faced by practitioners, without the constraints of theory being my primary driver for how I structured these studies – hence my 'practice through theory' approach. In the next and final chapter, I offer a summary of the findings in an attempt to understand which dichotomous positions appear to be better supported, with some implications of these findings, addressing both the research and applied contexts. Following this, the work is reviewed critically through the exploration of strengths and limitations, and finally some future directions for research are suggested.

Chapter 7. Get off the fence: Conclusions, limitations and recommendations for future study

7.1. Summary of the Findings

The overall aim of this thesis was to explore the evidence for and against a number of dichotomous perspectives in an attempt to better understand which position, absolutist or nuanced, is better supported through literature-based and empirical research. The contribution of the work was both specific and general in nature. In general terms the findings presented here demonstrate a need for a change in practice, both in applied work in order to more effectively support high-level performers, and in research, highlighting the need for a sharpening of research design in order for it be truly translational. Specifically, however, this work explored a number of real world issues, and their related dichotomies, each of which offer a contribution to our understanding of this ever-evolving discipline.

In Chapter 1, I introduced the concept of dichotomous positions, contrasting absolutist and nuanced stances. Of course, the applied implications of such contrasting positions for practitioners in an applied context is particularly problematic. At best, this results in practitioners being forced to sift through a significant amount of literature to better understand the underpinning biases of information before identifying how and when to deploy a reasoned synthesis of findings. Whereas at worst, a practitioner without the time or ability to identify these dichotomies can end up utilising the tools or approaches from one position thereby disregarding alternative, possibly superior, options. Indeed, given that so many of us are drawn to simplicity (cf. Berlin, 1953 on hedgehogs and foxes), taking the time to chase down a more exact stance would be rare. In Table 2.1 these positions, with appropriate implications, were highlighted and, building from that, I began to explore these dichotomies through a number of practical investigations. In each of these studies I have attempted to seek the level of support for either the absolutist or nuanced approach. This support was displayed as a crude pictorial

representation using a different coloured line. In Table 7.1 each line is presented in the appropriate colour, with an average offered where one dichotomy was addressed in multiple chapters. These findings by no means offer proof! But then neither do hypothesis testing studies, many of which lack the subtlety and rigour of design which could address the issues which are highlighted by these contrary positions. In short, I feel that my data are at least as valid as those offered by many of the studies critiqued and questioned in Chapter 2. I hope my findings are seen as positive contributions to the applied perspective I espouse!

These qualifications notwithstanding, throughout the empirical chapters of this thesis a consistent pattern emerged, which is reflected in Table 7.1. Barely anything in this world is black and white, as was demonstrated by each empirical chapter, none of which demonstrated exclusive support for the absolutist view. Within Chapter 3 the findings suggest that, whilst there are a number of factors that can create a successful athlete, these are developed through effort and learning (and, in Motorsport, a deep pocket!) more than birth and genetics alone. Indeed, a flexible, adaptable and even nuanced approach is essential in order to keep up with the ever-changing demands of the sport. As such, and as another example of the nuanced findings of this work, an ability to switch between internal and external focus or conscious and unconscious execution is a real necessity. Of course, as these findings demonstrated, the absolutist view cannot, and should not, be out-right rejected. For example, in some scenarios an internal focus is clearly appropriate. Or perhaps explicit knowledge of a skill may be debilitative. This is not *always* the case, however, and the implications of these stances may not always be the best answer. Therefore, contentions from researchers such as Wulf and colleagues (2001; 2003; 2013; 2015) and Masters and Maxwell (2008) may be partially correct. But not always, and the circumstances under which their clear guidelines may not apply are crucial if the findings are to be accepted in the way they are presented, as translational research.

This point is demonstrated strongly by the findings in Chapter 4 in which the participants were shown to have a switch of foci from attention (external) to intention (internal) in order to avoid possible negative impacts on performance. Indeed, it was shown that some traditional (and absolutist approaches, although the two are by no means mutually inclusive) can lead to performance decrement as well. Moreover, these findings suggested successful, and therefore optimal, performances can occur under a variety of conditions or mindsets. Again, there is a need to reiterate that these findings do not falsify the work outlined in the absolutist positions, although perhaps they do falsify the researcher's original interpretation. Instead, it is clear that performance is far more complex than outlined, and practitioners must remain cognisant of this.

