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The influence of coaching instructions on decision-making in soccer

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ABSTRACT

This experimental study examined if precueing influences soccer players' (N = 13, age = 19.5 ± 2.2 years) decisions and visual search behaviour in a soccer-specific video-based decision-making task. The decision-making task was preceded by a video containing either the basic rules of soccer (neutral condition) or specific coaching instructions that were either compatible or incompatible with the correct decision of the 30 subsequent clips (precue condition). Overall, decision-making accuracy (80.81 ± 8.40 %) was lower and response time (590.75 ± 203.47 ms) was faster in the precue condition compared to the neutral condition (85.85 ± 4.41 %; 630.47 ± 241.55 ms). Additionally, fixation location appeared to be marginally influenced by the compatibility of the precues given. This research supports the conclusion that compatible precues improve sport specific decision-making while incompatible precues hinder performance. Coaches with experienced athletes are advised to use a more implicit approach to allow players to optimize their decision-making and not constrain athletes' perception of environmental cues.

1. Introduction

It is common for athletes from different domains to receive tactical guidelines, instructions and/or feedback from their coach aimed at enhancing performance (Porter, Wu, & Partridge, 2010). Seemingly, a large body of instruction-related research has investigated whether an explicit (i.e., consciously clear and obvious) or an implicit (i.e., a not-obvious and more reliance on self-discovery) method is better for facilitating the acquisition of perceptual-cognitive skill in an athletic population. Research has demonstrated that the positive effects of explicit instructions seem to have an inverse relationship with an increase in experience, as explicitly instructing experienced athletes has been reported to be detrimental to sporting-performance (Buszard, Farrow, & Kemp, 2013). Accordingly, there is a greater advocacy for more implicit means of delivering instructions with experienced athletic populations. Allowing the participant to discover for themselves the relationships between cues/movement patterns and behavioural outcomes has been well documented to enhance perceptual-cognitive skills (Farrow & Abernethy, 2002; Kirlik, Walker, Fisk, & Nagel, 1996; Williams, Ward, Knowles, & Smeeton, 2002). Such research on how humans effectively interact with their environment is related to either the Information Processing Approach (Fitts & Posner, 1967; Schmidt, 1975) or the Ecological Approach (Turvey, 1977; Turvey, Shaw, Reed, & Mace, 1981) whereas research that adopts the theory of *priming* to explain the coupling of perception and action has largely remained in cognitive psychology literature.

Priming is an interesting paradigm to explain motor behaviour in sport because it focuses on the alteration in behaviour based on being subjected to previous stimuli (Elliott, 2004; Posner, Nissen, & Ogden, 1978). One common method to prime participants is known as precueing (Posner et al., 1978). A precue is defined as a stimulus provided to the participant prior to the task that offers them a hint as to what may occur next. Precueing is also a technique that many coaches use to deliver their instructions to athletes in order to encourage desired tactical responses (Farrow & Abernethy, 2002). For example, coaches may deliver probabilistic information about the opposition's tactics before the match, such as telling a tennis athlete that '75 percent of the time, the opponent serves more to the right'. Together, the similar incentives of both precueing techniques and instruction-related research is to further understand what transpires when an individual's attention is directed to a certain part of the environment by a cue, and how it impacts on the decision-making and motor behaviour of an individual.

Beavan et al. (2019) further demonstrated that implicit precues could either enhance or hinder the response times of highly

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talented youth football players based off the congruency of the delivered precue in a four-choice response time task. Advanced information was presented about the likely location of the upcoming stimulus, and players had to respond accordingly. The findings demonstrated that stimulus detection and response times were enhanced when athletes were provided with a precue that contained correct and beneficial information for the subsequent task (i.e., a congruent precue); confirming the results from the original study in a general population (Posner, Snyder, & Davidson, 1980). Opposingly, when the precue provided misleading or incorrect information before the subsequent task (i.e., an incongruent precue), it hindered athletes' response initiation times. This demonstrates that experienced athletes are able to act upon beneficial information, but are still susceptible to misleading information delaying their response times. However, as the results from Beavan et al. (2019) were based on simple motor responses, the authors advocated for such precueing paradigms to be further used in more ecologically valid environments to improve our understanding of how advanced information can alter the perception-action coupling of athletes and more complex sport specific movements.

In the same way, a coach's instructions may either be congruent or incongruent with a situation players may encounter during a game. For example, a soccer coach may instruct a team to maintain possession of the ball in central regions of the pitch to improve the likelihood of more shots on goal. If a situation arises during the game in which there is an available teammate who is in a position located centrally on the field, the precue (i.e., a coach's instruction) is congruent with the provided scenario, and in-turn the athlete may have a faster response time to act upon this decision. However, if a situation occurs where there are no good passing options to keep the ball central, the player may be forced to search for an option that is incongruent with the instructions; leading to an alternate decision being made (or having to disobey instructions) by passing to a player wider on the field that is more available. This may result in slower response times. It is therefore plausible that coaching instructions may alter a player's attention to different in-game cues, resulting in different information perceived and consequently a possible change of sporting behaviour (Buszard et al., 2013). Accordingly, the associated impact from tactical instructions on the decision-making process of an athlete may be similar to what has previously been demonstrated in precueing laboratory studies (Posner et al., 1980; Rosenbaum, 1983).

This alteration in motor behaviour is thought to be attributed to a change in the participant's attention relative to the intention of the precue (Posner et al., 1980); however many priming studies lack the inclusion of attentional measurements to confirm such. Indeed, one study compared the visual search behaviours of athletes under different instructions provided before the task. Buszard et al. (2013) reported that although no differences were found among three instructional groups in mean number of fixations, mean fixation duration and search rate, differences were found between the proportion of total time fixating on specific areas of interest as a result from the intention of the instruction. As a result, the authors concluded that an explicit direction of athletes' attention to certain in-game cues may change the information perceived from the environment, and may be an underlying reason for the negative influence that explicit tactical instructions has on many sporting-performers (Buszard et al., 2013; Memmert & Furley, 2007).

