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Thought processes during set shot goalkicking in Australian Rules football: An analysis of youth and semi-professional footballers using Think Aloud

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Thought processes during set shot goalkicking in Australian Rules football: An analysis of youth and semi-professional footballers using Think Aloud.

Highlights

- This is the first study to employ a Think Aloud protocol analysis in Australian Rules football to explore the cognitive processes during set shot goal kicking performance.
- Junior and Adult performers mainly verbalise thoughts relating to planning, gathering information and description of outcome during the performance of a set shot goal kicking attempt.
- Junior and Adult performers demonstrate different changes in cognition as task complexity increases (e.g. increasing distance difficulty).
- Understanding how task complexity (e.g. increasing distance difficulty) influences athlete cognitions appears an important point for intervention and training specific to Australian Rules football.

Abstract

Aims: At present, there has been little attention given to exploring the cognitive processes of athletes in Australian Rules football during self-paced tasks such as the set shot goal kick attempt. Therefore, this study used a Think Aloud (TA) protocol analysis to explore the cognitions of Junior and Adult footballers undertaking the performance of a set shot goal kicking attempt in naturalistic conditions. **Method**: This involved 64 male Australian Rules footballers, comprising 37 elite level senior (adult) players (M age = 23.3 years) and 27 elite-level junior (M age = 14.6 years) players. Player's verbalisations were recorded during each performance of the goal kicking task, transcribed verbatim, and deductively and inductively analysed. **Results**: Planning, gathering information and description of outcome were the main three verbalised themes overall among junior and adult footballers. Findings also indicated that as task difficulty increases, athlete cognitions relating to self-doubt increases and pre-performance routines decreased. In contrast to Adults, Junior footballers gather more information when undertaking close range set shot goal kicking attempts and also verbalise more diagnostic outcomes and comments relating to self-doubt when undertaking long range set shot goal kicking attempts. Adult footballers were also found to verbalise more reactive comments across all kick distances and verbalise more thoughts relating to mental readiness and pre-performance routine from close range compared long range distances. **Conclusion**: These findings have implications for the acquisition of skill in sport and draw on key perspectives from Dynamic Systems Theory to advance understanding of the cognitive processes underpinning set shot goal kicking performance in Australian Rules football.

Keywords

Think aloud; goal kicking; Australian football; expertise; performance

Introduction

There has been increasing interest in, and use of, Think Aloud (TA) to examine the thought processes of athletes during contextualised performances of sport-specific tasks. TA essentially involves participants continuously verbalising their thoughts during the performance of a task and is considered a reliable form of scientific data for studying associated thought processes. For example, TA has been used across a range of sport settings including cycling (Whitehead et al., 2018), golf (Arsal, Eccles, & Ericsson, 2016), trap shooting (Calmeiro, Tenenbaum, & Eccles, 2010), snooker (Welsh, Dewhurst, & Perry, 2018), distance running (Samson, Simpson, Kamphoff, & Langlier, 2017) and tennis

(Swettenham, Eubank, Won, & Whitehead, 2018). TA has also been used in other performance settings including high-stakes poker (St. Germain & Tenenbaum, 2011) and judging education in gymnastics (Lee, Knowles, & Whitehead, 2019). These studies have largely focused on understanding and exploring ‘real time’ cognitions, represented as verbalisations, in self-paced tasks. However, current understandings about the relationship between cognition and performance using TA has yet to be informed by sports that are fundamentally team-based, including Australian Rules football (AF).

The AF setting is especially poignant given concerns about the accuracy of vitally important self-paced tasks such as the set shot on goal (Anderson, Breed, Spittle, & Larkin, 2018). A set shot refers to self-pace goal kick attempts after marking (‘catching’) the ball, in which the player is given up to 30 seconds to perform the kick without threat of being actively defended (Robertson, Back, & Bartlett, 2016). A recent study indicates that set shot attempts on goal at the professional level of AF, the Australian Football League (AFL), is only 55%, and decreases by a further 13% in wet environmental conditions (Anderson et al.,2018). Although a number of biomechanical advances to increase field kicking accuracy and distance are recognised, including the study of ball flight trajectory (Peacock & Ball, 2018), knee angle and foot velocity (Ball, 2008), ankle rigidity (Peacock, Ball, & Taylor, 2017) and leg lean mass (Hart, Nimphius, Cochrane, & Newton, 2013; Hart, Nimphius, Spiteri, & Newton, 2014), we argue that other approaches can help to inform coaching strategies to improve goal kicking success. In essence, studying the physical components of set shot goal kicking needs to be complimented by studies that explore the psychological aspects of goal kicking performance. To this end, a novel alternative includes an exploration of players cognitions (i.e. thought processes) during the performance of a task by using TA; in this case, the set shot on goal in AF. This is a feasible line of inquiry given that the acquisition of skill is dependent the ecological principles of perception-action coupling (Davids, Button, & Bennett, 2008).

Current perspectives on using TA during self-paced tasks

At present, the TA literature reflects three key positions of theoretical significance. The first prominent perspective has shed light on how TA has been used to understand how athletes experience and attend to a range of dynamic and ever-changing cognitive processes during the performance of a task. In one study involving cyclists performing a 16.1km time trial, Whitehead et al. (2017) found that cyclists verbalised thoughts under four predominant themes including pain and discomfort, external feedback, environment and pace and distance. Depending on the stage of the time trial, athletes would negotiate varying levels of stress and exercise varying levels of attentional focus on environmental information and pacing. Similarly, Samson et al. (2017) examined the thought processes of distance runners and found that pace and distance, pain and discomfort, and environment were the major themes that characterised thought patterns during the task. In both studies, athletes experience continually changing thought processes that become more and less pronounced during endurance-specific performance (Samson et al., 2017; Whitehead et al., 2017; Whitehead et al., 2018), highlighting how athletes negotiate varying levels of stress, appraisals and coping.