Next, Chapter 5 explored the complex skill of DM. The findings in this case were rather firmly in the nuanced camp across all dichotomies explored. Participants were unanimous in their belief of the need to develop and learn skill such as DM, highlighting that explaining their processes explicitly to others actually supported their own development of the skill. Moreover, there was a clear role for cognition in this process indicating a far more nuanced understanding towards attention and automaticity than previous research might have presented. In this case, the conclusions drawn do seem, at face value, to disagree with some of the contentions outlined in the absolutist positions such as EcoD (Davids et al., 2012). Within the chapter, however, I did highlight that features of EcoD, such as perception-action coupling, could explain a component of skill execution, but not all. Therefore, once again, concepts that sit within the absolutist view make valid contributions to our understanding, but should not be considered or deployed in an absolutist manner.

Finally, the findings from Chapter 6 further supported those from the preceding chapters. Participants reported a multitude of DP learning behaviours with a preference to embed and store knowledge of their skills. Notably, this occurs in the apparent absence of formal coaching and therefore may perhaps more accurately reflect the preferences of athletes in other settings.

Furthermore, the participants expressed a clear need for feedback (verbal and non-verbal), understanding of errors and demonstration, among other tools, in order to continue to develop their performances. Notably, and similar to the previous findings outlined, participants spoke of a need to switch their focus, perhaps from an external to an internal view, again highlighting that whilst theories and literatures explored within the absolutist view are valuable, they are not always the best tools.

All of these findings certainly suggested that there is no 'one size fits all approach' to athlete development, coaching and the pursuit of excellence. Instead, I am certainly convinced that taking a nuanced approach, incorporating tools outlined in both the absolutist and nuanced positions, to support our athletes is wholly appropriate, and indeed necessary, in order to achieve sought after consistent optimal performances.

Notably, the dichotomies explored were separated into three categories, reflecting the context to which they replied. The findings of this thesis, and conclusions drawn, indicate that:

i.   Within a learning context, there is a need to consider a breadth of tools which foster a sense of adaptability for the learner, thereby equipping them to use their focus and cognition in a scalable manner. Of course, there may be some elements of skill which appear to be more naturally occurring. Importantly, however, more often effortful learning behaviours are responsible for long-term success. Additionally, this must be considered when supporting skill acquisition, as skills are acquired not exclusively from a performer-environment link but also through cognitive processes which appear to be stored internally, likely through internal representations.

ii. Across learning, performance and refinement contexts, similarly to the exclusive learning context, the role of cognition cannot be ignored. When engaging in complex skill execution, cognition is ever present, but likely bespoke to the context (i.e., it may narrow). It would appear that lower-level skill execution can then be explained by the

reciprocal relationship between a performer and their environment. Therefore practitioners should consider coaching and embedding these skills through a number of approaches. Of course, this informs use of mixed foci in learning and performance, as this research indicates both internal and external foci can be appropriate and effective.

iii. Finally, when operating exclusively in the performance context, the conclusions drawn from this research suggest that optimal performance can occur under a variety of execution states, both conscious and unconscious, and that some skills with more or less automatic activation. As such, again, practitioners and their performers should avoid striving for elusive performance states, and unconscious, fully automated executions. Instead, they should work collaboratively to prepare athletes to perform in a variety of performance states, considering the strategies most effective to optimise the most common states, which notably, is not flow. Metacognitions are likely to be a key part of this training, as the athlete must be capable of regulating their thoughts and proficiently deploying cognitive strategies to bring about the outcomes they desire.

Table 7.1

Summary of Pictorial Representation of Findings.

	Dichotomy	Absolutist Implications	Nuanced Implications
Learning	Pay attention in class	Explicit knowledge of how a skill is performed leads the athlete to 'fall back on' this when under pressure, to the decrement of performance	Different types of knowledge facilitate performance, enabling athletes to adapt using various control strategies in pressure conditions
	Maybe she's born with it	Certain individuals will enter the development pathway with inherent advantages, which they will maintain through the pathway	Progress on the pathway will be related to 'effortful learning behaviours', independent of, or at least extraneous to, inbuilt advantage
	Product of your environment	Skills are acquired as a result of the performer-environment interaction, and can only be learnt through the manipulation of that environment.	Skills are acquired as a result of the performer-environment, as well as additional cognitive process. As a result, elements of the skill are retained as internal representation.
Learning, Performance and Refinement	Where's your head at?	Whether working with an athlete to learn a new skill or perform a skill that they have already learnt, the psychological strategy remains the same. Coaches should always direct the performer's attention externally; that is, away from bodily mechanics and towards the action effect	A blend of approaches are required, a nuanced differential will emerge, with both learning and performance outcomes reflecting mixed benefits.