Therefore, the purpose of this study was to investigate the effects of tactical instructions as a form of precueing on measures associated with decision-making (i.e., gaze behaviour, response accuracy and response time) in a soccer specific video-based decision-making task. First, it was hypothesized that players would have poorer decision-making performance when receiving tactical coaching instructions compared to when no precues were provided. Second, it was further hypothesized that congruent precues would enhance decision-making performance while incongruent precues would hinder performance in a video-based decision-making task. Last, due to the intention of the delivered precues (reported below in the methods section), the third hypothesis was that participants would demonstrate a higher proportion of total time visually fixating on defenders and the goalkeeper/net, and a lower proportion on unmarked attackers in the precueing condition compared to the neutral condition.

2. Methods

2.1. Participants

A total of 13 male intermediate soccer players (19.5 ± 2.2 years) were recruited from several regional soccer clubs, all of whom were midfielders and right footed. Seven of these participants had their eye movements recorded. Participants had an average of 13.4 ± 2.0 years of experience in soccer and all had normal or corrected to normal vision. Written informed consent or consent from either a parent or guardian if participants were under the age of 18 was received prior to the commencement of this study. Ethical approval was obtained by the local Human Research Ethics Committee.

2.2. Test film

Thirty film based, offensive-play videos previously developed and validated by Vaeyens, Lenoir, Williams, Mazyn, and Philippaerts (2007) were used to assess perceptual-cognitive skill (Figure 1). The videos used in the current study were identical to those used in the original studies (Vaeyens, Lenoir, Williams, Mazyn, et al., 2007; Vaeyens, Lenoir, Williams, & Philippaerts, 2007). Vaeyens and colleagues used a professional cameraman to film the simulations from an elevated perspective (approximately 3 m) in the centre circle area behind one of the attackers. Participants are required to imagine themselves as an offensive midfielder playing in the central position that was just in front of the camera, playing in the yellow vest and was at all times clearly identifiable (i.e., 'yellow player' in Figure 1). The recorded simulations varied in the number of players presented on film: 2 versus 1 (i.e., 2 attackers, including the yellow player, vs. 1 defender), 3 versus 1, 3 versus 2, 4 versus 3, and 5 versus 3. Each condition also included a goalkeeper. Videos lasted an average of 6 s and ranged between 4-9 s. A freeze frame of 1.5 s on the initial scene of each clip allowed participants to identify their teammates and the opposing team, as well as their positions on the field (Roca, Ford, McRobert, & Williams, 2011). Each video clip was occluded using iMovie (10.0.9, Apple Inc., California, USA), indicated by a black screen. The moment of occlusion occurred at the critical decision moment, considered to be the precise moment at which the participant was required to make a decision and execute a response action (Vaeyens, Lenoir, Williams, Mazyn, et al., 2007; Williams et al., 2002). Accordingly, each sequence ended with a pass toward the player wearing the yellow vest. Five experienced soccer coaches independently viewed the offensive simulations to ensure that each sequence was realistic and was representative of actual game play. The presented test films included only the sequences approved by all five coaches, being a total of 30 trials consisting of: four 2 vs.1 (offensive players vs. defensive players), nine 3vs.1, six 3vs.2, five 4vs.3 and six 5vs.3 scenarios.

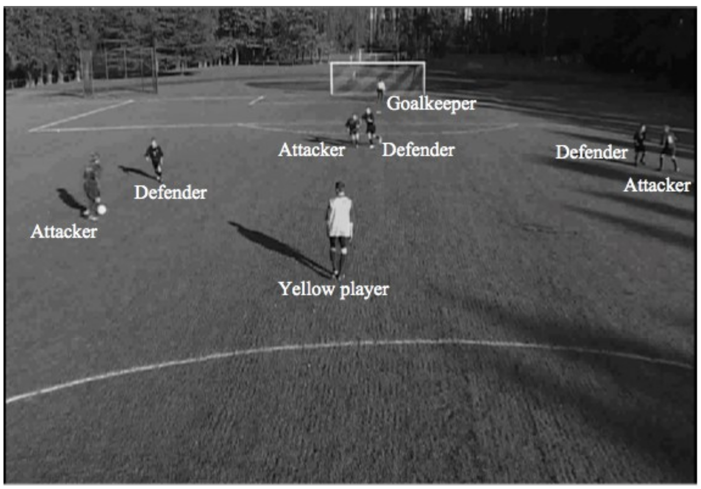

Figure 1: A screenshot of an offensive scenario (Vaeyens, Lenoir, Williams, Mazyn, et al., 2007).

2.3. Precueing and neutral videos

The animated videos were created using VideoScribe (Sparkol, Bristol, England). The precueing video was designed to simulate tactical instructions from a coach typically received before the game or during half time using a whiteboard to display their instructions. The precueing video presented three written phrases with a voice overlay and a diagrammatic representation of the instructions. The precues were as follows: i) "The opposition's goalkeeper is insecure, so just get a shot in on target whenever you get the chance", ii) "The opposition's defenders are fast and strong, but they are not agile. In a one-on-one situation, taking them on is the best choice", and iii) "In our formation, we outnumber the opposition in the central axis, so avoid using the width of the field". These three phases were written in appropriate coaching language by an experienced, appropriately qualified coach to ensure the realism of the situations was maintained. Furthermore, the creation of the videos went through several drafts until the coach deemed it was a suitable delivery of instructions. In contrast, the neutral video presented the basic rules of soccer with similar diagrammatic representations implemented to avert participants from making a link between the intention of the video and the subsequent task.

Three independent raters watched each trial and separately rated whether the best decision was congruent with at least one of the instructions (18/30 trials) or incongruent with all three instructions (12/30 trials). In the case that a certain trial was not agreed by all three reviewers if the best option was positively aligned with the coaching instructions or not, a fourth reviewer was asked to watch the trials and the majority ruled.

2.4. Apparatus

A mobile, head-mounted, binocular eye-tracking system (ETG 2.0 by SensoMotoric Instrument, Teltow, Berlin, Germany) with proprietary recording software (Version 2.6, iViewETG) was used to record visual search strategy with a sampling frequency of 24 Hz. The recording of the eye-tracking data was controlled through a wired connection by a connected laptop (Lenovo, Beijing, China). A positional cursor was used to identify visual point of gaze with a manual three-point calibration by the tester.