There has also been much interest in examining a variety of sports that contain discrete skill executions at varied time intervals (i.e. driving from the tee in golf). Although these sports have a duration element in terms of time, a focus on specific task demands using TA have also made significant contributions to the field. For instance, Swettenham et al. (2018) investigated stress and coping during tennis practice and competition using TA. It was found that gender and context influence the types stressors athletes appraise and attend to. Although both male and female athletes utilised problem-focused coping across practice and competitive settings, males verbalised more performance stress in competition and physical stress in practice, while females verbalised external stress and utilise problem-focused responses more in competition than practice. Calmeiro et al. (2010) also sought to examine the thought processes associated with the specific task of golf putting. In their study, they illustrated clear differences in cognition between highly skilled golfers and low skilled golfers. Specifically, experienced players spent more time assessing conditions and planning, verbalised more thoughts about gathering information and attended to more planning strategies in comparison to less experienced players. Moreover, experienced players established goals and strategies without focusing on mechanical aspects of the task in contrast to less experienced players. These studies highlight the dynamic and complex nature of thought processes that occur, in real time, during tasks that demand discrete, specialised skills.

While these studies have largely contributed to advancing an understanding of the underlying cognitive processes relating to appraisals, coping and differences in stress, they also have high relevancy for the acquisition and development of skill. For instance, a number of studies have shown that elite athletes tend to exhibit a superior level of visual perception and cognitive processing in contrast to less experienced counterparts (Welsh et al., 2018). In general, elite athletes typically verbalise more thoughts that focus on evaluating external situational cues in the environment or diagnosing difficulties in skill execution in preparation for the next performance (Calmeiro et al., 2010; St. Germain & Tenenbaum, 2011). They also tend to verbalise more thoughts than less experienced individuals in relation to the performance of a task (Arsal et al., 2016; Calmeiro et al., 2010; St. Germain & Tenenbaum, 2011). Furthermore, higher performing athletes process meaningful situational information related to performance faster than less skilled athletes, delineating skilful performance. Highly skilled athletes have also been found to effectively utilise distraction techniques, positive self-talk, relaxation strategies, trigger words, visualisations and positive reinforcements in performance (Cotterill, Sanders, & Collins, 2010). In contrast, novice athletes have a tendency to ruminate over technical or biomechanical aspects of performance, especially in preparatory phase of skill performance (Calmeiro et al., 2010; Whitehead, Taylor, & Polman, 2016). It is suggested that these differences may be a reflection of greater domain-relevant knowledge among experienced individuals which can be linked to heightened autonomous motor control and, thus, a more efficient reallocation of cognitive resources to identifying, evaluating and adapting to external dynamic constraints on performance rather than solely focusing on mechanics of skill execution (Calmeiro et al., 2010). However, it is also suggested that when task demands are too complex for highly skilled athletes to process, declarative knowledge and experience are drawn on in order to negotiate performance (St. Germain & Tenenbaum, 2011). Taken together, these studies have helped to explore the expert-novice paradigm. However, we argue that cognitive differences between expert and novice performers is yet to be fully explored from the perspective of self-paced tasks that occur within invasion-based, team sport such as Australian football. This oversight appears to be justifiably worthy of investigation given that the successful performance of self-paced tasks like set shot goal kicking remains an elusive challenge for players and coaches at the elite level.

It is also worth noting the current state of debate surrounding the use of TA for collecting and recording thoughts during the performance of a task. Early criticisms trace back to a paper by Cotterill (2011) detailing the development of pre-performance routines in cricket. One concern was that the use of TA was disruptive and in turn the validity of thoughts elicited in relation to the task being performed. Similarly, Lee et al. (2019) concede that employing a TA method may comprise a distraction in performance settings such as judging and assessment. However, others contend that while TA may increase the time required to complete a task, it does not affect the accuracy of task performance or the nature of the accompanying thoughts processes in self-paced tasks within golf (Eccles & Arsal, 2017; Whitehead, Taylor, & Polman, 2015). This is methodologically significant in attempting to understand the differences in cognition in other self-paced tasks such as the AF set shot on goal.

How TA can extend current skill acquisition perspectives

Think Aloud has never been used to understand goal kicking performance in Australian football. This is methodologically novel and has the potential to shift the parameters of the field in how scholars and practitioners seek to optimise goal kicking performance. Specifically, Think Aloud presents utility to capture data that specifically emerges from the link between perception and action in human movement. Recent perspectives in skill acquisition are increasingly emphasising the importance of perception in skill acquisition processes (Savelsbergh, van der Kamp, Oudejans, & Scott, 2004). Specifically, the ability to perceive and process intrinsic and extrinsic information to satisfy movement objectives. The process of harnessing sensory information to enable movement performance is acknowledged as ‘perception-action coupling’ (Warren, 1990). Cognitive psychology holds perception as a process of constructing meaning whereby sensory information is managed in two key cognitive operations. The first is ‘attending’, whereby sensory information is scrutinised for relevance to a movement objective – certain information may be harnessed or ignored in movement production (Warren, 1990). The second involves comparing sensory information against memory to interpret and stereotype it’s meaning for movement production (Warren, 1990). Skill Acquisition research has typically focused measuring technical and tactical outcomes of performance as independent variables with fewer investigations of perception as a learnt process underpinning performance.

