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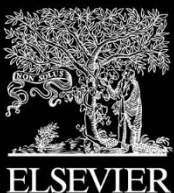
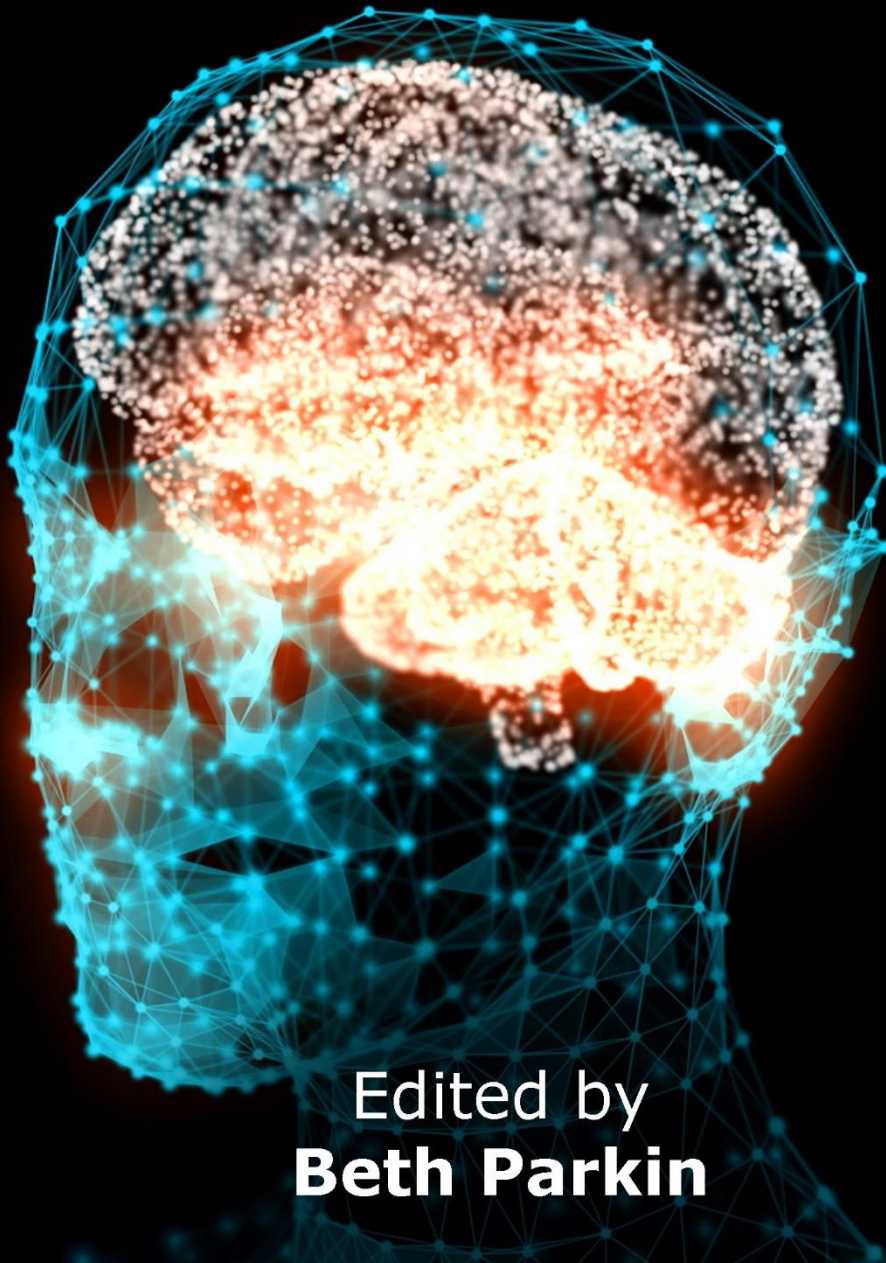
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PROGRESS IN BRAIN RESEARCH

# Real-World Applications in Cognitive Neuroscience

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Edited by  
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# Expertise differences in a 2D animation simulation decision-making task: The influence of presentation speed on performance

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## Abstract

This article investigates the effect of using different playing speeds of 2D animation on the decision accuracy and reaction times of elite footballers. Groups of players from different age categories (under 16, under 18 and under 23 years old) elite academy footballers watched 2D animations at five different ratios of real-life speed (0.5, 0.75, 1, 1.25- and 1.5-times real-world speed). Participants responded by choosing, from a number of options, which was the best attacking option in each 2D animation clip. After each clip, players also rated each clip for how “game-like” or realistic the scenario felt. Results showed a significant difference between all groups, whereby participants became faster and more accurate by age. Also, the result of “game-like” perception probing which compared perception in each group to each speed showed that the under 16 age group had statistically lower perception accuracy compared to the under 18 and under 23 age groups. This highlights that the more expertise a player has the faster information is processed.