2.5. Procedure

Participants completed two 30-minute sessions, with a four week separation to negate any learning effects, and allow for a wash-out period (Woods, Williams, & Tavel, 1989). Upon arrival, participants completed a generic sports participation history questionnaire that asked for participants' years of experience playing soccer, their current playing position, age and preferred foot. Prior to testing, eye-tracking glasses (ETG 2.0 by SensoMotoric Instrument, Teltow, Berlin, Germany) were calibrated at 1.5 m away from the projector screen. To ensure adequate calibration, this process was repeated after the five practice scenarios, and between blocks of 10 videos. After the calibration of the eye-tracking glasses, participants watched either a precueing video (1:33 min) or a neutral video (1:13 min) projected onto a 2.65 m high x 4.35 m wide screen positioned 4.4 m from the participant using a projector (Sony, XGA VPL-CX70, Japan) (see Figure 2).

Following the completion of the video, participants completed five practice trials of various scenarios. Participants then completed the 30 aforementioned offensive game-play trials in a randomized order. An inter-trial rest period of 10 seconds was administered between each clip. Participants were required to watch the soccer scenarios and execute a response action as quickly and as accurately as possible following the occlusion of each video. Participants responded by either: i) passing the ball to another team mate on the screen, ii) shooting the ball towards the goal, or iii) dribbling the ball as if they are moving around a defender. Participants performed one of the three movements with a soccer ball placed 1 m in front of them as depicted in Figure 2. Additionally, participants were asked to immediately verbalize their intended decision and response after each scenario.

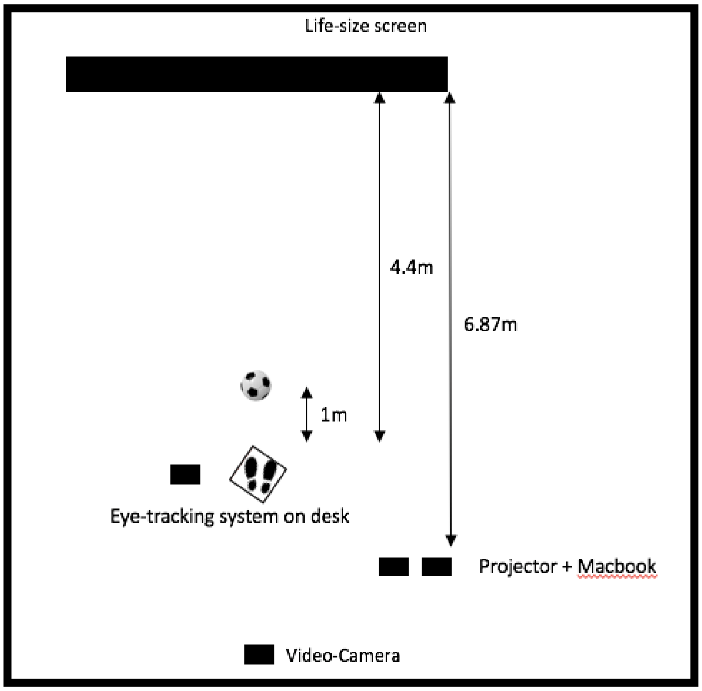

Figure 2: A diagrammatic representation of the laboratory testing procedure adapted from Vaeyens, Lenoir, Williams, Mazyn, et al. (2007).

2.6. Dependent variables

2.6.1. Decision-making

Response accuracy: Three nationally accredited coaches subjectively determined a four-point scale based on the most ideal decision that would lead to a goal scoring opportunity. In accordance with Vaeyens, Lenoir, Williams, Mazyn, et al. (2007), i) 3 points – the most goal oriented action that will directly lead to a goal scoring opportunity; ii) 2 points – not the most goal oriented action, however it is likely that it will create a goal scoring opportunity; iii) 1 point – allows for the maintenance of possession but doesn't create a goal scoring opportunity, and; iv) 0 points – an action that is likely to result in the loss of possession. Response accuracy was measured as a percentage of the total score available for each situation, with a total score out of 60 points.

Response time: Response time was measured as the time taken following the occlusion at the critical decision moment to the initiation of response, recorded when the participant raised their heel off the floor from either foot with intention to kick the ball (ms). A Garmin VIRB (Schaffhausen, Switzerland) video recording device was used to record participant's movement (120 fps). Analysis was conducted using a frame-by-frame approach with Kinovea software (version 0.8.15, Kinovea open source project, www.kinovea.org).

Frequency of response: Frequency of responses was measured as the amount of times a participant selected a certain response in each condition. Response choices were: pass right, pass left, pass centre/centre right/centre left, shoot and dribble.

2.6.2. Visual search data

Fixation location % (per scenario) for one of nine areas listed was analysed manually: 1. yellow offensive player [YP]; 2. player in possession of the ball [PB] ; 3. ball [B]; 4. unmarked attacker [A]; 5. attacker closely marked by a defender [A/D]; 6. defender [D]; 7. goalkeeper [K]; 8. free space [FS]; and 9. unspecified areas that did not match the aforementioned areas [U]. Analysis was conducted using a frame-by-frame approach with Kinovea analysis software. Data was collected from the initiation of the video until the occlusion of the video.

2.7. Statistical analysis

For statistical analysis, SPSS 24.0 (IBM, New York, United States) was used. Data are presented as mean ± SD. Prior to analysis, data were tested for normality by visual analysis of box plots. A Repeated Measures Multivariate Analysis of Variance (RM-MANOVA) with two within-subject factors [condition (neutral x precue) and congruency (congruent x incongruent)] was used to analyse the differences in performance for each scenario (3vs.1, 3vs.2, 4vs.3 and 5vs.3). The 2vs.1 scenarios were not considered in the analysis as no scenarios were deemed incongruent with instructions. In all repeated measures analyses, Bonferroni corrections were applied for multiple comparisons, and partial eta squared effect sizes (ES) were used to analyse the magnitude of effects. Effect sizes were interpreted as follows: 0.02 = small; 0.13 = moderate; and >0.26 = large (Bakeman, 2005; Cohen, 1988). Furthermore, a Repeated Measures Analysis of Variance (RM-ANOVA) was used to analyse differences in the frequency of different responses given by the participants (pass left, pass right, pass centre, shoot, dribble). The criterion alpha level for significance was set at $p \leq 0.05$.

3. Results

3.1. Preparatory analysis

The reliability of the visual search behaviour analyses was assessed using intra-class correlation coefficient (ICC), with a wash out period of three months. The reliability was described as "excellent" for ICC values in the range of 0.8-1.0, "good" for 0.6-0.8, and "poor" for <0.6 (Shrout & Fleiss, 1979). Upon analysis, an excellent degree of reliability was observed in the visual search behaviour measurements. The average measure of ICC was 0.993 with a 95% confidence interval from 0.990 to 0.995 ($F(129,129) = 145.695$, $p < 0.001$). For univariate analyses, see Table 1 for decision-making variables and Table 2 for fixation location variables.