Dynamic Systems Theory (DST) is a relevant framework by which to shape and interpret Think Aloud research focusing on perception-action coupling in skill acquisition. DST adopts a view of human movement as complex and dynamic (Davids et al., 2008). Complex in the sense that humans have many interacting components and these components dynamically shift in and out of coordination synergies (Davids et al., 2008). The components of a movement system that exceed the minimum number required to satisfy a movement objective are referred to as ‘Degrees of Freedom’ (Savelsbergh et al., 2004; Vereijken, Emmerik, Whiting, & Newell, 1992). From a DST perspective, the challenge for the human movement system is to master redundant Degrees of Freedom to enhance efficiency and success of goal directed movements (Davids et al., 2008). Degrees of Freedom as a concept was originally applied to the biomechanical components of the human body (Davids et al., 2008), though more recent investigations have acknowledged the validity of perceptual Degrees of Freedom in movement performance (Savelsbergh et al., 2004). Perceptual Degrees of Freedom function in the same way as their mechanical counterpart, affording the propensity for variable movement to satisfy movement objectives. However, perceptual Degrees of Freedom rely on the learner being attuned to their meaning and significance for goal directed behaviour. This involves the application of cognitive processes including attending and memory (Savelsbergh et al., 2004). Interestingly, a study involving striking and catching demonstrated that perceptual degrees of freedom may better differentiate novice compared to elite athlete performance more than mechanical degrees of freedom (Savelsbergh & Bootsma, 1994). For interceptive actions such as the AFL set shot on goal, perceptual degrees of freedom may connect to visual, tactile, kinaesthetic, vestibular and auditory receptors affording the performer with specific information about forces, position and motion of the body relative to the ball (Davids, Savelsbergh, Bennett, & Van der Kamp, 2002). The athlete must attempt to satisfy these temporal and spatial constraints culminating at the end of the movement; dropping the ball from the hands and striking it with the foot. Variances in how these constraints are perceived or processed may underpin ball drop trajectory and foot + ball contact locations, influencing shot accuracy. As such, the complexity of the AFL set shot is tied up in keeping within smaller margins of temporal and spatial errors at foot + ball contact as the distance requirement of the shot increases.

Think Aloud presents as a novel tool for research to examine the nexus of perception and action, eliciting data that emerges from the junction of attending and memory combining to process perceptual Degrees of Freedom in movement performance. Think Aloud investigations in skill acquisition research may provide insight into how perception-action coupling is delineated by experience and task. Findings in this area this may inform curricula and pedagogical considerations for movement practitioners that function to enhance perception-action coupling to improve AFL goal kicking. As such, and using TA, the overall purpose of this project was to (a) explore the differences in cognition while performing set shot goal attempts across varying distances and difficulties, and (b) discover how thought processes differentiate between adult and junior footballers while performing a set shot goal attempt.

Methods

Participants

Participants included 64 male Australian Rules footballers, comprising 37 elite-level senior (adult) players (*M* age = 23.3 years) and 27 elite-level junior (*M* age = 14.6 years) players. The adult participants had elite level experience in Australian Rules football (the Australian Football League) and/or the semi-professional, state-league men’s competition (the South Australian National Football League). The junior participants were comparatively inexperienced, situated at the beginning of the talent pathway within the state-league’s junior competition. All participants were recruited through a university-led, high-performance program in which the footballers were given the opportunity to consider their involvement in the study across two separate training days in December 2017 and September 2018.

Materials

A pair of professional grade iVUE action camera eyewear (1080P Horizon) were used to capture real-time thoughts that were verbalised during a series of set shot goal kicking attempts. The action camera eyewear was fitted to each player akin to wearing a pair of ‘sunglasses’ for the duration of the task.

Procedure

Each participant was asked to complete nine set shot goal kicking attempts from a range of pre-determined distances and angles (see Figure 1). The angles included shots from a 45-degree angle on the left-hand side of goal, a 45-degree angle on the right-hand side of goal, and directly in front of goal. Within each angle, participants attempted shots from 30m and progressed outward to 40m and then 50m distances from the goal line (see Figure 1). All participants performed this task on the same field, between 11:00 and 14:00, in dry conditions. The wind was approximately 5 km/hour (blowing in South-West direction) and the temperature was 31 degrees (September 2018) and 34 degrees (December 2017).