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	Dichotomy	Absolutist Implications	Nuanced Implications
	Context is key	All information athletes use is directly perceived, and decision making is emergent.	What a performer brings to a situation impacts on how they see their environment and interact with it. Therefore both the environment and internal lens (representation) need to be considered.
Performance	To think or not to think	'Peak' performances will be associated with subconscious executions. Therefore to achieve the best possible outcome coaches should work with athletes to remove conscious control over their movements.	Optimal performances will occur under conscious *and* subconscious executional states. Therefore, coaches should work with athletes to think themselves into and maintain different functional performance modes. Part of this process will be to identify for each athlete what conscious motor processing strategies are most effective.
	Just do it	Skills are best developed to be automatically executed with little variance	Different elements of the skill will be more or less automatic, so more or less consistent

Note: Each coloured line denotes the strength of support for each chapter: Chapter 3 = Green, Chapter 4 = Red, Chapter 5 = Blue, Chapter 6 =

Purple and average = Black.

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7.2. Implications for Future Research and Practice

Each chapter explored a real world problem I, and my peers, have experienced previously, which served as the contextual laboratory against which I could evaluate the dichotomies presented. Within each chapter, relevant implications from the findings were presented. Reflecting these findings and the resultant implication, I could leave the thesis on those two crucial words; it depends. However, this would almost be too absolutist of me! Instead, I must consider the broader implications of this work, because not only do practitioners need to consider the it depends nature of performance and development, they must also consider what it might depend on. As such, as clear implication of this work is a call for refinement in best practice research processes in order to ensure that the work produced is truly translational.

With regards to the research exploring when it depends and therefore what it depends on, a clear implication is the need to look for shades of grey, as opposed to the studies which set out with the implicit (or explicit!) aim to prove an absolutist view. For example, there is a need for studies to vary their research context by using a continua of independent variables against the dependent ones (cf. Goginsky & Collins, 1996). For instance, if the dependant variable was performance under external or internal focus of attention then this is one continuum. As such, researchers need to systematically vary the participants' attention *across* internal and external, as opposed to internal *or* external focus. The latter either/or approach will always produce an absolutist position, whereas the former encourages a more comprehensive overview of the possible variables impacting performance. Indeed, researchers could go further. Instead of one continuum, research could explore both internal versus external attention *and* expert versus novice performers. One thing is certainly clear, to seek an accurately absolutist answer, we need an appropriately nuanced design. Something which is considered in section 7.4, future directions for research.

For practitioners, the implications are a little more complex. Of course, the changes suggested for research need to occur, as this would offer practitioners a more coherent appreciation of the nuances within practice. However, the findings of this thesis have hopefully gone some way to bridging this gap in knowledge. Therefore, as practitioners, we must be acutely aware of the idiosyncratic nature of both performances and performers (cf. Robazza et al., 2016). This would impact typical consultancy in a number of ways. For example, during a needs analysis, practitioners should continue to be aware of their own bias or preference to offer answers to the presenting problems (cf. Collins & Richards, 2021). Feeding into case conceptualisation, practitioners should consider what they would like to measure in order to make sure they are offering the optimum blend for the individual client. A tool to suit both of these implications lies within the PJDM framework (Martindale & Collins, 2005) which encourages a concept of nested thinking (Abraham & Collins, 2011) and contingency planning (known as the Big 5, in which back-up interventions are considered in case the original case conceptualisation, and therefore implemented tool or support, is incorrect; Collins & Collins, 2020). Most importantly, however, PJDM encourages and facilitates reflection *in* action and on-action/in-context. This process encourages a practitioner to be consistently reviewing and reflecting upon their suggested course of action, thereby equipping practitioners to see beyond their preference for a particular teaching tool, attentional focus or performance mindset and instead support the athlete to identify the appropriate, nuanced approach to success. Indeed, one such way practitioners might move their practice in the right direction is to put the performer, or learner, at the centre of the process (as opposed to allowing them to be just a corner of the theoretical approach).