Table 1: Results of three types of responses under different conditions.

		Neutral		Precue		Condition		Congruency		Interaction	
		Congruent	Incongruent	Congruent	Incongruent						
	Scenario	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	F-value	ES	F-value	ES	F-value	ES
Response Accuracy	3 vs. 1	2.95 (0.10)	2.62 (0.54)	2.67 (0.60)	2.24 (0.76)	4.622	0.262	6.241*	0.324	0.157	0.012
	3 vs. 2	2.55 (0.52)	2.71 (0.52)	2.71 (0.29)	2.19 (0.89)	4.452	0.255	0.663	0.049	5.315*	0.290
	4 vs. 3	1.63 (0.87)	2.43 (0.94)	1.68 (0.56)	2.43 (0.94)	0.047	0.004	5.084*	0.281	0.047	0.004
	5 vs. 3	2.43 (1.02)	2.67 (0.30)	2.57 (0.51)	2.31 (0.60)	0.668	0.049	0.003	<0.001	1.534	0.106
Response Time	3 vs. 1	569.924 (135.198)	569.773 (181.970)	540.188 (128.192)	569.242 (129.922)	0.174	0.017	0.418	0.040	0.810	0.075
	3 vs. 2	846.848 (230.951)	635.909 (258.894)	657.697 (230.848)	653.182 (183.067)	4.873	0.328	7.658*	0.434	6.256*	0.385
	4 vs. 3	686.295 (217.172)	754.909 (328.683)	647.114 (200.847)	675.909 (163.352)	1.150	0.103	1.403	0.123	0.278	0.027
	5 vs. 3	615.273 (157.279)	614.939 (160.947)	572.818 (238.208)	564.018 (161.819)	1.086	0.098	0.010	0.001	0.010	0.001
Frequency of Response	Pass Right	10.67 (1.291)		8.20 (3.278)		8.421*	0.376				
	Pass Left	4.67 (1.633)		2.93 (1.668)		7.608*	0.352				
	Pass Centre	2.47 (2.326)		2.93 (2.658)		0.560	0.038				
	Shoot	7.80 (1.612)		9.07 (1.981)		13.513**	0.491				
	Dribble	4.0 (2.699)		6.40 (5.422)		2.925	0.173				

Note: * = $p < 0.05$, ** = $p < 0.01$, ES = partial eta squared effect sizes. Effect sizes were interpreted as <0.02 as small; 0.13 as moderate; and >0.26 as large (Cohen, 1988).

Table 2: Results of fixation locations between different conditions

		Neutral		Precue		Condition		Congruency		Interaction	
		Congruent	Incongruent	Congruent	Incongruent						
Fixation Location	**Scenario**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	**F**	**ES**	**F**	**ES**	**F**	**ES**
YP	3 vs. 1	0.114 (0.047)	0.253 (0.113)	0.104 (0.059)	0.239 (0.111)	2.588	0.301	20.445**	0.773	0.025	0.004
	3 vs. 2	0.221 (0.085)	0.274 (0.090)	0.219 (0.062)	0.186 (0.073)	2.199	0.268	0.310	0.049	11.881*	0.664
	4 vs. 3	0.161 (0.066)	0.171 (0.059)	0.089 (0.039)	0.104 (0.078)	6.492*	0.520	1.717	0.223	0.025	0.004
	5 vs. 3	0.214 (0.059)	0.173 (0.085)	0.227 (0.064)	0.166 (0.067)	0.016	0.003	7.943*	0.570	0.750	0.111
PB	3 vs. 1	0.423 (0.064)	0.234 (0.063)	0.440 (0.116)	0.199 (0.053)	0.113	0.019	53.557**	0.899	1.021	0.145
	3 vs. 2	0.424 (0.118)	0.381 (0.052)	0.446 (0.135)	0.393 (0.143)	0.083	0.014	1.737	0.224	0.047	0.008
	4 vs. 3	0.336 (0.103)	0.260 (0.085)	0.366 (0.111)	0.296 (0.113)	6.626*	0.525	4.125	0.407	0.011	0.002
	5 vs. 3	0.254 (0.112)	0.301 (0.077)	0.304 (0.098)	0.286 (0.058)	0.129	0.021	1.742	0.225	1.338	0.182
B	3 vs. 1	0.199 (0.102)	0.116 (0.089)	0.147 (0.114)	0.179 (0.104)	0.106	0.017	2.046	0.254	24.304**	0.802
	3 vs. 2	0.030 (0.058)	0.033 (0.037)	0.016 (0.024)	0.049 (0.060)	0.007	0.001	2.765	0.315	1.099	0.155
	4 vs. 3	0.079 (0.076)	0.164 (0.108)	0.076 (0.061)	0.051 (0.086)	8.107*	0.575	2.168	0.265	3.309	0.355
	5 vs. 3	0.036 (0.029)	0.033 (0.048)	0.031 (0.043)	0.011 (0.011)	3.096	0.340	2.400	0.286	0.377	0.059
A	3 vs. 1	0.061 (0.032)	0.060 (0.055)	0.066 (0.033)	0.089 (0.074)	2.394	0.285	0.385	0.060	1.633	0.214
	3 vs. 2	0.011 (0.016)	0.019 (0.011)	0.019 (0.020)	0.020 (0.021)	0.462	0.071	1.350	0.184	0.632	0.095
	4 vs. 3	0.003 (0.008)	0.010 (0.019)	0.001 (0.004)	0.003 (0.008)	1.241	0.171	0.939	0.135	0.495	0.076
	5 vs. 3	0.036 (0.037)	0.101 (0.064)	0.051 (0.058)	0.106 (0.030)	0.651	0.098	5.352	0.471	0.149	0.024
A/D	3 vs. 1	<0.001 (<0.001)	<0.001 (<0.001)	0.001 (0.004)	<0.001 (<0.001)	1.000	0.143	1.000	0.143	1.000	0.143
	3 vs. 2	0.053 (0.059)	0.041 (0.038)	0.120 (0.256)	0.049 (0.045)	0.627	0.095	0.513	0.079	0.607	0.092
	4 vs. 3	0.174 (0.117)	0.097 (0.080)	0.140 (0.072)	0.171 (0.067)	0.532	0.082	0.828	0.121	7.402	0.552
	5 vs. 3	0.184 (0.087)	0.139 (0.062)	0.116 (0.045)	0.173 (0.029)	0.680	0.102	0.345	0.054	7.722	0.563
D	3 vs. 1	0.051 (0.033)	0.116 (0.066)	0.124 (0.101)	0.121 (0.059)	4.287	0.417	1.850	0.236	3.421	0.363
	3 vs. 2	0.109 (0.100)	0.077 (0.064)	0.106 (0.093)	0.157 (0.102)	2.377	0.284	0.420	0.065	6.169	0.507
	4 vs. 3	0.051 (0.039)	0.111 (0.085)	0.132 (0.056)	0.216 (0.194)	3.939	0.396	5.424	0.475	0.087	0.014
	5 vs. 3	0.053 (0.042)	0.049 (0.027)	0.057 (0.035)	0.061 (0.025)	0.429	0.067	<0.001	<0.001	0.229	0.037
K	3 vs. 1	0.017 (0.029)	0.051 (0.076)	0.017 (0.022)	0.021 (0.021)	0.922	0.133	2.324	0.279	4.021	0.401
	3 vs. 2	0.006 (0.005)	0.017 (0.030)	0.031 (0.042)	0.017 (0.037)	1.617	0.212	0.028	0.005	4.359	0.421
	4 vs. 3	0.007 (0.015)	0.013 (0.026)	0.024 (0.022)	0.024 (0.046)	1.030	0.147	0.123	0.020	0.078	0.013
	5 vs. 3	0.031 (0.079)	0.014 (0.025)	0.034 (0.051)	0.016 (0.011)	0.037	0.006	0.707	0.105	0.002	<0.001
FS	3 vs. 1	0.027 (0.016)	0.019 (0.025)	0.060 (0.049)	0.026 (0.025)	1.461	0.196	4.397	0.423	1.717	0.223
	3 vs. 2	0.016 (0.010)	0.013 (0.014)	0.017 (0.024)	0.013 (0.013)	0.008	0.001	0.728	0.108	0.011	0.002
	4 vs. 3	0.030 (0.034)	0.034 (0.033)	0.034 (0.032)	0.031 (0.043)	0.003	<0.001	0.005	0.001	0.257	0.041
	5 vs. 3	0.006 (0.008)	0.030 (0.020)	0.014 (0.014)	0.021 (0.013)	<0.001	<0.001	60.5**	0.910	1.946	0.245
U	3 vs. 1	0.006 (0.008)	0.021 (0.042)	<0.001 (<0.001)	0.001 (0.004)	2.730	0.313	1.108	0.156	0.781	0.115
	3 vs. 2	0.006 (0.015)	0.001 (0.004)	<0.001 (<0.001)	0.007 (0.019)	<0.001	<0.001	0.083	0.014	1.670	0.218
	4 vs. 3	0.019 (0.041)	<0.001 (<0.001)	0.006 (0.011)	<0.001 (<0.001)	0.563	0.086	2.643	0.306	0.563	0.086
	5 vs. 3	0.020 (0.017)	0.010 (0.013)	0.019 (0.024)	0.004 (0.005)	0.434	0.067	2.959	0.330	0.102	0.017