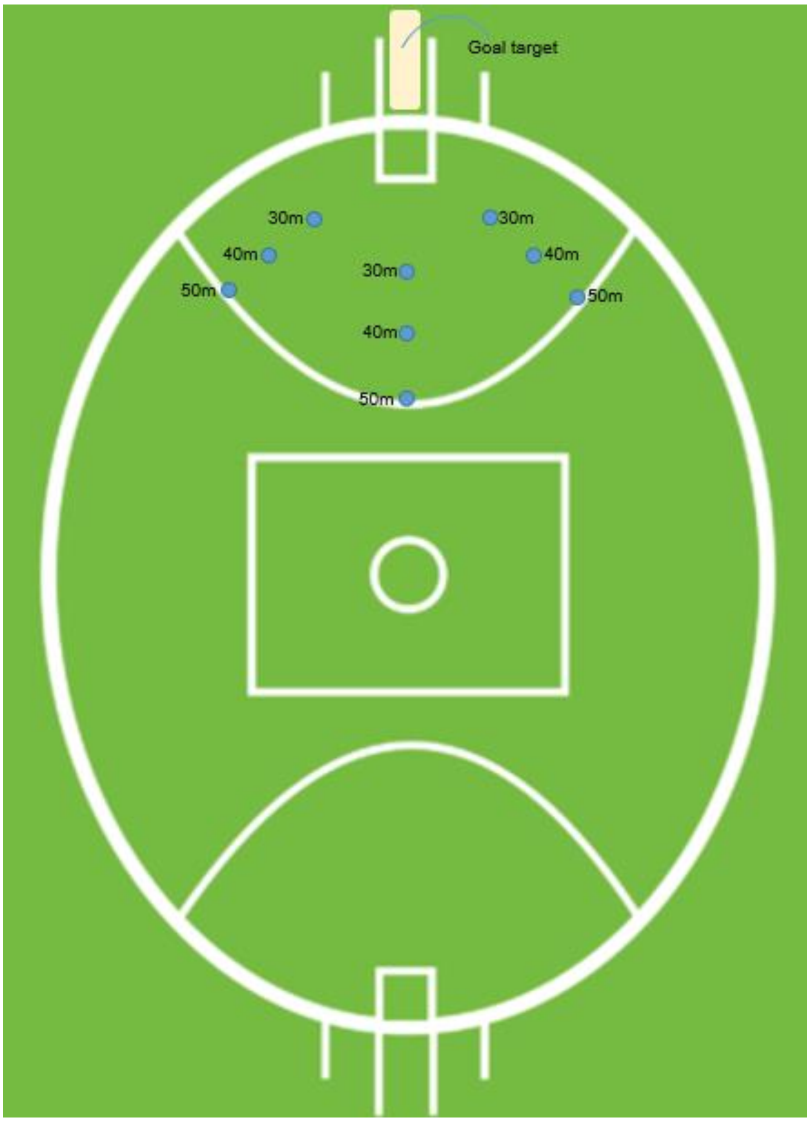

Figure 1. An illustration of the goal kicking task performed by each participant.

Prior to commencing data collection, participants were required to complete a video-based TA training exercise specifically designed for this project. Similar to the methods described by Whitehead et al. (2018), the video included three different TA training tasks including (1) an alphabet exercise, (2) counting the number of dots on a page, and (3) verbal recall exercise. The customised training video also included step-by-step examples of how to (a) wear and activate the iVUE action camera eyewear (activate and deactivate recording) and (b) rotate through the set shot task. To avoid disrupting performers' normal warm-up routines, all participants completed a warm-up task representative of routines normally undertaken before training and games. This involved a self-determined process of dynamic and static stretching, functional movement progressions, stride lengthening, and ball-related tasks involving marking (catching), kicking and handballing. Players were then organised into groups of three to perform the task. In each group, player A was behind the goals to retrieve the ball, player B was undertaking the goal kicking attempt, and player C was defending the mark, forcing the kicker to undertake their routine in conditions representative of set shot goal kicking in Australian football. Once player B had attempted all nine kicks, players rotated roles until they all completed the goal kicking task. To reinforce conditions to reflect the competitive nature of Australian football and the significance of set shot goal kicking, all footballers were given notice that the best performer would receive a $100 sport store voucher.

Analysis

In keeping with most of the TA research (Arsal et al., 2016; Calmeiro et al., 2010; Whitehead et al., 2017; Whitehead et al., 2018) a post-positivist epistemology informed this study. All participants TA data was audio recorded and transcribed verbatim by the first and third author. All 64 participant transcripts (which produced 111 pages of single-spaced text) were subject to line by line content analysis by the second author. Data was analyzed both deductively and inductively. An initial deductive framework was used based on previous research by Whitehead et al. (2018) and Calmeiro and Tenenbaum (2011) (see Table 1). However, an additional theme of self-doubt was developed through an inductive analysis. A dual analysis was considered an opportunistic, yet important part of the study given that each of the authors came to the research from a range of epistemological (post-positivist and interpretivist) and disciplinary (pedagogy, psychology and sport coaching) positions. The lead author undertook an inductive content analysis involving familiarization with transcripts, coding all verbalizations within the context of the task, aggregating codes into broader categories, comparing and contrasting categories with the data to develop ‘themes’, developing accurate names for each theme, and report on the findings. This analytical process produced nine themes for further analysis including the same eight themes from the deductive analysis as well as the theme ‘Self-Doubt’. During the inductive coding (using NVIVO 12 Pro) each verbalization that had been assigned to a theme accounted for a value of 1. Therefore, each theme had a number of verbalization frequencies assigned to it following the coding process. The number of verbalizations for each theme verbalized by each individual participant and also each kicking distance was then retrieved from NVIVO 12 Pro and inputted in IMB SPSS Statistics to conduct a series of inferential statistics.

Prior to conducting any interferential statistics, the data was tested for normality, all *p* values were less than .05 therefore we proceeded with a non-parametric analysis. Initially successful kicks were recorded and an independent t-test was conducted to identify whether there was a significant difference between junior and adult performance. A Friedman test was conducted to investigate the overall differences between the frequency of themes verbalized and follow up Wilcoxon tests were conducted to identity where these differences occurred. Following this, data was split into distances and further Friedman tests and follow up Wilcoxon test were conducted to identify significant differences across kicking distance. Data was then split into Junior and Adults and a series of Man Whitney U tests were conducted to identify differences between Adults and Juniors and their themes and distances within these themes. Furthermore, separate Freidman tests were conducted within Junior and Adult groups to identify differences within each group across the kick distance. Follow up Wilcoxon tests were conducted with any significant results to identify where these differences were.

Table 1: Themes used to code verbalizations

Theme	Description	Example of raw data quote
Gathering Information	Searching for relevant characteristics of the environment.	"Little bit of wind coming from the left side"
Planning	Referring to a plan of action for a kick.	"Hanging this one out to the right"
Technical Instruction	Specified technical aspects of the motor performance.	"Straight leg", "Try and point my toe"
Description of Outcome	Refers to what had happened in terms of process or evaluation of the action.	"Missed left", "That was a horrible kick, totally short"
Diagnosis out Outcome	Refers to the reasons for the observed outcome.	"I leant back too much on that one", "Didn't hook back enough"
Pre-Performance Routine	Any sequence of task relevant thoughts or actions engaged in systematically prior to a kick.	"Sticking to my routine", "go through my normal routine"

Reactive Comments	Refers to verbalizations referring to reactive comments to performance.	“That was bleep”, “F-Sake”
Mental Readiness	Refers to psychological preparation for the task.	“Positive thoughts in the head before I kick”, “go to a happy place”
Self-Doubt	Any reference to doubting ability to succeed with the present kick.	“I’m not going to be able make the distance”