Keywords: Expertise; Decision-making; Performance; Football; Talent identification

## Introduction

Developing new methods and solutions to measure the gap between expert and non-expert performance, and identify sporting talent has received significant attention during the last few decades. Understanding the mechanisms underlying the superior performance of experts compared to novices has been explored in a range of different domains including teaching (Borko and Livingston, 1989; Wolff et al., 2016), physics (Fakcharoenphol et al., 2015; Larkin et al., 1980), database design (Batra and Davis, 1992), fighter pilot training (Guckenberger et al., 1993; Seamster and Redding, 2017), nursing (Benner, 1982; Kydonaki et al., 2016) and numerous different sports (Ericsson and Smith, 1991). While expert performance has been studied in a variety of disciplines, the nature of sporting performance provides an ideal platform for researchers to investigate elite performance in a dynamic, ever-changing environment, often under stressful and constrained conditions (Lorains et al., 2013a, Lorains et al., 2013b).

During the last few decades, the elite performance approach (EPA), proposed by Ericsson and Smith (1991), has been used as a theoretical framework. An increasing body of

work has converged on the conclusion that perceptual-cognitive skills such as anticipation (Abernethy et al., 1994; Müller et al., 2006; Williams et al., 2002), pattern recall and recognition (Abernethy et al., 2005; Baker et al., 2003; Gilis et al., 2008) and decision making (Abernethy, 1996; Johnson and Raab, 2003; Starkes and Lindley, 1994) play a key role in the success of elite athletes.

Given the complex nature of competitive sports performance, developing research methods to capture how elite athletes make decisions in a different way to novices, and achieve superior outcomes can be time-consuming and difficult (e.g., MacMahon et al., 2009). In order to investigate this gap, researchers have often employed different process-tracing techniques which have been successful in individual and team sports (see Williams and Jackson, 2018 for a more in-depth review).

For example, the spatial and temporal occlusion paradigm has been used to identify the most relevant cues that experts use to make their decision in tennis and badminton (e.g., Farrow et al., 2005; Müller et al., 2006). In the temporal occlusion paradigm, a video is stopped at multiple time periods prior to the action of opponents, and spatial occlusion is used to remove specific parts of the opponents' body and racquet during the action. (e.g., Abernethy, 1990; Abernethy and Russell, 1987; Abernethy et al., 2001). Several studies which have used the occlusion paradigm showed that expert athletes are faster and more accurate in anticipating the next action in the match, across different sports, and can do more with less available information (see Williams and Jackson, 2018 for a more in-depth review).

A second example of process-tracing methods used in the study of expertise is the manipulation of the playback speed. This is based on the hypothesis that if elite athletes can use the minimum amount of information to make high-quality decisions, they will also perform better than novices if they are exposed to events at a faster speed. This is based on the concept of automaticity in elite athletes first proposed by Fitts and Posner (1967).

Automaticity refers to the superiority of elite performers in comparison to novices in performing the task with little need for thought or the details of the skill. These are usually the result of learning, repetition, and practice. The automaticity theory was investigated across different skills such as reading and language (Robinson, 2003), medicine (Stefanidis et al., 2007), and military training (Halff et al., 1986). In the domain of sport, automaticity was first investigated in physical skills by Beilock et al. (2002). In more recent work researchers have reviewed the concept in perceptual-cognitive skills such as decision-making. For example, Johnson and Raab (2003) investigated the effect of time pressure on decision accuracy in handball by asking them to make their decisions as quickly as possible. The results showed that athletes make more accurate decisions when they choose the first option they generated. In other words, if participants have a limited time to respond to a decision-making scenario, this may force them to make decisions more automatically. These findings have been supported by other recent research (e.g., Hepler and Feltz, 2012; Laborde and Raab, 2013; Raab and Gigerenzer, 2015; Sherwood et al., 2019).

Based on these findings and with recent advances in the use of technology, video-based assessment (Lorains et al., 2013a, Lorains et al., 2013b) 2D animation (Farahani et al., 2017) and 3D animation (Roza, 2004), simulation and virtual reality (Neumann et al., 2018; Pereira et al., 2018) are now widely used to compare how elite athletes are performing compared to novices in different sports. Among these technologies, video-based assessment and 2D animation have gained more attention due to the technically less complex procedure of producing example clips. Within these researches, a few attempts have been made to apply the use of speed as a process-tracing method. For example, Gilis et al. (2009) used a 2D simulation and speed manipulation for an off-the-pitch official assessment. Manipulation of speed on video was also studied by Lorains and MacMahon (2009). They reported that the use of speeded video creates a more “game-like” task. They compared elite, sub-elite and novice

athletes on normal speed and  $1.5 \times$  speed on the accuracy of decision-making. As a result of speeding up the clips, it was assumed that participants must make their decisions more automatically by identifying and processing the vital cues from the clip. Results showed that the effect of speed on the decision-making of elite athletes was significant as they were more accurate on fast clips than on the normal speed clips. On the other hand, sub-elite and novice athletes failed to keep their score on the fast clips and performed better on the normal ones.