Note: * = $p < 0.05$, ** = $p < 0.01$, ES = partial eta squared effect sizes. Effect sizes were interpreted as 0.02 as small; 0.13 as moderate; and 0.26 as large (Cohen, 1988). a) Yellow offensive player [YP]; b) player in possession of the ball [PB]; c) ball [B]; d) unmarked attacker [A]; e) attacker closely marked by a defender [A/D]; f) defender [D]; g) goalkeeper [K]; h) free space [FS]; and i) unspecified areas that did not match the aforementioned areas [U].

3.2. Response accuracy

The RM-MANOVA did not reveal a significant condition x congruency interaction effect in response accuracy. However, a trend towards a main effect of test condition (F = 3.023, *p* = 0.07, ES = 0.547) and a significant large main effect of congruency (F = 3.705 *p* = 0.042, ES = 0.597) was apparent. Further univariate analysis revealed a trend towards a main effect of condition and congruency in the 3vs.1 and the 3vs.2 scenarios. Overall, the neutral condition (85.85 ± 4.41 %) yielded a higher response accuracy compared to the precue condition (80.81 ± 8.40 %; Figure 3C). Furthermore, response accuracy was higher in precue congruent scenarios and lower in precue incongruent scenarios compared to their neutral scenarios (Figure 3A, B).

3.3. Response time

No significant condition x congruency interaction effects on response time were observed. However, further univariate analysis revealed a condition x congruency interaction effect, and a large main effect of condition and congruency in the 3vs.2 scenarios. Yet, the precue condition was faster (590.75 ± 203.47 ms) compared to the neutral condition (630.47 ± 241.55 ms; Figure 3F). Furthermore, the precue condition consistently yielded faster response times for both the congruent and incongruent scenarios compared to the neutral condition (Figure 3D, E). Although, the incongruent 3vs.2 scenarios were slower than the neutral scenarios.

3.4. Fixation location

3.4.1. Condition x congruency

Multiple RM-MANOVA's revealed a trend towards a significant condition x congruency interaction effect on YP and A/D (F = 6.557, *p* = 0.077, ES = 0.897; F = 10.052, *p* = 0.044, ES = 0.931) respectively. Univariate analysis revealed a condition x congruency interaction effect of B and K in 3vs.1 (F = 24.304, *p* = 0.003, ES = 0.802; F = 4.021, *p* = 0.092, ES = 0.401); of YP, D and K in 3vs.2 (F = 11.881, *p* = 0.014, ES = 0.664; F = 6.169, *p* = 0.048, ES = 0.507; F = 4.359, *p* = 0.082, ES = 0.421); of A/D in 4vs.3 (F = 7.402, *p* = 0.035, ES = 0.552) and of A/D in 5vs.3 scenarios (F = 7.722, *p* = 0.032, ES = 0.563) respectively.