Rigour

Consistent with a post-positivist approach, interrater reliability was practiced as a strategy to promote rigour. Overall, this technique yielded 87.5% theme agreement, reflecting congruence with eight out of nine themes. One theme, self-doubt (representing the other 12.5% disagreement), was then discussed via two skype meetings and emails to clarify the development of the theme and its appropriateness to the overall purpose of the project. We additionally employed strategies akin to what Smith and McGannon (2018) describe as the ‘critical friend’ to advance the analysis as a way of promoting reflexivity. Although using a ‘critical friend’ does not traditionally align with post-positivist research, qualitative methods involving transcription and coding can be strengthened by employing means and methods to provide transparency and attempt to deepen our analyses (Smith & McGannon, 2018). The second author acted as a critical friend and sounding board to promote reflexivity and exploration about the data. One outcome was that the theme in question, self-doubt, would remain included in the analysis and write up given its frequency in the data verbalised through coded examples of scepticism and hesitation about the self-paced task.

Results

An independent t-test was conducted to examine the performance of successful kicks between juniors and adults. A significant difference was evidence, (t(62(, 2.45, p = .01). The adult group had a significantly higher success rate (M = 2.62, SD = 1.34) compared to juniors (M = 1.81, SD 1.24).

	Mean (SD)	Description	Diagnosis	Gathering	Mental	Planning	Reactive	Technical	Pre-	Self-Doubt

Overall differences between themes for all players and all distances.

A Friedman test was conducted to identify within group differences across all 9 verbalized by all the 64 football players during all of their kicking performance. A significant main effect was found between these themes: X^2 (7) = 198.67, *p* = .00. Further follow up Wilcoxon tests were conducted to identify where these differences in verbalized themes were, table 1 provides this data.

Table 2: Means, standard deviation, Wilcoxon signed rank and significance statistics of comparisons between all 9 themes.

		of outcome	of outcome	information	Readiness		Comments	Instruction	Performance Routine	
Description of outcome	3.56 (2.67)		*Z* = -3.35 *P* = .001	*Z* = -3.31 *P* = .002	*Z* = -5.08 *P* = .000	*Z* = -6.53 *P* = .001	*Z* = -3.30 *P* = .000	*Z* = -4.77 *P* = .000	*Z* = -2.83 *P* = .005	*Z* = -5.93 *P* = .000
Diagnosis of outcome	2.20 (2.26)			*Z* = -4.93 *P* = .000	*Z* = -2.32 *P* = .020	*Z* = -6.78 *P* = .000	*Z* = -.735 *P* = .463	*Z* = -3.95 *P* = .000	*Z* = -2.78 *P* = .69	Z = -.69 *P* = .489
Gathering information	5.18 (4.02)				Z = -5.81 *P* = .000	Z = -5.89 *P* = .000	Z = -4.54 *P* = .000	Z = -5.61 *P* = .000	Z = -4.42 *P* = .000	*Z* = 5.61 *P* = .000
Mental Readiness	1.34 (2.03)					*Z* = -6.71 *P* = .000	*Z* = -1.90 *P* = .057	*Z* = -.586 *P* = .558	*Z* = -1.15 *P* = .246	*Z* = -2.07 *P* = .038
Planning	10.64 (6.01)						*Z* = -6.52 *P* = .000	*Z* = -6.76 *P* = .000	*Z* = -6.61 *P* = .000	*Z* = -6.81 *P* = .000
Reactive Comments	1.89 (2.05)							*Z* = -2.17 *P* = .020	*Z* = -.44 *P* = .661	*Z* = 3.34 *P* = .001
Technical Instruction	2.20 (1.97)								*Z* = -1.76 *P* = .078	*Z* = -1.05 *P* = .291
Pre-Performance Routine	2.20 (3.40)									*Z* = -2.90 *P* = .004
Self-Doubt	.73 (.96)									

Differences between distances of kick.

Table 3. Descriptive statistics (mean and standard deviation) and Wilcoxon signed rank test for all 9 themes verbalized by all 64 players.

Theme	Kick Distance	Mean (SD)	Friedman test
Description of outcome	30m	1.23 (1.30)	$X^2(2) = 8.00$, $p = .018$
	40m	1.23 (1.09)	
	50m	.82 (.91)	
Diagnosis of outcome	30m	.73 (.96)	$X^2(2) = .62$, $p = .732$
	40m	.97 (1.10)	
	50m	.68 (.92)	
Gathering information	30m	1.78 (1.74)	$X^2(2) = 1.47$, $p = .48$
	40m	1.57 (1.78)	
	50m	1.82 (1.73)	
Mental Readiness	30m	.56 (1.02)	$X^2(2) = 2.43$, $p = .297$
	40m	.45 (.81)	
	50m	.32 (.77)	
Planning	30m	3.60 (2.49)	$X^2(2) = .13$, $p = .29$
	40m	3.46 (2.09)	
	50m	3.71 (2.53)	
Reactive Comments	30m	.50 (.77)	$X^2(2) = 2.74$, $p = .25$
	40m	.67 (.85)	
	50m	.67 (1.02)	
Technical Instruction	30m	.49 (.80)	$X^2(2) = 3.71$, $p = .15$
	40m	.41 (.81)	
	50m	.33 (.74)	
Pre-Performance Routine	30m	.84 (1.48)	$X^2(2) = 7.08$, $p = .02$
	40m	.87 (1.31)	
	50m	.46 (1.14)	
Self-Doubt	30m	.09 (.29)	$X^2(2) = 17.87$, $p = .00$
	40m	.15 (.47)	
	50m	.46 (.73)	