Finally, an implication of the findings presented here focusses on how practitioners disseminate and digest their knowledge. As highlighted in Chapter 1, social media, blogs and podcasts are a big sources of information for practitioners. For this reason, academics are

keen to share their research on these platforms. Indeed, this is not just a case of self-promotion and the promotion of our ideas. In recent years, journals have started requesting academics to include their social media handles, a short sharable summary of the work and, in some cases, even a promotional video. Unfortunately, due to the limitations of these platforms, nuanced perspectives are not particularly well received due to their complexity. Resultantly, absolutism is often favoured as I would suggest it lends itself to simplification. The findings I have presented here, therefore, would certainly demonstrate a need for a change in practice.

Whilst peer-review for social media would surely defeat the purpose of quick and accessible nature of the platforms, a personal peer-review process for those publishing information could avoid the distribution of easily misinterpreted ideas (cf. Stoszkowski et al., 2020). However, we must remember this is a universal issue in which all must play their part. Indeed, Popper stated that "I see our scientific theories as human inventions—nets designed by us to catch the world" (1988, p. 42). As such, if we as human beings are fallible, therefore too must be the theories that we create. Whilst a number of theorists have argued against this point (see Andersson, 1984) I believe that some Popperian thinking could hold us in good stead when sharing ideas. A consideration of our own fallibility, and therefore the inevitable fallibility of our ideas, could steer us as a community away from absolutist statements, and claims of absolutist answers. Certainly, such a conditional stance should be a characteristic of any responsible scientist (cf. Feynman, 1988)!

Of course, changes should be the responsibilities of the consumers, not just the creators of the knowledge. In line with recommendations from Stoszkowski et al. (2020), there are a number of tools or rules that practitioners could consider when digesting knowledge. For example, being willing to follow accounts and digest information which may sit in contrast to our absolutist opinions, where possible seek the truthfulness in the

information presented, or consider the it dependness of the information presented. In this vain, a consumer can consider: when would this information be applicable, who for and how?

7.3. Strengths and Limitations

Throughout this work a pragmatic approach was deployed. Consequently, for each empirical chapter, the most appropriate research methodology was selected in order to answer the objectives outlined, a clear strength of the research considering the translational agenda, thereby further supporting the use of mixed-methods throughout the work. Of note, Morgan (2014) claimed that the benefit of a pragmatic approach is often considered to be exclusively practical, promoting the use of a mixed-methods design. However, a further benefit is the philosophical strengths, which support the use of experience and inquiry in social research. Indeed, the use of thematic analysis in two of the chapters (Chapter 5 and 6) allowed for a deep exploration of participant narratives (Smith et al., 2009), which was essential when considering the nature of the individual chapter objectives. In this thesis, both the researcher's and the participant's experience were utilised, acting as co-collaborators in the analysis process. Based on Dewey's original assertions of pragmatism, there is no 'fixed reality' and therefore we must consider the individual realities of those around us (Hickman, 2007).

Indeed, related to this is the breadth and level of the experience participants contributed to this research. Each study explored a different sport, which enabled a holistic overview of the contentions considered in this piece. For example, a consideration of the learning process and performance conditions came from team and individual sports, open and closed skills, novice and expert performers, and players and coaches. This sense of triangulation offered a clear depth to the research findings and the eventual conclusions drawn, as well as improved generalisability of the findings.

Furthermore, in every empirical chapter of this work, the participants included were all high-level performers in their individual pursuits. For example, elite drivers in Chapter 3, average of 4-handicap Golfers in Chapter 4, international Rugby Union players in Chapter 5 and 'top-enders' in Chapter 6. Dewey, when realising pragmatism, explored the role of *a priori* in inquiry, or specifically *operational a priori* whereby individuals create their own laws of inference. Dewey states that these laws are successful when "operative in a manner that tends in the long run, or in continuity of inquiry, to yield results that are either confirmed in further inquiry or that are corrected by use of the same procedures" (cited in Hickman, 2007, p. 212). Based on this, it can be concluded that the level of experience brought from these participants to the research has resulted in successful laws of inference, and therefore effective operational a priori. As such, the insights offered by the participants have been accrued in relation to their subject expertise and can be seen as strong, clear and applicable representation of their personal truths.