3.4.2. Condition

Multiple RM-MANOVA's revealed a significant and large main effect of condition in PB (F = 63.401, *p* = 0.003, ES = 0.988). Further univariate analysis revealed a trend in the large main effect of D in 3vs.1 (F = 4.287, *p* = 0.084, ES = 0.417); and significantly large main effect of YP, PB, B and a trend in D in 4vs.3 scenarios (F = 6.492, *p* = 0.044, ES = 0.52; F = 6.626, *p* = 0.042, ES = 0.525; F = 8.107, *p* = 0.029, ES = 0.575; F = 3.939, *p* = 0.094, ES = 0.396) respectively (Figure 4C).

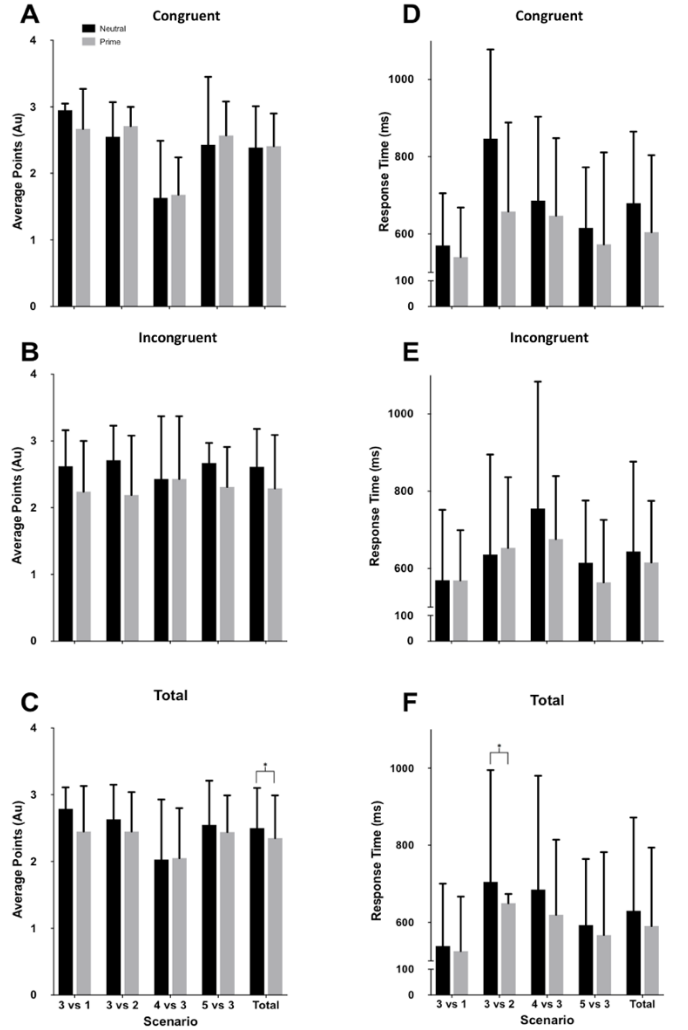

Figure 3: Effects of precues on response accuracy (A-C) and response time (D-F).

3.4.3. Congruency

Multiple RM-MANOVA's revealed a significant and large main effect of congruency in YP (F = 9.257, *p* = 0.049, ES = 0.925), PB (F = 12.136, *p* = 0.034, ES = 0.942) and FS (F = 143.022, *p* = 0.001, ES = 0.995). Further univariate analysis revealed large main effects of YP, PB and a trend in FS in 3vs.1 (F = 20.445, *p* = 0.004, ES = 0.773; F = 53.557, *p* < 0.001, ES = 0.899; F = 4.397, *p* = 0.081, ES = 0.423); trends in the large main effect of PB and D in 4vs.3 (F = 4.125, *p* = 0.089, ES = 0.407; F = 5.424, *p* = 0.059, ES = 0.475); and of YP, A, and FS (significant) in 5 vs 3. scenarios (F = 7.943, *p* = 0.03, ES = 0.57; F = 5.352, *p* = 0.06, ES = 0.471; F = 60.5, *p* < 0.001, ES = 0.910) (Figure 4A, B).

Overall, the neutral condition yielded a higher percentage of time spent fixating on the yellow player compared to the precue condition (Figure 4C), and in both congruent and incongruent scenarios (Figure 4A, B). Yet, the precue condition yielded a higher percentage of time spent fixating on defenders compared to the neutral condition, and in both congruent and incongruent scenarios.

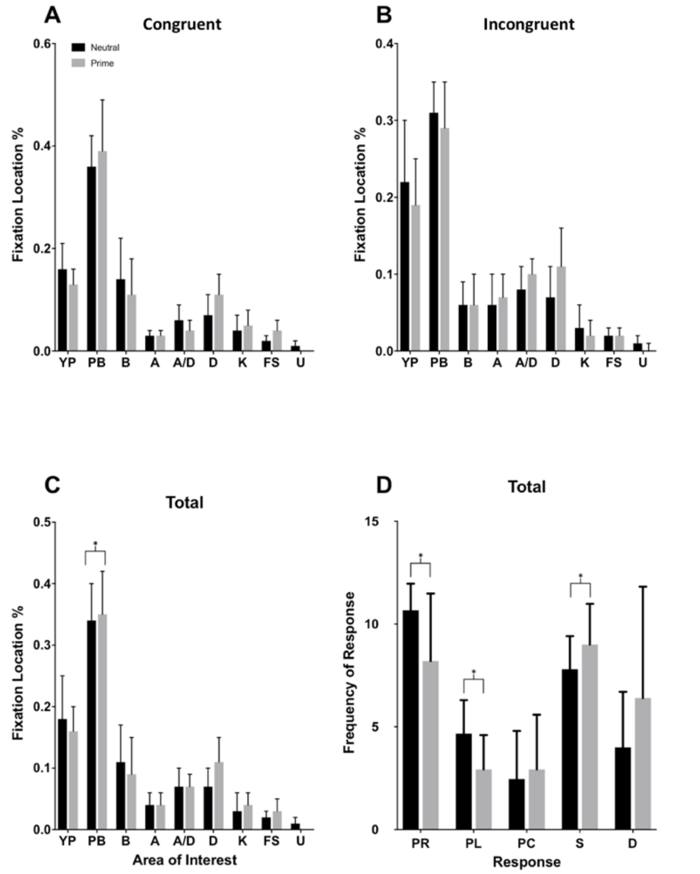

Figure 4: Effects of precues on fixation location (A-C) and frequency of response (D). Graph D abbreviations are as follows: PR (pass right), PL (pass left), PC (Pass centre), S (shoot) and D (dribble).