Following the initial research by Lorains and Ma Mahon (2009), another study on the use of speed as a process-tracing method has been conducted by Lorains et al., 2013a, Lorains et al., 2013b on 85 elite, sub-elite and novice athletes. They compared the decision-making quality of these three groups using 6 different speeds ( $\times 0.75$ ,  $\times 1$ ,  $\times 1.25$ ,  $\times 1.5$ ,  $\times 1.75$  and  $\times 2$ ) on 70 clips. The duration of all the clips remained the same, but when they were played at a different speed, the length of the clip was converted based on the speed. For example, a six-second clip at a speed of  $2 \times$  actual speed took 3 s to be watched. They also asked the elite and sub-elite athletes to use a 7-point scale as a measure of “game-likeness” to rate each clip. The result showed that elite athletes were more accurate than the sub-elite and novice groups, and the sub-elite group was more accurate than the novice group. Also, it was reported that at a speed of  $\times 1.5$ , the gap in performance between elite athletes and the other 2 groups was significant. In terms of the “game-like” feeling of clips, both elite and sub-elite groups reported  $\times 1.25$  and  $\times 1.5$  as the most “game-like” speed. Although they used speed as a manipulation factor in their experiment, no data is reported on the response time of the athletes. The previous literature on video-based assessment showed that elite athletes are faster than their sub-elite and novice counterparts (e.g., Kioumourtzoglou et al., 1998; Nakamoto and Mori, 2012).

Following this study, a few more attempts were conducted on the use of speed as a process-training method in sport. Put et al. (2016) investigated the effect of speed on decision-making quality of assistant referees. They compared assistant referees' offside decision-making at three speeds (slow, normal and fast) and reported that the decision-making accuracy was higher in real-time and fast video clips in comparison with the slow motion. In another study by Spitz et al. (2018) the use of video-based assessment for assistant referees' decision-making skills, slow-motion speed has been used on 60 foul-play (whether an action is a foul or the game can continue) scenarios. They reported that for certain types of situations, such as contact of two players in a foul action or location of a foul (inside or outside the penalty box) slow-motion video can be a helpful tool. In another study by Fukuhara et al. (2018), slow-motion footage was used to assess and train the anticipation skills of elite and novice tennis players. Although the results failed to show any effect for the use of slow-motion training on anticipation skills, researchers reported superior performance of elite tennis players compared to novices' performance on the task. Their results suggest that even if the use of slow-motion footage enhances the recognition of key kinematic cues, it may not immediately improve anticipatory judgments in tennis.

The effectiveness of speed manipulation on video was also investigated in training the perceptual-cognitive skills of elite athletes. In an early attempt by Lorains et al., 2013a, Lorains et al., 2013b, the effect of video-based training on decision-making skills in Australian football was investigated. Pre to post-training tests were implemented for a normal speed group and an above real-time (playing the clip at a faster speed than normal) group. Lorains et al., 2013a, Lorains et al., 2013b suggested that video-based training above real-time could improve decision-making accuracy earlier in training compared to normal speed. Also, by comparing the post-test with a retention test, researchers reported that the fast group retained more of the performance improvement. Their findings were aligned with the automaticity theory.

Following Lorains et al., 2013a, Lorains et al., 2013b study, Farahani et al. (2017) examined the effects of video-based training in elite footballers' decision-making by presenting videos with training and testing scenarios at above real-time speeds. They compared five elite academy footballers' group performance on pre and post-test protocols based on different schedules after receiving five training sessions to investigate how much and on what schedule training is beneficial. Farahani et al. (2017) reported improvement in accuracy and response time on the task and also suggested that the effect of training did not last beyond 2 weeks.

Based on recent research into the effectiveness and validity of the video-based and simulation assessment in elite athletes, it is well-established that these technologies can be beneficial. However, with a limited number of comparisons between video-based assessment and 2D animation simulation, it is not clear which platform could most accurately distinguish the elite players from their novice counterparts in their perceptual-cognitive skills. Recent studies on comparison of Under 16, 18 and 23 decision-making skills on video and 2D animation showed that 2D animation is a more reliable platform as it is a simplified representation and more focused on the tactical picture of the game, and there is no information available on the body posture of the participants to guide the decision-making process of athletes. On the other hand, the effectiveness of the speed manipulation paradigm as a process-tracing method has been investigated in a few studies but is not yet established. As such, the aim of this experiment is to compare decision-making accuracy and speed of Under 16, 18 and 23 elite footballers at different speeds using 2D animation.

## **2. Methods and materials**

### ***2.1. Participants***

In total, 58 male participants (range 15–23 years old, mean 18 (SD = 2.34) years old) were drawn from three age groups (Under 16, 18 and 23). The U23 group comprised 20 footballers with a mean age of 21.2 who had been training and playing at Premier League level for at least 5 years. The U18 participants were 18 Premier League academy footballers with a mean age of 17.6 and at least 4 years of experience at the same level. The U16 group were 20 Premier League academy footballers with a mean age of 15.8 years and a minimum of 4 years of experience at Premier League academy level. They were all based at one of two major Premier League football academies. All participants had normal or corrected-to-normal vision. All participants were naive to the purpose of the study. All participants gave their written informed consent in accordance with the Declaration of Helsinki and the guidelines approved by the Ethical Committee of University College London (UCL).