An initial Friedman test was conducted to identify any significant differences in the overall verbalizations of all themes across 30m, 40m and 50m differences. No significant differences were found between total number of verbalizations across each theme ($X^2(2) = 2.54$, $p = 2.80$). Following this a Friedman test was conducted to identify if there was a significant difference between the distances kicked within the nine themes verbalized by all the 64 football players during all of their kicking performance. Table 3. shows that significant differences were found between distances for the themes, Description of outcome, Self-Doubt, and Pre-Performance Routine. Further follow up Wilcoxon signed ranks test were conducted. For the theme Description of Outcome a significant difference was found between 30m and 50m ($Z = 2.75$, $p = .006$) and 40m and 50m ($Z = -2.77$, $p = .006$), it is evident from the means that significantly more verbalizations relating to the description of outcome were found in distances 30m and 40m in comparison to 50m. For the theme Pre Performance routine, follow up Wilcoxon signed rank test revealed that there were significantly more Pre-performance routine verbalizations during the 30m kick in comparison to the 50m kick ($Z = -2.33$, $p = .020$) and the same was also evident with the 40m kick in comparison to the 50m kick ($Z = -2.59$, $p = .009$). Finally follow up Wilcoxon signed rank revealed that for the theme Self Doubt more verbalizations were evident at 50m in comparison to 30m ($Z = -3.62$, $p = .000$) and verbalizations were also significantly higher at 50m than 40m ($Z = -2.76$, $p = .006$).

Differences between adult and junior

Table 4. Descriptive statistics (mean and standard deviation), Man Whitney test for all themes, distances, and comparisons between adult and junior, and Friedman test if differences across distance

Theme	Kick Distance	Adult Mean (SD)	Junior Mean (SD)	Man Whitney
Description of outcome		3.43 (2.25)	3.74 (3.20)	*U* = 492.00 *P* = .91
	30m	1.02 (1.14)	1.51 (1.47)	*U* = 408.50 *P* = 1.96
	40m	1.27 (.99)	1.18 (1.24)	*U* = 457.00 *P* = .55
	50m	.78 (.78)	.88 (1.08)	*U* = 497.50 *P* = .97
Friedman		$X^2(2) = 4.88$, $p = .08$	$X^2(2) = 8.89$, $p = .02$	
Diagnosis of outcome		2.45 (2.52)	1.85 (1.83)	*U* = 450.50 *P* = .49
	30m	.67 (.91)	.81 (1.03)	*U* = 463.500 *P* = .59
	40m	.89 (1.26)	.66 (.83)	*U* = 481.50 *P* = .78
	50m	.91 (1.06)	.37 (.56)	*U* = 355.00 *P* = .02
Friedman		$X^2(2)$, 1.48, $p = .47$	$X^2(2)$, 6.18, $p = .04$	
Gathering information		3.72 (2.53)	7.18 (4.80)	*U* = 285.00 *P* = .00
	30m	1.16 (1.23)	2.62 (1.98)	*U* = 276.50 *P* = .00
	40m	.86 (1.08)	2.55 (2.08)	*U* = 251.00 *P* = .00
	50m	1.64 (1.70)	2.07 (1.77)	*U* = 425.50 *P* = .303
Friedman		$X^2(2)$, 4.81, $p = .09$	$X^2(2)$, 3.071, $p = .21$	
Mental Readiness		1.51 (1.92)	1.11 (2.18)	*U* = 417.00 *P* = .219
	30m	.67 (1.13)	.41 (.84)	*U* = 436.50 *P* = .28
	40m	.59 (.89)	.25 (.65)	*U* = 406.50 *P* = .11
	50m	.24 (.59)	.44 (.97)	*U* = 452.50 *P* = .36
Friedman		$X^2(2)$, 6.19, $p = .04$	$X^2(2)$, 1.40, $p = .49$	
Planning		10.75 (6.17)	10.48 (5.90)	*U* = 480.00 *P* = .79
	30m	3.78 (2.43)	3.33 (2.55)	*U* = 438.00

				$P = .39$
	40m	3.58 (2.43)	3.29 (2.12)	$U = 440.50$ $P = .52$
	50m	3.59 (2.53)	3.85 (2.53)	$U = 486.50$ $P = .85$
Friedman		$X^2(2)$, .05, $p = .97$	$X^2(2)$, .62, $p = .73$	
Reactive Comments		2.48 (2.30)	1.07 (1.29)	$U = 324.00$ $P = .01$
	30m	.70 (.87)	.22 (.50)	$U = 350.50$ $P = .01$
	40m	.83 (.89)	.44 (.75)	$U = 369.50$ $P = .05$
	50m	.94 (1.22)	.29 (.46)	$U = 355.00$ $P = .02$
Friedman		$X^2(2)$, 1.39, $p = .49$	$X^2(2)$, 2.39, $p = .30$	
Technical Instruction		1.24 (1.90)	1.18 (2.09)	$U = 485.00$ $P = .83$
	30m	.43 (.80)	.55 (.80)	$U = 442.50$ $P = .350$
	40m	.48 (.86)	.29 (.72)	$U = 432.50$ $P = .23$
	50m	.32 (.66)	.34 (.64)	$U = 480.00$ $P = .98$
Friedman		$X^2(2)$, 2.08, $p = .35$	$X^2(2)$, 4.73, $p = .09$	
Pre-Performance Routine		2.40 (3.74)	1.92 (3.09)	$U = 499.50$ $P = 1.00$
	30m	1.00 (1.64)	.62 (1.21)	$U = 447.00$ $P = .41$
	40m	1.02 (1.51)	.66 (.96)	$U = 466.50$ $P = .61$
	50m	.35 (.97)	.62 (1.33)	$U = 439.50$ $P = .23$
Friedman		$X^2(2)$, 12.66, $p = .00$	$X^2(2)$, .12, $p = .94$	
Self-Doubt		.51 (.93)	1.03 (.93)	$U = 315.00$ $P = .00$
	30m	.08 (.27)	.11 (.32)	$U = 484.50$ $P = .68$
	40m	.10 (.31)	.22 (.64)	$U = 477.50$ $P = .60$
	50m	.32 (.71)	.66 (.73)	$U = 355.50$ $P = .02$
Friedman		$X^2(2)$, 4.66, $p = .09$	$X^2(2)$, 13.34, $p = .001$	
Total verbalisations 30m		9.54 (4.53)	10.22 (5.47)	$U = 475$ $P = .73$
Total verbalisations 40m		9.56 (3.66)	9.59 (5.04)	$U = 494.00$ $P = .94$
Total verbalisations 50m		9.10 (3.68)	9.55 (4.78)	$U = 486.00$ $P = .85$