3.5. Frequency of responses

The RM-ANOVA revealed a significant and large main effect of test condition (F = 4.494, *p* = 0.021, ES = 0.692). Further univariate analysis revealed a significantly large main effect in the 'pass right', 'pass left' and 'shoot' (F = 8.421, *p* = 0.012, ES = 0.376; F = 7.608, *p* = 0.015, ES = 0.352; F = 13.513, *p* = 0.002, ES = 0.491) respectively. Overall, 'pass right' and 'pass left' were lower, and 'pass centre', 'shoot' and 'dribble' were higher in the precue condition compared to the neutral condition.

4. Discussion

Coaches often use instructions before a game to encourage or discourage tactical responses from their players during a game. These instructions often contain information of how the opposition is likely to play, or how athletes should act in specific circumstances (Farrow, Baker, & MacMahon, 2013). Accordingly, the aim of this study was to determine if precueing using tactical instructions influences soccer players' decision-making skill in a sport-specific task through the investigation of visual search behaviour, response accuracy and response time. The primary finding of the current investigation was that tactical instructions provided using simulated coaching instructions impaired the accuracy of soccer-specific decision-making skill, but slightly enhanced participants' response time. Additionally, fixation location data demonstrated that athletes did not differ regarding their visual search patterns between conditions, highlighting that similar information was extracted from the performance environment with or without instructions.

Overall, response accuracy was significantly lower in the precue condition compared to the neutral condition. This is in line with other studies reporting that an adherence to explicit instructions was also detrimental to the decision-making accuracy of low-experienced level players in Australian football (Buszard et al., 2013) and handball (Memmert & Furley, 2007). Conversely, response times were revealed to be consistently faster across all scenarios in the precue condition compared to the neutral condition. This finding contradicted the main hypothesis that the precue condition would have both inferior response accuracy and response time compared to the neutral condition. It was expected that athletes would have slower response times associated with incompatible precues due to the inhibition of return effect demonstrated in previous precueing studies (Beavan et al., 2019; Posner, Rafal, Choate, & Vaughan, 1985; Rosenbaum & Kornblum, 1982). This inhibition process refers to when a movement towards the likely target's location must be cancelled, and attention must then be redirected to the actual location of the target allowing for a new movement program towards the correct location of the target to be created (Elliott, 2004).

One explanation for the observed faster response times and worse accuracy scores in the precue condition may be linked with the decision-making heuristics of taking the options that only aligned with the prior instructional precues. For example, when precues were congruent with the scenario, response accuracies were similarly accurate to when no precue was given in the same scenarios as the neutral condition, but they had faster initiation times demonstrating the advantage of beneficial precues (Posner et al., 1980). However, when confronted with situations that were incongruent with the precues, a large decrease in response accuracy was observed, yet the athletes still responded faster than the neutral condition. This implies that athletes did not make the most correct decision due to the adherence of the precues, and their response times indicate that their motor behaviour was primed to act in accordance with this heuristic. Decision-making heuristics have previously been observed in a sporting domain. Buszard et al. (2013) discussed the 'take the first option (TTF)' heuristic. In about 60% of scenarios, TTF may benefit the athletes (i.e., a congruent heuristic), yet in the other 40% scenarios the first option is not the best option (i.e., an incongruent heuristic) but nevertheless a player's attention is drawn to incorrect environmental cues leading to possible wrong decisions being generated. In support, the frequency of 'pass right' and 'pass left' were lower, and 'pass centre', 'shoot' and 'dribble' were higher in the precue condition compared to the neutral condition; demonstrating adherence to instructions.

Discrepancies in decision-making performance may further be attributed to changes in attention, as previous studies demonstrated instructions can guide an athlete's attentional focus (Williams, Davids, & Williams, 1999) and change breadth-of-attention (Memmert & Furley, 2007). Memmert and Furley

(2007) demonstrated that when athletes in handball were given two common instructions related to observing a specific defender, 83% of the instructional group failed to notice the free defender compared to 17% of the no-instructions group. Although inattentional blindness ('blindness' as a result of 'not paying attention' to a cue) was not the primary focus of this study, it is plausible the instructions given may have directed the participants' attention to different cues in the environment. Similar to Buszard et al., (2013), the main visual search patterns remained unchanged between instructional conditions, and the results did not provide strong evidence in support the hypothesis that athletes had different visual fixation patterns in between conditions. However, the lack of differences reported in participants visual search behaviour is an important finding in itself. The fact that visual search behaviour remaining largely unchanged, but other response measures were affected by the precues demonstrates that the precues indeed have a constraining effect. Athletes appear to still perceive the same information in the environment, but they do not couple it with appropriate action as effectively. Indeed, such results provides evidence that is in favour of hands-off pedagogical strategies such as the constraints-led approach (Davids, Button, Araújo, Renshaw, & Hristovski, 2006). Coaches are recommended to manipulate the constrains of training drills in order to elicit a technical and tactical behaviour without having to explicitly instruct the athletes to do so. For example, Otte et al. (2020) reports a case study on how Nonlinear Pedagogy and Constraints-Led approaches can be used for training professional football goalkeepers.

Certain limitations must be considered when interpreting the observed findings. First, the eye-tracking glasses were connected by a cable to a laptop stationed to the side of the participant, possibly restricting the participants' movements. Second, the present findings are limited by the small sample size as the gaze behaviour was recorded in only seven participants. Additionally, the use of a video-based decision-making task - although popular due to the advantage of internal validity, reliability and ethical considerations (Mann, Williams, Ward, & Janelle, 2007) - has questionable ecological validity as key environmental conditions such as crowd noise, physical exertion and performance pressure could not be included. Finally, the methodology of this study was based on the concept that athletes are provided with coaching instructions prior to the commencement of a match. Yet, it is unknown how long these effects last, or whether certain types of instructions induce a larger change in sporting-performance. Therefore, future research should implement and compare different instructional approaches, and modify the content and method of delivery of the pre-cues.