### ***2.2. Experimental design***

The study comprised three experimental groups which differed in age and experience. Each participant performed the tasks while seated using an individual tablet in a quiet room. All testing sessions happened in the morning after team breakfast and before the gym and football session on the pitch to prevent the effect of physical fatigue due to exercise. Participants were asked to perform a tablet-based task by watching short video clips of football matches.

The task consisted of two parts. First, they had a warm-up session (comprised of 12 trials) and once they completed the warm-up, actual testing began with 50 clips (10 clips at each speed). In the warm-up session, all participants watched the clips at least once at one of

five different speeds (0.5, 0.75, 1, 1.25, and 1.5). For each trial, the participants were first shown a paused video of a football match with the location of the ball highlighted for 1 s. The 2D animation clip then played for 5 s, after which the screen paused again and three locations where the ball could have been passed to were highlighted (see Fig. 1).

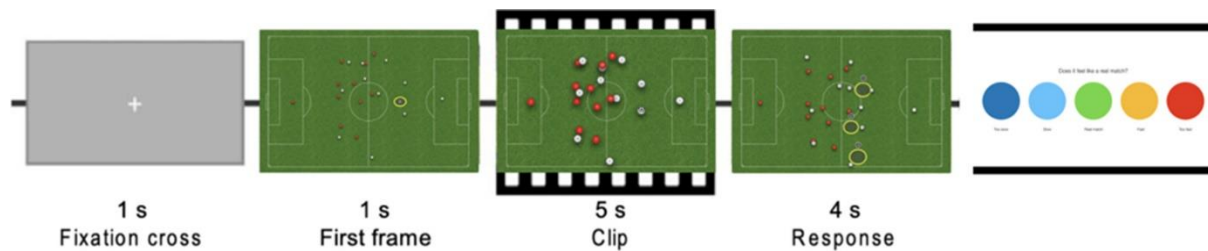


Fig. 1. Diagram showing the order and duration of stimuli for one trial.

The participants' task was to indicate the best option in terms of building a good attacking scenario by tapping on their choice of location on the tablet screen. They had 4 s to make a decision. After 4 s no response was available and the software moved to the next clips. Options were ordered indicating the best choice (value = 1), an intermediate choice (value = 2), and the worst choice (value = 3), failure to respond in 4 s was categorized as a value 3 decision. To determine the best choices for each scenario, each video clip was watched and independently rated by three UEFA-A (Union of European Football Associations) licensed coaches, and only clips with more than 60% agreement on the options were used.

The 2D animation clips were extracted from Premier League matches by a camera placed in the middle of the field and converted to birds-eye view. The duration of the 2D animation clips was 5 s and no feedback was provided during testing sessions (both in the warm-up phase and also in the actual test). Duration of each trial varied depending on the speed. 0.5 and 0.75 speeds (lower than 1) were categorized as slow speed and 1.25 and 1.5 (higher than 1) were considered above real-time speed (e.g., Guckenberger et al., 1993). For instance, if the normal speed of a trial lasted for 5 s, in 0.5-speed participants completed the clips in 7.5 s and if they watched a 1.5-speed trial, it was completed in 2.5 s. Trials were separated by a fixation cross on the screen for 1 s. Participants were asked to respond as quickly and as accurately as possible. Accuracy on the task was measured by converting the score (a value of 1, 2 or 3) to a percentage of the maximum possible score, and response time was measured in milliseconds.

At the end of each trial, all participants were asked to rate how game-like that particular clip speed had felt. They responded by tapping on one of the options on the screen (very slow, slow, normal, fast, very fast). Each option was mapped with one of the speeds (see Fig. 2).

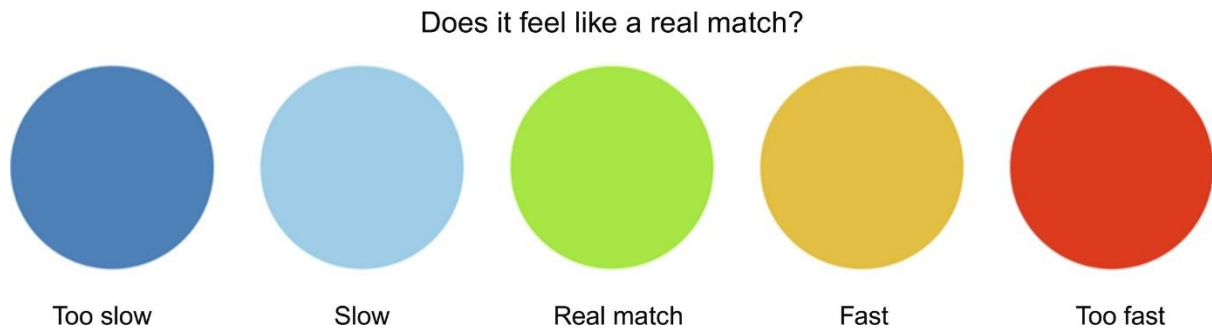


Fig. 2. Diagram showing the game-like options after each clip.