Of course, this research was not without its limitations. Having used a breadth of research methods in order to explore these topics, each of these methodologies could impact the validity of the research. For example, a review of peer-reviewed and grey literature took place in Chapter 3. I would stress that this was not presented as a systematic review, and therefore did not follow PRISMA (Moher et al., 2009) guidelines. However, there is of course a possibility that some articles, or key texts, could have been omitted even when using this methodology for my specific purpose.

In Chapter 4, I highlighted the considerations needed when collecting EEG data, many of which were mitigated at the point of collection. However, any data representing possible artifact (Croft & Barry, 2002) were rejected prior to analysis. At this point, $2 \times 2 \times 2 \times 3$ ANOVAs were conducted. Although omnibus tests were used to control Experiment wise Type I error, some research would suggest that the unequal sample sizes (occurring as a result

of the rejected artifact data) could compromise the robustness of the equal variance assumption.

Chapter 5 and 6 drew on qualitative methodologies. Thematic analyses were deployed in both cases, the trustworthiness of which is considered in Section 5.2.5. However, more generally speaking, there are some other considerations needed when deploying qualitative methods. For example, in Chapter 5 participants were asked to consider their in-game processes which could be subjected to recall biases, or a decay of memory. Additionally, some might consider nine participants to be a small size. However, a small sample size is not considered a limitation in research which engages in deep inquiry or examination of a particular event or phenomenon. Finally, there is a concern over the lack of rapport built between research and participant in both Chapter 5 and 6, as the participants had not met the researcher prior to interview (and data for Chapter 5 was collected over video call). Of course, this could equally be a strength of the research due to the possible social desirability bias which would be present had a pre-established relationship between participants and the researcher existed (Grimm, 2010). Notably, I would suggest that the experience level of the participants, and the inclusion of either coaches within the participant sample or SMEs as informal reviewers, mitigated the possible limitations of qualitative research.

7.4. Future Directions for Research

As stated, I would never be so bold at to suggest that I could prove either the absolutist or nuanced approach for each dichotomy in this thesis. As such, there are a great number of possible future directions for research in order to offer further insight to the unanswered questions. One implication of this thesis, highlighted in Section 7.2, was the need to adjust research design in order to obtain more coherent and comprehensive findings, especially as fits with applied environments, in order to produce more translational research. When commencing this project I set out with the intention to be as neutral, and unbiased, as

possible when reviewing the underpinning literature of the dichotomies. However, as my findings continued to show support for the nuanced view, it was evident that a consideration of the supporting research for absolutist views was needed. It has become clear that there are a number of specific issues that need consideration, these lie within the categories under which the dichotomies were placed. However, a number of general, or common, issues seemed to appear in a number of key studies underpinning the absolutist view.

For example, if one were to review the underpinning work for CAH by Wulf and colleagues (1998) they might identify a number of problems within the research design. For example, participants were given either internal focus instructions or external focus instructions. Moreover, participants' previous experiences of skill acquisition and instruction is not considered. Therefore, by limiting participants to one condition, individual differences were neither considered nor accounted for. An additional methodological flaw of this research was the control protocols. Whilst there was a control group, there was no evidence of how this group was indeed controlled. The lack of a quality control group compromises the significance of the research findings, as the intervention is not being compared in a rigorous way. Notably the control group could, and likely was, deploying an internal or external (or perhaps both!) focus, and therefore was not an appropriate comparison for the intervention group. Finally, one could criticise the relevance or quality of the learning tasks, one of which was a balance task. As has been explored through this work thus far, it is common of researchers to select more simple tasks, ones which do not reflect the complexities of sport performance (especially under unfamiliar or pressured conditions), when attempting to understand the impact of a particular intervention. Therefore, the true impact, or indeed, limits of their intervention, or theoretical approach, are not coherently explored (leaving their findings lacking in value in applied scenarios). In spite of these limitations, the lead author of this work remains steadfast in their absolutist views following the findings of such research.