To conclude, experiments that deliberately manipulate how information and movement are coupled in a response time task present an interesting avenue for researchers interested in adopting a priming-based approach to explain perceptual-motor control in sport. The present study examined the influence of instructional precues on decision-making in a video-based soccer-specific decision-making task, revealing that coaching instructions are not always beneficial to performance. The findings of this study suggest certain instructional language may negatively influence an athlete's decision-making skill in scenarios where the correct response does not correspond with a specific instructions. Coaches should therefore consider integrating a more self-discovery approach in training, blinding athletes to the true incentive of the training drill that allows for creative behaviour in the athletes. This can be completed by coaches being aware of explicitly 'over-instructing' and 'over-coaching' athletes. From a practical perspective, the coach should reduce the use of explicit tactical instructions, and provide better guidance during training. Coaches should aim to design environments that allow for a certain behaviour to emerge without explicitly instructing their athletes to act in such way.

Conflict of Interest

The authors declare no conflict of interests.

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References

Bakeman, R. (2005). Recommended effect size statistics for repeated measures designs. *Behavior Research Methods, 37*(3), 379-384.

Beavan, A., Spielmann, J., Mayer, J., Skorski, S., Meyer, T., & Fransen, J. (2019). Age-related differences in executive unctions within high-level youth soccer players. *Brazilian Journal of Motor Behavior, 13*(2), 64-75.

Buszard, T., Farrow, D., & Kemp, J. (2013). Examining the influence of acute instructional approaches on the decision-making performance of experienced team field sport players. *Journal of Sports Sciences, 31*(3), 238-247.

Cohen, J. (1988). *Statistical power analysis for the behavioural sciences.* Hillside. NJ: Lawrence Earlbaum Associates.

Davids, K., Button, C., Araújo, D., Renshaw, I., & Hristovski, R. (2006). Movement models from sports provide representative task constraints for studying adaptive behavior in human movement systems. *Adaptive Behavior, 14*(1), 73-95.

Elliott, T. N. W. D. (2004). Effects of response priming and inhibition on movement planning and execution. *Journal of Motor Behavior, 36*(2), 200-211.

Farrow, D., & Abernethy, B. (2002). Can anticipatory skills be learned through implicit video based perceptual training? *Journal of Sports Sciences, 20*(6), 471-485.

Farrow, D., Baker, J., & MacMahon, C. (2013). *Developing sport expertise: Researchers and coaches put theory into practice*. Routledge.

Fitts, P. M., & Posner, M. I. (1967). *Human performance*. Boorks/Cole.

Homack, S., Lee, D., & Riccio, C. A. (2005). Test review: Delis-Kaplan executive function system. *Journal of Clinical and Experimental Neuropsychology, 27*(5), 599-609.

Kirlik, A., Walker, N., Fisk, A. D., & Nagel, K. (1996). Supporting perception in the service of dynamic decision making. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 38*(2), 288-299.

Mann, D. T., Williams, A. M., Ward, P., & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport and Exercise Psychology, 29*(4), 457-478.

Memmert, D., & Furley, P. (2007). "I spy with my little eye!": Breadth of attention, inattentional blindness, and tactical decision making in team sports. *Journal of Sport and Exercise Psychology, 29*(3), 365-381.

Otte, F. W., Millar, S. K., & Klatt, S. (2020). What do you hear? The effect of stadium noise on football players' passing performances. *European Journal of Sport Science*, 1-26. doi: 10.1080/17461391.2020.1809714

Porter, J., Wu, W., & Partridge, J. (2010). Focus of attention and verbal instructions: Strategies of elite track and field coaches and athletes. *Sport Science Review, 19*(3-4), 77-89.

Posner, M. I., Nissen, M. J., & Ogden, W. C. (1978). Attended and unattended processing modes: The role of set for spatial location. In H.L. Pick & E.J. Saltzman (Eds.) *Modes of Perceiving and Processing Information* (pp. 137-157). Hillsdale, NJ: Erlbaum.

Posner, M. I., Rafal, R. D., Choate, L. S., & Vaughan, J. (1985). Inhibition of return: Neural basis and function. *Cognitive Neuropsychology, 2*(3), 211-228.

Posner, M. I., Snyder, C. R., & Davidson, B. J. (1980). Attention and the detection of signals. *Journal of Experimental Psychology: General, 109*(2), 160-174.

Roca, A., Ford, P. R., McRobert, A. P., & Williams, A. M. (2011). Identifying the processes underpinning anticipation and decision-making in a dynamic time-constrained task. *Cognitive Processing, 12*(3), 301-310.

Rosenbaum, D. A. (1983). The movement precuing technique: Assumptions, applications, and extensions. *Advances in Psychology, 12*, 231-274.

Rosenbaum, D. A., & Kornblum, S. (1982). A priming method for investigating the selection of motor responses. *Acta Psychologica, 51*(3), 223-243.

Schmidt, R. A. (1975). A schema theory of discrete motor skill learning. *Psychological Review, 82*(4), 225-260.

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: uses in assessing rater reliability. *Psychological Bulletin, 86*(2), 420-428.

Turvey, M. T. (1977). Preliminaries to a theory of action with reference to vision. In R. Shaw & J. Bransford (Eds.) *Perceiving, acting and knowing* (pp. 211-265). Erlbaum.

Turvey, M. T., Shaw, R. E., Reed, E. S., & Mace, W. M. (1981). Ecological laws of perceiving and acting: In reply to Fodor and Pylyshyn (1981). *Cognition, 9*(3), 237-304.

Vaeyens, R., Lenoir, M., Williams, A. M., Mazyn, L., & Philippaerts, R. M. (2007). The effects of task constraints on visual search behavior and decision-making skill in youth soccer players. *Journal of Sport and Exercise Psychology, 29*(2), 147-169.

Vaeyens, R., Lenoir, M., Williams, A. M., & Philippaerts, R. M. (2007). Mechanisms underpinning successful decision making in skilled youth soccer players: An analysis of visual search behaviors. *Journal of Motor Behavior, 39*(5), 395-408.

Williams, A. M., Davids, K., & Williams, J. G. P. (1999). *Visual perception and action in sport*. Taylor & Francis.

Williams, A. M., Ward, P., Knowles, J. M., & Smeeton, N. J. (2002). Anticipation skill in a real-world task: measurement, training, and transfer in tennis. *Journal of Experimental Psychology: Applied, 8*(4), 259-270.

Woods, J. R., Williams, J. G., & Tavel, M. (1989). The two-period crossover design in medical research. *Annals of Internal Medicine, 110*(7), 560-566.