The experiment was developed on the Game Intuition® platform (London Cognition limited, UK) using the web portal for editing the 2D animation clips and building the decision-making screen. An iOS tablet pro with 10.5 in. touch (made by Apple Inc., USA) screen was used for the presentation of stimuli and participants were required to tap on the screen of the tablet to indicate their responses.

### 2.3. Statistical analysis

Accuracy and reaction time of different groups were compared using repeated measures ANOVA over five different speeds. Statistical significance was determined at the alpha level of 0.05, and the effect size was computed and interpreted for each analysis using Cohen's guidelines (i.e., 0.2 = small, 0.5 = medium, and above 0.8 = large; Cohen, 2013).

### 3. Results

There was a statistically significant difference across the five speed points,  $F(4,220) = 6.276$ ,  $P < 0.001$ , power = 0.98 and statistically significant differences between groups,  $F(2,55) = 34.403$ ,  $P < 0.001$ , power = 1.0, in accuracy. There was also a significant interaction between speed and group,  $F(8,220) = 3.521$ ,  $P = 0.001$ , power = 0.98. Following this interaction indicated there was a reduction in accuracy from TooSlow to Slow and an increase from Slow to Fast as well as a reduction from Fast to TooFast. Pairwise comparison showed that accuracy increased significantly from Slow to Fast (mean difference  $4.176 \pm 1.21$ ,  $P = 0.01$ ) and decreased from Fast to TooFast (mean difference =  $6.01 \pm 1.28$ ,  $P < 0.001$ ). Comparing accuracy in each group averaged across speed showed that the U23 group had statistically higher accuracy compared to the U16 (mean difference =  $8.02 \pm 1.01$ ) and U18 (mean difference =  $6.17 \pm 1.03$ ) groups, both for  $P < 0.001$  (Fig. 3).



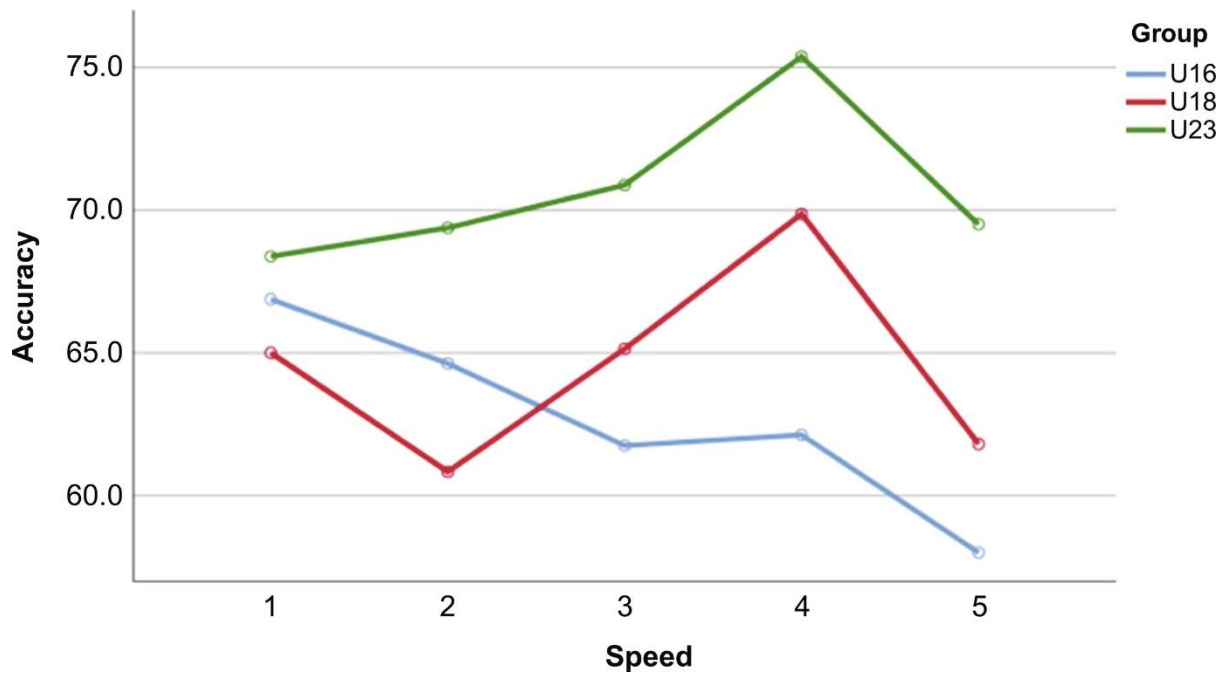


Fig. 3. Estimated marginal means for accuracy across different speeds for different groups.