As evidenced within table 4, juniors verbalised more **diagnosis of outcome** related thoughts during 50m kicks than adults. Overall and at 30m and 40m juniors verbalised more thoughts linked to **gathering information**. However, adults verbalised significantly more **reactive comments** overall and across all kicking distances than juniors. Finally, juniors verbalised significantly more thoughts relating to **self-doubt** overall and during the 50m kicks than adults.

Table 4 also shows that there is a significant difference across kick distances for adults in the themes Mental Readiness and Pre-performance routine. Follow up Wilcoxon test reveal that for Mental Readiness there is a difference between 30m and 50m kicks (Z = -3.09, p = .00) where more verbalisations referring to mental readiness occurred at 30m (M = .67) than 50m (M = .24). In addition, a significant difference was found between 40m and 50 (Z = -2.09, p = .03), where more verbalisations were evident at 40m (M = .59) than 50m (M = .24). For adults there was also a significant difference across distances for the theme Pre-Performance routine, where more verbalisations occurred at distance 30m in comparison to 50m (Z = -2.64, p = .00). In addition, significantly more verbalisations of Pre-Performance routine were evident at 40m in comparison to 50m (Z = -3.00, p = .00).

For Juniors, there was a significant difference across kick distances for the theme Description of Outcome, further Wilcoxon tests revealed that there were more verbalisations of this theme at 30m in comparison to 50m (Z = -3.09, p = .00). Furthermore, within Juniors there were significant differences across distances for Diagnosis of outcome. Follow up Wilcoxon test revealed that significantly verbalisations relating to this theme were present at 30m in comparison to 50m (Z = -2.32, p = .00), in addition more verbalisations relating to this theme were present at 40m in comparison to 50 (Z = -1.90, p = .05). Finally, within Juniors there was a significant difference across distances for the theme Self Doubt. Follow up Wilcoxon tests revealed that there was more Self-Doubt Verbalisations at 50m in comparison to 30m (Z = -309, p = .00). Significantly more Self-Doubt themes were verbalised at 50m in comparison to 40m (Z = -2.10, p = .03).

Discussion

The overall purpose of this project was to (a) explore the differences in cognition while performing set shot goal attempts across varying distances and difficulties, and (b) discover how thought processes differentiate between adult and junior footballers while performing a set shot goal attempt. The findings indicate that as task difficulty increases, athletes describe the outcome less frequently. The findings also demonstrate that as task difficulty increases, cognitions relating to self-doubt increases too. Furthermore, Pre-performance routines appear to be particularly prominent during tasks of low to moderate difficulty (e.g. 30 and 40 m distances) and less prominent in tasks of high difficulty and challenge (e.g. the 50m distance). The findings also reveal how cognitions between Junior and Adult performers differentiates during the task of set-shot goal kicking. Specifically, Junior footballers tend to more information gathering at 30 and 40m distances and also verbalised more diagnostic outcomes and comments relating to self-doubt at 50m distances compared to Adult footballers. In contrast, Adult footballers verbalise more reactive comments across all kick distances. Adults also verbalised more thoughts relating to mental readiness and Pre-performance routine at 30m than compared to 50m distances. Finally, planning, gathering information and description of outcome were the main three verbalised themes overall among junior and adult footballers. This is consistent with previous TA research which has also reported planning-, gathering information- and description of outcome-oriented verbalisations during the performance of self-paced tasks in sport (Calmeiro & Tenenbaum, 2011; Whitehead et al., 2015, 2016).

From a motor control perspective, planning, gathering information and description of outcome may reflect involvement of memory and attending as central cognitive operations for movement production. By planning for movement production, athletes are relying on ‘memory representations’ of the task and extrapolating meaning for the specific task demands in front of them (Warren, 1990). Gathering information and describing performance outcomes requires the use of ‘attending’, whereby sensory information is scrutinised for relevance to the immediate performance (Warren, 1990). From a Dynamic Systems theory perspective, memory and attending may be employed at different stages of learning as the athlete attempts to grapple with the vast mechanical and perceptual degrees of freedom relevant to the kicking action during the set shot on goal. Memory and attending will now be considered in offering possible explanations for differences in TA themes between junior and adult footballers, mediated by task complexity in kicking distance.

Previous research has found that experienced athletes verbalise performance outcomes more frequently than novice athletes (Calmeiro & Tenenbaum, 2011). In the present study, junior footballers verbalised the description of the outcome more than adults. One possible factor for this difference is that although the present study compared juniors with adults, both groups were elite footballers for their age groups. Higher verbal descriptions among juniors compared with adults in the present study may reflect an earlier stage of learning, characterised by greater involvement of 'cognitive chunking'; a process that seeks to consolidate movement-related information for transfer into long-term memory. Anderson (1982) theorised that as motor learning progresses, perception-action associations are aggregated into larger cognitive chunks. At an earlier stage of learning, juniors more than adults may be grappling with aggregating the vast array of perceptual information and how it influences action. Specifically, attempting to identify how visual, tactile, kinaesthetic, vestibular and auditory feedback impact on forces, position and motion of the body relative to the ball. Verbal description of the shot outcome may assist or manifest because of 'cognitive chunking' as an act of aggregating various perception-action associations for memory storage. For example, a junior footballer in the present study demonstrated cognitive chunking: *"Started out too wide. Need to allow for the wind a bit more. Put it off to the left. Going to aim for the point post this time"*. In this example, the footballer is aggregating the influence of the wind on the ball trajectory and associating its impact on a possible mechanical solution for the next attempt by aiming further for the left goal post. Cognitive chunking is suggested to alleviate cognitive burden on the short-term memory, allowing for more advanced performance to occur (Anderson, 1982).