Such concerns have been expressed by a number of authors. Such as criticisms of the

work on priming (e.g. Winter & Collins, 2013) or implicit learning (e.g. Bobrownicki et al.,

2020). Interestingly, these and other papers make a consistent set of comments surrounding

some key tenets of research design. Consequently, in practical terms, it is clear that, as stated,

research design should be reviewed if we wish to obtain a more holistic, accurate and

translational understanding. These changes include the need for researchers to begin to

consider the nature, or complexity, of the learning tasks set, the individual differences of the

participants they recruit and the quality (or veracity) of the control groups utilised, among

other things. In essence, the representative design of the research. Reflecting this, I have

considered the three categories which the dichotomies sat within, offering potential research

designs which I anticipate would facilitate exploration of the nuances highlighted in this

thesis, and therefore prevent unnecessary or unfalsified absolutist views in the future.

Notably, these recommendations address both the general issues highlighted already, as well

as the specific problems arising for each category.

7.4.1. Learning

'Pay attention in class', 'maybe she's born with it' and 'product of your environment'

were the dichotomies which sat within the learning category. Whilst there were different

contexts, and sometimes theoretical lenses, explored within each of the dichotomies, the

absolutist and nuanced approaches in the learning category can be summarised. Simply put,

whilst the nuanced approach would suggest learning, and therefore by extension skill

acquisition, is an effortful, cognitive process, the absolutist approach seems to suggest that

leaning and skill acquisition 'happens to' a performer. Therefore, as with any study on

learning and skill acquisition, the gold standard would be a longitudinal research design.

However, much of the present research in this domain appears to offer implications for this

process by drawing inferences between two individual, sometimes arbitrary, time points (cf. Windt et al., 2018).

As such, future research needs to explore true longitudinal research to better understand this process. For example, practitioners and researchers could replicate Chapter 6 by seeking a sport or environment which lacks formal coaching. This could come generally, by seeking another upcoming sport (perhaps speed climbing as another new Olympic addition), or specifically from an athlete based on the participant's experience, using individuals who have not experienced formal coaching before (of course the limitations explored in Section 7.3 still stand). Participants progress on a skill acquisition journey, notably for a variety of open and closed skill and individual and team sports, could then be tracked using the following experimental groups: control (no coaching tools, although this could come with ethical considerations), ecological coaching, cognitive coaching and mixed (an intervention group which uses both ecological and cognitive coaching tools as appropriate). This type of research is what Ployhart and Vanenberg (2010) refer to as explanatory longitudinal research, whereby the cause for the 'change' (in this regard skill acquisition) is identified, as opposed to the change simply being observed or evaluated. However, they suggest that in order to understand this, we must first conceptualise the form of change before seeking theoretical causes.

The aim of this research design would be to explore the differences of the approaches to learning and skill acquisition, and therefore highlight which tool, approach or ontological perspective, is more appropriate across a spectrum of skills. As the findings of Chapter 5 highlighted, it seems that both the cognitive and ecological approaches could offer parsimonious explanations for different levels of skills across the same sport. As such, a research design of this nature would begin to identify how coaches can use different approaches, either at different levels of skill acquisition, or for different skills.

However, longitudinal research does not come without difficulties, such as the high rates of attrition, the difficulty to recruit appropriate participant samples, and of course the extraneous variables that cannot always be accounted for (Kirk, 1995). Therefore, it is important to consider alternatives. Whilst still longitudinal in nature, researchers could consider Latent Class Growth Modelling (LCGM; Andruff et al., 2009) as a statistical tool to identify and explore potentially impactful variables. For example, if LCGM was to be used when evaluating the veracity of natural talent by tracking a number of athletes from starting in the sport, researchers could identify subpopulations that underlie the sample. These could be psychosocial factors such as funding, biological factors such as reaction times (although these could change with the population) or biopsychosocial factors such as attitude (e.g., Dweck, 2008). Completing LCGM analysis would enable researchers to identify which subpopulations are most pertinent for further investigation, and of course broaden conventional wisdom by attempting to explain the underpinning reasons for different change classes, and thereby predict them.

An additional consideration that researchers could take in the future work would be to consider change at different levels of analysis in their research. In this context, researchers could consider individual change, as well as sample, simultaneously. Whilst this would be best done longitudinally, individual change could be considered using a cross-sectional design as well. This would enable researchers to consider a hybrid of multilevel and longitudinal models (Ployhart & Vanenberg, 2010), offering practitioners a more coherent view of the nuances I have shown exist in their practice.