Within U16 group, there was a statistically significant increase in accuracy from TooSlow to TooFast (mean difference  $8.87 \pm 2.32$ ,  $P = 0.003$ ) and from Slow to TooFast (mean difference  $6.62 \pm 2.23$ ,  $P = 0.04$ ). Within U18, there was a statistically significant increase in accuracy from Slow to Fast (mean difference  $9.02 \pm 2.18$ ,  $P = 0.001$ ) and a statistically significant decrease from Fast to TooFast (mean difference  $8.05 \pm 2.30$ ,  $P = 0.009$ ). Within U23 group, there was a statistically significant decrease from TooSlow to Fast (mean difference  $7.00 \pm 1.68$ ,  $P = 0.001$ ).

### 3.1. Response time

There was a statistically significant difference across the five speed points,  $F(3.38, 220) = 13.08$ ,  $P < 0.001$ , power = 1.0 and statistically significant differences between groups,  $F(2, 55) = 23.09$ ,  $P < 0.001$ , power = 1.0, in reaction time. There was also a significant interaction between speed and group,  $F(6.76, 220) = 14.09$ ,  $P < 0.001$ , power = 1.0.

Following up this interaction indicated there was an increase in reaction time from TooSlow to Slow and a decrease from Slow to Fast as well as an increase from Fast to TooFast. Pairwise comparison showed that reaction time increased significantly from TooSlow to Slow (mean difference =  $0.31 \pm 0.84$ ,  $P = 0.005$ ), from TooSlow to TooFast (mean difference =  $0.52 \pm 0.89$ ,  $P < 0.001$ ), from Normal to TooFast (mean difference =  $0.44 \pm 0.08$ ,  $P < 0.001$ ), and from Fast to TooFast (mean difference =  $0.47 \pm 0.05$ ,  $P < 0.001$ ). Comparing reaction time in each group averaged across speed showed that the U16 group had statistically higher reaction time compared to the U18 (mean difference =  $0.83 \pm 0.12$ ) and U23 (mean difference =  $1.36 \pm 0.12$ ) groups, and U18 had statistically higher reaction time compared to the U23 (mean difference =  $0.53 \pm 0.12$ ), all for  $P < 0.001$  (Fig. 4).

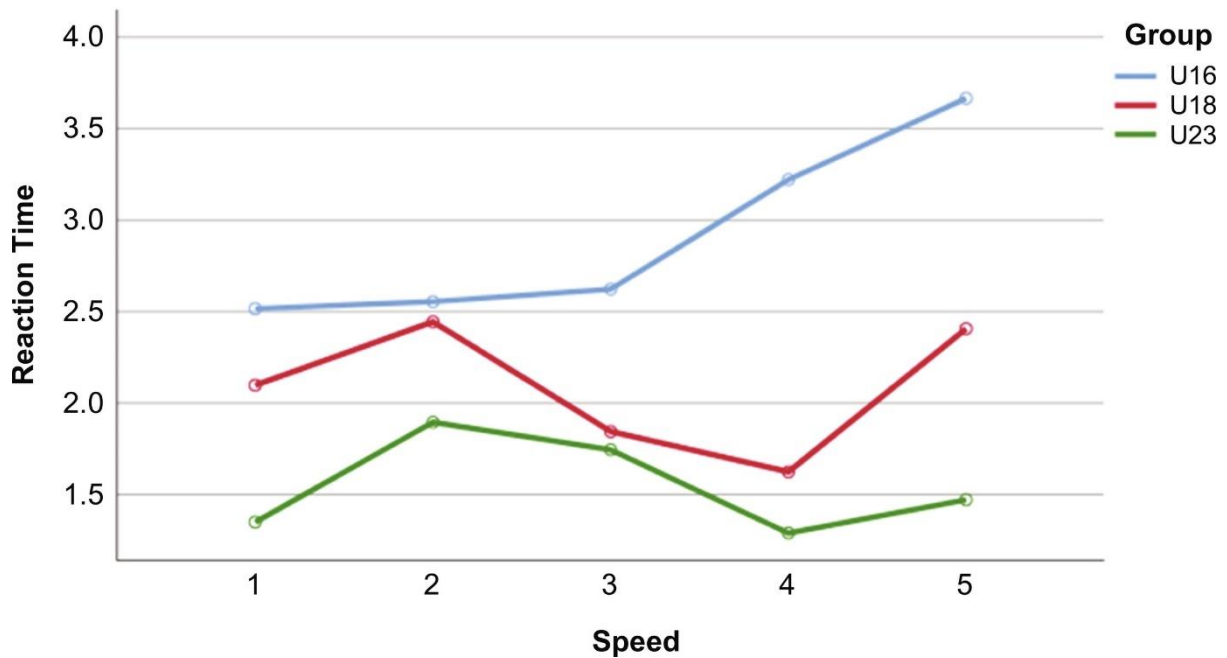


Fig. 4. Estimated marginal means for reaction time across different speeds for different groups.

