Skill-Based Differences in Decision Time when Responding to Verbal Information from Intrateam Communication in Lacrosse

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Abstract

Verbal intrateam communication has been shown to be important for effective team sports performance. However, in the sports anticipation literature, there is a disparity between the vast body of work examining the use of visual information and the limited research investigating the use of auditory or verbal information. This study examines skill-based differences in athletes' use of intrateam communication to anticipate an opposing team's actions in the absence of visual information. Skilled and less-skilled lacrosse players acted as defenders in a laboratory-based experiment where only verbal information from simulated teammates was available. Participants used sequences of calls made during an unfolding action to respond to an end call and predict the actions of the opposing team. Independent sample *t*-tests revealed that skilled players had quicker decision times and movement times compared to less-skilled players ($ps < .05$). Findings demonstrate that information from teammate communication can be used for anticipation in sport.

Keywords

Team cognition, anticipation, decision making, sport, expertise

Introduction

In team-based sports, an important mechanism that contributes to effective performance is team cognition (Fiore & Salas, 2006). Team cognition can be viewed as shared knowledge and shared awareness of a situation (McNeese et al., 2015; 2016). Communication has been suggested to underpin team cognition and enables a team to develop their shared awareness of a situation and enhance their decision making (Eccles & Tenenbaum, 2004). Verbal communication between teammates can occur "in game" and "out of game," with the former suggested to be more relevant as it directly relates to performance outcomes (Sullivan et al., 2014; Tenenbaum and Gershgoren, 2014). In-game verbal communication often involves providing teammates with probabilistic information related to what the opposition team and its individual members are likely to do (Eccles & Tran, 2012), which will enable teammates to anticipate upcoming opponent actions more effectively.

The ability to anticipate opponent intentions is an essential factor of sports expertise (Loffing & Cañal-Bruland, 2017). Researchers investigating anticipation in sport have used the expert-novice paradigm to isolate important attributes that differentiate skilled from less-skilled performers (Williams & Ericsson, 2005). For example, expert sports performers have frequently been shown to pick up and utilize early occurring visual information to anticipate opponent actions more effectively than less-skilled performers (Jones & Miles, 1978; Mann et al., 2007; Williams & Jackson, 2019). However, in team-based sports, there will be situations where visual information is degraded or missed, such as when teammates and opponents are outside of the visual field (e.g., behind the player).

While a disproportionate amount of research has focused on the use of visual information, recent research has given attention to the potentially crucial role of auditory information. Cañal-Bruland et al. (2018) presented experienced tennis players with videos of tennis rallies in which the intensity of the sound produced by an opponent's racket-ball contact was systematically manipulated. Clips were occluded when the sound emanating from the contact had ceased. It was shown that, the more intense the sound, the longer participants predicted the ball's trajectory. Camponogara et al. (2017) examined skill-based differences in basketball players' ability to intercept an attacker by listening only to audio recordings of the players' movements. Skilled basketball players were more accurate in their predictions than novices, demonstrating that an opponent's action intentions can be perceived through sound alone.

While these studies demonstrate the importance of auditory information emanating from opposition movements (see also Sors et al., 2017, 2018; Petri et al., 2020), researchers have yet to examine the role of verbal information from intrateam communication for anticipation in sport, an important shortcoming of the literature. Indeed, the publication by Williams and Jackson (2019), which provided an overview of the past 50 years of research on anticipation in sport, made no reference to the role of auditory information, let alone verbal communication from teammates. The current research provides a novel attempt to examine skill-based differences in the use of verbal information from intrateam communication when anticipating an opposition team's upcoming action in lacrosse.

Lacrosse is a team-based sport in which the majority of play happens in the end zones around the goals. In front of each goal are two semi-circles called fans: an outer 15-meter fan and an inner 11-meter fan, from which attacking shots are taken. Typical attacking play takes place in a rough circle in the outer fan and involves the attackers passing the ball around until one player cuts into the inner fan to shoot. To defend an attack, each defender places themselves goal side of one attacking player, forming a smaller ring. This is referred to as a "settled" position (see Figure 1a). When an attacking player cuts into the inner fan to shoot, the defender marking that player calls "red" and the defensive players converge in the fan to defend against the shot. The extreme time constraints associated with stopping the attack require defenders to continuously scan the environment for as much relevant visual information as possible. However, due to the restricted visual field of humans and the positioning of the goal and attacking players, verbal information from teammates' communication is likely to contribute significantly to anticipating when the goal attempt will occur. Lacrosse is therefore an ideal sport in which to investigate how intrateam communication contributes to skilled anticipation.

The aim of this study is to compare the ability of skilled and less-skilled lacrosse players to anticipate the actions of an opposition team using only verbal information from in-game intrateam communication. Participants took part in a laboratory-based task simulating an attack. Intrateam communication was played through multiple speakers representing teammates. Upon hearing a call signifying a goal attempt, participants responded by moving to where they predicted the opposing player would be. Based on the expert performance approach, we hypothesized that skilled participants would be more accurate and confident in their judgements, as well as faster in their decision and movement times, compared to less-skilled participants.