7.4.2. Learning, Performance and Refinement

The 'where's your head at?' and 'context is key' dichotomies sat across the learning, performance and refinement category. These dichotomies aimed to explore focus and the role of cognition, and therefore has significant overlap across environments and practical

problems. As, I imagine, you will have come to expect, the absolutist approach leans towards exclusivity, such as promoting exclusive external focus (Wulf and colleagues, 2001; 2003; 2013; 2015) or refuting the need for cognition and internal representation (Araújo et al., 2019). In contrast, a number of positions exist to suggest that learning, performance and skill refinement are far more nuanced (Broadbent et al., 2019; Carson & Collins, 2011; Maurer & Munzert, 2013).

In order to dig deeper into a dichotomy within this category, I suggest a mixed methodology research design, which extends across a number of different continua, needs to be deployed. For example, within the 'where's your head at?' dichotomy, previous research has suggested that athlete's preference (between an internal and external focus) is a mediating factor toward the efficacy of the focus deployed. Ideally, participants would be novice performers and therefore have no experience of instructional focus, promoting neither internally or externally. However, even common experiences of coaching such as physical education in schools is likely to impact this preference. Moreover, many external focus instructions could rely on metaphors, which are open to misinterpretation. Therefore, participants should be screened and then included within research, based on either; preference for instructional information with an equal spread of internal and external foci preference participants or using a selection of participants that sit across an expert to novice spectrum.

Following this, participants should conduct a range of activities, from relatively closed, low-cognitive effort skills such as running, through to open and/or cognitively taxing skills, perhaps sport specific skills, which could include a tennis serve, a swimming tumble-turn or a freestyle jump sequence. Of note, all participants should complete all tasks under both internal and external foci conditions (similar to the design of Chapter 4 which asked participants to complete a putting task under both TFA and BFA conditions), with baseline measures taken across all skills. To advance this further researchers might consider the nature

of the internal and external focus instructions. Perhaps offering internal cues which are more relevant to the task, or external instructions which avoid metaphors.

Relating to the measurements utilised within the research, the use of tests against challenges which are meaningful to the applied context would be recommended. The duration of the study should be considered also, to ensure meaningful learning conditions. Whilst many protocols are designed over a set number of weeks, or even days, it would be more reflective of real world practice to attempt to have participants learn through one focus for a number of years (if indeed this was even possible!). Completing the study, and the mixed-method approach, I would recommend follow up investigation in which participants reflected on the degree to which they adhered to each protocol. This would allow researchers to explore the statistical significance of each type of focus, whilst also considering and accounting for possible confounding variables.

7.4.3. Performance

Under the performance category sits two dichotomies; 'to think or not to think' and 'just do it'. Relating to this category, the absolutist approach could be typified by the suggestion that the best performances are 'unthinking' or subconscious and therefore highly automated. Whereas the nuanced approach suggests that whilst optimal performances can be automatic or subconscious, they can also be executed in a conscious, controlled state.

As highlighted previously, an abundance of the research, displaying both the absolutist and nuanced findings, in this category is operationalised using self-report measures, requiring performers to retrospectively recall their performance experiences (e.g., Swann et al., 2016). Indeed, research in this thesis asked something similar of the participants in Chapter 5; notably, this was addressed in the limitations. Moving forward, however, in order to understand the performance category more coherently research must look beyond this typical approach.

Some researchers have promoted the idea of think aloud protocols (TA; Ericsson & Simon, 1993) in which participants are required to verbalise their thought processes while performing. This protocol has been used to capture conscious cognition from a variety of settings, such as teaching (Ellis, 2013), coaching (Stephenson et al., 2020) and sports (Welsh et al., 2018). Recent research into TA has begun to suggest the importance of task-specific TA training in order to maximise the use of the protocol (Birch & Whitehead, 2020). Therefore, TA could be used by researchers in order to delve deeper into these dichotomies. Importantly, however, TA, and the surrounding original protocols such as stimulated recall, also have limitations. For example, individuals can falsify their verbalisations (choosing not to represent their cognitive processes) and therefore offer inaccurate dialogues. Alternatively, participants may feel uncomfortable with this heightened self-awareness, resulting in their discourse becoming dysfunctional. Finally, even if the verbal information recorded reflect a genuine and accurate picture of their thoughts, this certainly does not mean that this is the best model for practice.