Decreased verbal description of outcome and increased diagnoses from 30m to 50m for adults may signal that performance description could be an important step in transitioning short-term resources to diagnosing shot outcome. More specifically, adults have acquired enough memory representations of successful and unsuccessful shot attempts and their associated perception-action states, and, therefore able to harness and contrast against performance as part of the diagnosis. This is similar to an explanation provided by (St. Germain & Tenenbaum, 2011) who suggested that declarative knowledge around performance may underpin negotiating future skill execution. The finding that adults verbalised more diagnosis of outcome related thoughts during 50m kicks than juniors further supports this possible explanation. This is consistent with other research studies that have found outcome diagnosis to be more frequent among more experienced or highly skilled athletes (Calmeiro & Tenenbaum, 2011; St. Germain & Tenenbaum, 2011). In the context of the present study, adults are more likely to possess the required kicking strength to make the 50m distance (regardless of scoring) compared to juniors and there may have greater experience to draw upon to diagnose performance. This would make sense given that juniors verbalisation of more thoughts linked to gathering information at all kicking distances reflecting a more focused need to build memory representations of the task aided by cognitive chunking.

Across kick distances description of the outcome and pre-performance routine was verbalised significantly less at 50m. Additionally, self-doubt was verbalised significantly more at 50m and juniors verbalised more self-doubt than adults at this distance. Consequently, self-doubt in capability appears to overshadow description of the outcome and pre-performance routine. Pre-performance routines (PPR's) are a self-regulatory strategy used to improve attention and emotion control (Moran, 2016). Research has provided evidence for the effectiveness of PPR's, with novices benefitting the most (Beauchamp, Halliwell, Fournier, & Koestner, 1996; Crews & Boutcher, 1986; Mccann, Lavallee, & Lavallee, 2001). Hill, Hanton, Matthews, and Fleming (2011) found that within elite golfers, PPR's could alleviate choking under pressure by increasing perceived control, lowering anxiety levels and improving focus. Therefore, our findings may be showing that, specifically within juniors, this lack of PPR being used at 50m could have a relationship with the level of self-doubt cognitions being verbalised. A practical implication for this study could be that regardless of kicking distance, PPR's should be employed, this in turn may reduce the number of self-doubt thoughts and improve kicking accuracy. Though, individual thought processes as part of PPR's should be expected to transition as skill ability increases. Movement practitioners should tailor PPR's to the specific types of perceptual and performance related degrees of freedom at different stages of learning. For example, the findings of this study support PPR's routines of junior athletes focusing on cognitively chunking a broader array of informational variables relevant to performance than more experienced athletes. Movement practitioners may facilitate cognitive chunking in PPR's through learning activities that exaggerate the impact of certain degrees of freedom on kicking performance. PPR's of more experienced athletes may benefit from less attentional processing of degrees of freedom, focusing only on those that may require significant adaptions to skill performance (e.g. adjusting angle for extreme wind conditions or kicking technique for angle). Independent of skill ability, coping strategies addressing self-doubt may assist athletes to maintain or continue developing PPR's for tasks of high perceived difficulty. For example, PPR's routines appeared to be disrupted at 50-meter range in the present study. This study reinforces the significance of Dynamic Systems Theory as a framework for creating explicit perception-action learning activities which facilitate a cyclical relationship between performer and environment.

Overall, the collective research findings and their possible explanations from a skill acquisition perspective provided above are consistent with Bernstein's degrees of freedom proposal. At an earlier stage of learning, the athlete attempts to identify relevant mechanical degrees of freedom that may underpin kicking performance. The identification process may be facilitated by cognitive chunking. As task complexity is increased (reflected by greater kicking distances), athletes begin to diagnose performance to master a greater array of degrees of freedom to satisfy task demands. Previously established memory representations may be used as a key component to transition from task description to task diagnosis, possibly reflecting a more advanced stage of grappling with greater or complicated degrees of freedom in task performance. There is evidence that consciously grappling with degrees freedom through attentional monitoring and thinking-aloud may facilitate novice learners (Beilock, Wierenga, & Carr, 2002) but disrupt automaticity of skilled performers (Masters & Maxwell, 2008). Consistent with Fitts and Posner's (1967) model of skilled performance, automaticity as a hallmark of skilled performance may be undone through attentional monitoring and thinking-aloud. This phenomenon, acknowledged as reinvestment, may have adversely impacted on elite performers in this study, disrupting automaticity in their performance built through cognitive chunking. Arguably reinvestment may be more pronounced among players in this study who specialised in set shot goal kicking through their field position. A subsequent limitation of this study was the sample consisting of players from all field positions, not just those who specialised in goal kicking. Identification of thought processes that reflect reinvestment behaviours may have been observable and possibly accounted for if the sample consisted purely of specialised goal kickers. Another limitation of this study was the use a financial reward to create competitive conditions in goal kicking. The nature of the performance environment for a competitive game may impact on thought processes differently to conditions created for this study. A final limitation was the short time allotted for training the athletes using TA. This may have impacted their ability to verbalize implicit cognitions during set shot goal kicking, especially when comparing junior and adult performers.

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