Within U16 group, there was a statistically significant increase in accuracy from TooSlow to Fast (mean difference  $0.70 \pm 0.15$ ) and to TooFast (mean difference  $1.15 \pm 0.15$ ), from Slow to Fast (mean difference  $0.66 \pm 0.16$ ) and to TooFast (mean difference  $1.11 \pm 0.14$ ), from Normal to Fast (mean difference  $0.59 \pm 0.14$ ) and to TooFast (mean difference  $1.04 \pm 0.14$ ), and from Fast to TooFast (mean difference  $0.44 \pm 0.09$ ), all for  $P < 0.05$ . Within U18, there was a statistically significant decrease in reaction time from Slow to Normal (mean difference  $0.60 \pm 0.15$ ) and to Fast (mean difference  $0.82 \pm 0.17$ ), and an increase from Normal to TooFast (mean difference  $0.56 \pm 0.15$ ) and from Fast to TooFast (mean difference  $0.78 \pm 0.09$ ), all for  $P < 0.05$ . Within U23 group, there was a statistically significant increase from TooSlow to Slow (mean difference  $0.54 \pm 0.14$ ), a statistically significant decrease from Slow to Fast (mean difference  $0.60 \pm 0.16$ ), and from Normal to Fast (mean difference  $0.45 \pm 0.14$ ), all for  $P < 0.05$ .

### 3.2. Perception

There was a statistically significant difference across the five speed points,  $F(4,220) = 22.34$ ,  $P < 0.001$ , power = 1 and statistically significant differences between groups,  $F(2,55) = 21.16$ ,  $P < 0.001$ , power = 1.0, in Perception. There was also a significant interaction between speed and group,  $F(8,220) = 2.50$ ,  $P = 0.01$ , power = 0.90.

Following up this interaction indicated there was a reduction in perception from TooSlow to Slow and an increase from Slow to TooFast. Pairwise comparison showed that perception decreased significantly from TooSlow to Slow (mean difference  $10.75 \pm 2.06$ ), to Normal (mean difference  $7.22 \pm 1.88$ ), to Fast (mean difference  $7.31 \pm 2.07$ ), and decreased from TooSlow to TooFast (mean difference  $6.77 \pm 1.72$ ), all for  $P < 0.05$ . Perception also increased from Slow to TooFast (mean difference  $17.53 \pm 2.17$ ) and from Normal to TooFast (mean difference  $14.00 \pm 1.87$ ), and from Fast to TooFast (mean difference  $14.09 \pm 1.81$ ), all for  $P < 0.05$ . Comparing perception in each group averaged across speed showed that the U16 group had statistically lower perception accuracy compared to the U18 (mean difference =  $6.03 \pm 2.11$ ) and U23 (mean difference =  $13.40 \pm 2.06$ ) groups, both for  $P < 0.05$ . U18 group

had statistically lower perception accuracy compared to the U23 (mean difference =  $7.36 \pm 2.11$ ),  $p = 0.003$ .

Within U16 group, there was a statistically significant decrease in perception from TooSlow to Slow (mean difference  $11.00 \pm 3.50$ ), to Normal (mean difference  $15.00 \pm 3.19$ ), and an increase from TooSlow to TooFast (mean difference  $9.00 \pm 2.93$ ), from Slow to TooFast (mean difference  $20.00 \pm 3.70$ ), from Normal to TooFast (mean difference  $24.00 \pm 3.19$ ), and from Fast to TooFast (mean difference  $1.00 \pm 3.08$ ), all for  $P < 0.05$ . Within U18, there was a statistically significant decrease in perception from Slow to TooFast (mean difference  $16.11 \pm 3.90$ ) and from Fast to TooFast (mean difference  $17.77 \pm 3.25$ ), both for  $P < 0.05$ . Within U23 group, there was a statistically significant decrease from TooSlow to Slow (mean difference  $13.50 \pm 3.50$ ) and an increase from Slow to TooFast (mean difference  $16.50 \pm 3.70$ ), both for  $P < 0.05$ .

To summarize the more experienced (18–23 years old) players made better and faster decisions at  $1.25 \times$  actual speed. The U16s did not show these benefits and become less accurate with increasing speed.

#### 4. Discussion

The aim of this study was to investigate the effect of using different playing speeds of 2D animation on the accuracy and decision time of elite footballers. Groups of players from different age categories, U16, U18 and U23 elite academy footballers watched 2D animations at five different ratios of real-life speed (0.5, 0.75, 1, 1.25- and 1.5-times real-world speed). Participants responded by choosing from a number of options which the best attacking option was in a particular 2D animation clip. After each clip, all groups also rated each clip for how “game-like” or realistic the scenario felt. Results showed a significant difference between all groups. There was an interaction between performance and age group, whereby the older age groups were faster and more accurate.

In chapters “Assessing decision-making in elite academy footballers using real-world video clips” by Farahani et al. and “Assessing decision making using 2D animations in elite academy footballers” by Farahani et al., the effect of conceptual information and game information in the video were examined. In our previous work, we also had information about how people perceive the game (Farahani et al., 2017). The goal of this experiment was to understand whether there is a relationship between the playing speed at which the game is presented, knowing that players perceive games at different speeds, and what seems faster to a novice might seem fast to the expert?