Reflecting this, and moving beyond this tool, research can continue to seek the perspectives and experiences from experts, as I have done in this thesis, then triangulate the information provided. Triangulation could come in the form of group discussions, in which those individuals within a context discuss their shared experiences to look for commonalities. Alternatively, researchers could carry out performance analysis, perhaps of competition footage, and compare this against the participant's recollections to verify the accuracy of their retrospective recall. In other words, are they doing what they say they are doing. Of course, as with all data collected retrospectively, this would be susceptible to inaccuracies also. However, by deploying the implications of this research, practitioners should begin to support performers in becoming 'intelligent selves'. Meaning, performers understand their preferences for learning and refinement, and are well versed in deploying adaptable tools for

performance. As such, we could begin to rely more heavily on this recall as it will be the product of individuals who are comfortable and confident with the processes of introspection and self-regulation.

7.5. Conclusion

Having taking a pragmatic approach to this research, it seems clear that pragmatic conclusions have been drawn. Throughout this work, both absolutist and nuanced approaches were considered, with an objective to understand which position was better supported through literature and empirical research. The research conducted drew on the experience and expertise of high-level participants across a number of different sporting contexts, from individual pursuits in golf, to team sports in Rugby Union, and from established pursuits such as Motorsport through to those in their relative infancy, skateboarding. From these chapters, staunch evidence was offered in support of the nuanced perspective across a number of important and contentious dichotomies. The implications of the research were far reaching. Of note, this work suggests that practitioners must be more aware of their own biases, and absolutist views, when working with clients and should engage in ongoing reflection in order to ensure they are servicing the needs of the client in the best way, with the best tool, possible. Moreover, practitioners should consider the nature of their work and how this information is disseminated. For example, practitioners must remember the fallibility of scientific theory, and therefore avoid professing that they have *the* answer, as opposed to an answer. Moreover practitioners should be more open to considering the views of those that may differ to their own. Finally, this work has highlight a significant implication for the research that is conducted within this field. Researchers should consider their research design, and ensure that it is setup in order to conclude any number of possible answers, not simply prove the one they are already expecting. Simply put, we must be clearer in our assertions, rigorous in our research, and honest in our findings! The findings of this thesis, and the

subsequent implications, highlight the need for practitioners to become comfortable in dancing in the shades of grey that exist within our domain, and always consider the idiosyncrasy and complexity of performance. In summary, it really does depend.

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Appendix

Semi-structured interview guide for Chapter 5

	Open Question to achieve this purpose	**Probes if participants do not provide enough detail in their answer**	**Stimuli to ask them to directly comment on, if the purpose is not achieved**	**What is the purpose of this line of enquiry?**
Pre-performance process	_During a ball stoppage situation, where is your attention?_	- Is there anything in particular you're looking at? - Are you thinking about it? - Do **Macro** (Score line, time of the game, position on the pitch), **Meso** (knowledge of the people around you) and **Micro** (position of the players around you) factors effect this?	- Are you looking for something in particular? - Are there thoughts going into your DM process? - Do factors impact upon your decision making process? If so, what are they? - Do you process the information you're looking for? If so, how?	Establish if there is a use of **knowledge and understanding** to make a skill execution decision, and if cognitions underpinning visual search strategies. Aim to develop a rich picture of the elements players look at/think about on a macro, miso, micro level
In performance process	_Once the game restarts, where is your attention?_ _(foci for attention)_	- Are you looking at the same things? Fewer/more? - Are you thinking about these factors now? - Do **Macro**, **Meso** and **Micro** (position of the players around you) factors effect this? - Does information carries through into action? If so, what?	- Are still you looking for something in particular? How does the information impact action? - Are there thoughts whilst <u>IN</u> your decision making process? If so, what are they?	Explore if understanding develops through action, and how/if it is drawn upon during action. Does cognition stop when the ball comes into play?

	Open Question to achieve this purpose	Probes if participants do not provide enough detail in their answer	Stimuli to ask them to directly comment on, if the purpose is not achieved	What is the purpose of this line of enquiry?
			- What possible factors impact upon your DM process?	
Development of cognitively primed understanding, if it exists	*Where has this ability/skill come from?*	- Can you recall specific activities, practices or coach inputs that developed these skills? - Is this a skill you have improved over time? - How did you learn it initially and how did/do you develop it? - Is this something that can be taught, or is it developed through practice?	- What factors affect the efficacy of this skill?	Establish if use of knowledge is a developed skill, and if implementation requires recognition/deliberate application