So, one of my predictions here was that the more advanced players will be better at the higher speeds, which are aligned with the previous studies in aviation (Kolf, 1973) and Australian football (Lorains et al., 2013a, Lorains et al., 2013b).

Comparing the current data with chapters “Assessing decision-making in elite academy footballers using real-world video clips” by Farahani et al. and “Assessing decision making using 2D animations in elite academy footballers” by Farahani et al., in this volume it looks like the utility of using speed to assess players lies somewhere between 2D and video. Video-assessment was not very sensitive and 2D seemed to be quite sensitive. At the lower levels of expertise (U16 and U18), speed does not really work which actually fits with the video-based assessment experiment. It seems here adding timing information to accuracy has no benefits for less experience players.

The result of perception questions on different speeds (Fig. 5) is good evidence that the more expertise a player has the faster he processes information, which may account for the reaction time differences noted in the earlier experiment. It might seem obvious as we know elite athletes are better than sub-elite and novices but in the previous experiments, there

was not always a difference between U16, U18 and U23 groups. Here however I have now found a strong link between the application of above real-time training. The speed at which the game is presented and the speed at which the game is perceived has a great effect on players. In order to learn better, we should be thinking about the speed which we present to the different age groups. Perhaps we should try slower speeds for the U16 group and faster speeds for U23 groups. Perhaps limiting time forces them to access their automatized expertise. Maintaining my comparison with the music literature, it is a common strategy in music training to ensure that people can play a piece of music slowly before they play quickly (Roden et al., 2014).

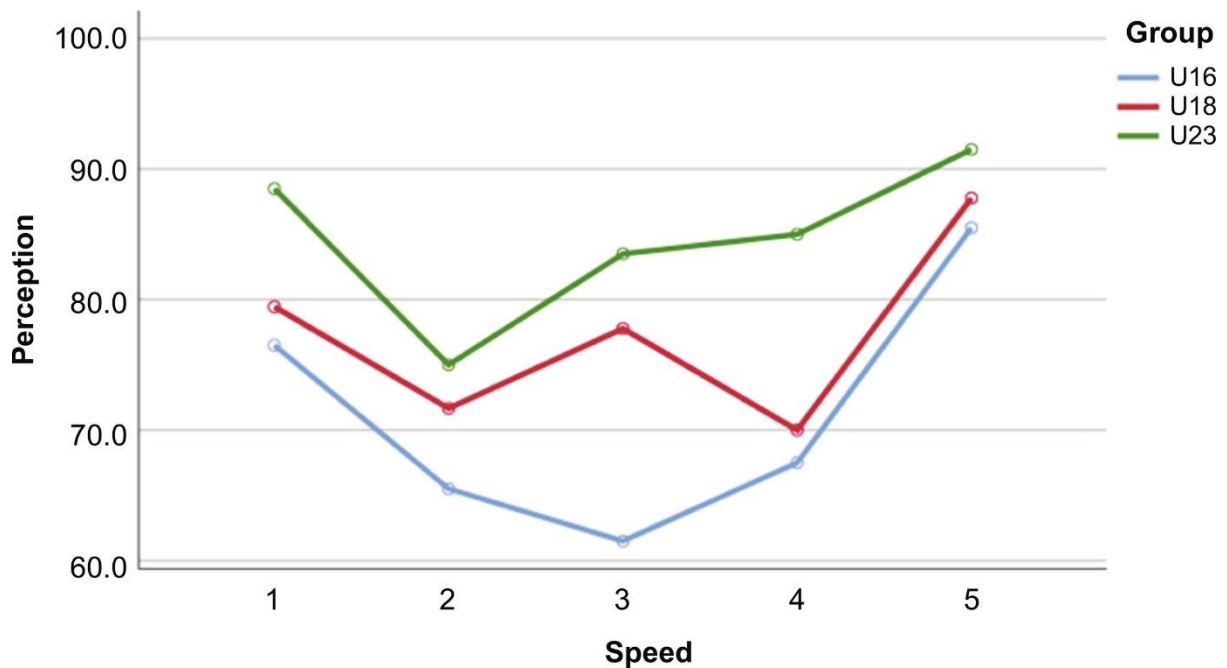


Fig. 5. Estimated marginal means for perception across different speeds for different groups.

When it comes to the perception of the speed, at all speeds the more elite players are better at knowing the speed of the presentation relative to the real game. The interesting point is that those elite players are better at decision making  $1.25 \times$  speed which is aligned with the Lorains et al., 2013a, Lorains et al., 2013b study in Australian football. The poor performance of U16 in identifying the speed of the task could be additional evidence of their need to get more experience and it maybe titrated in future experiments as a marker of their progress. This result suggests that the U16 as a group have a poorer internal model of game representation and therefore cannot process all the information as quickly or as accurately as the U18 and U23 players.

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