Materials and Methods

Participants

10 skilled (M_{age} = 21.20 years, *SD* = 1.23) and 10 less-skilled female lacrosse players (M_{age} = 20.90 years, *SD* = 2.47) took part in this study. Skilled participants had an average of 5.55 years (*SD* = 3.50) of competitive playing experience, whereas less-skilled participants had played recreationally for less than a year (*M* = 0.50 years, *SD* = 1.41). A statistical power analysis was performed for sample size estimation using G*Power 3.1. Based on data from a published study (Loffing et al., 2015), which examined skill-based differences in decision time, sample size was determined on the basis of a large sized effect (*d* = 0.95) with an alpha of .05 and a power of .8. This projected a sample size of N = 15 in each group. As noted in previous research, access to skilled participants in what is a limited population is not always feasible, which was the case in the current study (Schweizer & Furley, 2015). We therefore followed the recommendation to report adjusted effect size ($d_{unbiased}$) estimates to circumvent the problem of inflated effect sizes in small sample studies (Cumming, 2012). Ethical approval was obtained from the ethics committee of the lead author's institution.

Test Stimuli

The study consisted of 15 trials ranging from 6-37 seconds in duration. There were originally 17 trials but two had technical issues, which resulted in all participants responding incorrectly, and so were removed from analysis. Trials varied in duration because each contained a different number of calls from the simulated teammates (ranging between 5-20 calls). The calls used, and associated definitions, are outlined in Table 1. To create the test stimuli, six female lacrosse players, one for each defensive teammate, recorded the calls at varying intensities as if they were in a match. Using Adobe Premier Software, calls were assembled into sequences by the lead researcher, who is a qualified lacrosse coach, to simulate specific plays that would occur in a match. A table with the sequence of calls from the different simulated teammates in each trial is in the supplementary materials available at https://doi.org/10.17633/rd.brunel.16885426.v1

Table 1. Definitions of the calls used in the test stimuli

Call	Definition
"Red"	Signifying that the defender making the call is marking an opponent who is entering the 11-meter fan and attempting to shoot on the goal
"Cutter"	Signifying that the defender making the call is marking an opponent who is moving through the fan to line up for an offensive attack on goal
"Got ball"	Signifying that the defender making the call is marking the attacker with the ball
"On your left"	Signifying that the defender making the call is to the left of the person marking the ball and is ready to back up play
"On your right"	Signifying that the defender making the call is to the right of the person marking the ball and is ready to back up play

The different trial lengths are representative of actual competition where goal attempts can take place at any moment, but importantly it also meant that participants could not anticipate the final call based on the *number* of calls made. Each trial contained a different combination of calls played through speakers positioned around the laboratory to represent other defensive teammates. The number of calls from different simulated teammates in each trial, as well as the average response accuracy, confidence scores, decision time and movement time for each trial, is shown in Table 2. As the trials were presented to the participants in the same order, to check for a practice order effect, a *t*-test was conducted to compare the dependent variables in the first half of the test (i.e., trials 1-8) and the second half of the test (i.e., trials 9-15). No significant difference was observed between the two halves of the tests for the number of calls (p = .82) and the mean response accuracy (p = .53), confidence (p = .19), decision time (p = .28) and movement time (p = .57).

Table 2. The number of calls from different simulated teammates in each trial and the mean (*SD*) response accuracy (%), confidence rating (out of 10), decision time (ms), and movement time (ms) on each trial

Trial	No. Calls	RA	Confidence	DT	MT
1	16	90 (30.78)	7.7 (1.75)	692 (208.49)	2942 (295.79)
2	8	100 (.00)	7 (1.81)	678 (176.27)	2564 (412.62)
3	16	95 (22.36)	8.25 (1.45)	520 (132.35)	2754 (256.38)
4	5	50 (51.30)	6 (2.90)	842 (233.87)	2882 (401.86)
5	10	90 (30.78)	8.2 (1.77)	574 (135.66)	2786 (277.52)
6	18	90 (30.78)	7.7 (1.95)	680 (226.79)	2596 (317.86)
7	14	100 (.00)	8.35 (1.76)	608 (123.53)	2862 (304.209)
8	17	100 (.00)	8.75 (1.37)	494 (173.76)	2288 (249.83)
9	13	85 (36.63)	7.9 (1.71)	792 (266.79)	3046 (300.53)
10	20	100 (.00)	8.2 (1.36)	768 (140.14)	2994 (258.34)
11	18	90 (30.78)	8 (1.86)	620 (180.99)	2922 (469.26)
12	14	80 (41.04)	7.9 (1.86)	656 (210.22)	2574 (359.48)
13	14	90 (30.78)	8.1 (1.55)	678 (206.21)	2906 (309.37)
14	7	95 (22.36)	8.6 (1.39)	622 (182.37)	2804 (315.47)
15	9	95 (22.36)	8.8 (1.24)	716 (215.56)	2944 (324.39)

Laboratory Set-up

Six speakers, representing defensive teammates, were set up in a circular formation around an imaginary 11-meter fan, representative of a settle: four above the “goal line” and two below. This study was conducted in 2019 before England Lacrosse changed the rules from twelve on-field players to ten, and so the set-up is representative of the old rules of the game. Four cones were placed close to the imaginary goal, representing the “crash zones” that participants ran to in response to the final call. Participants always started at the top of the inner fan facing out, taking the role of the defensive player (see Figures 1A and 1B).

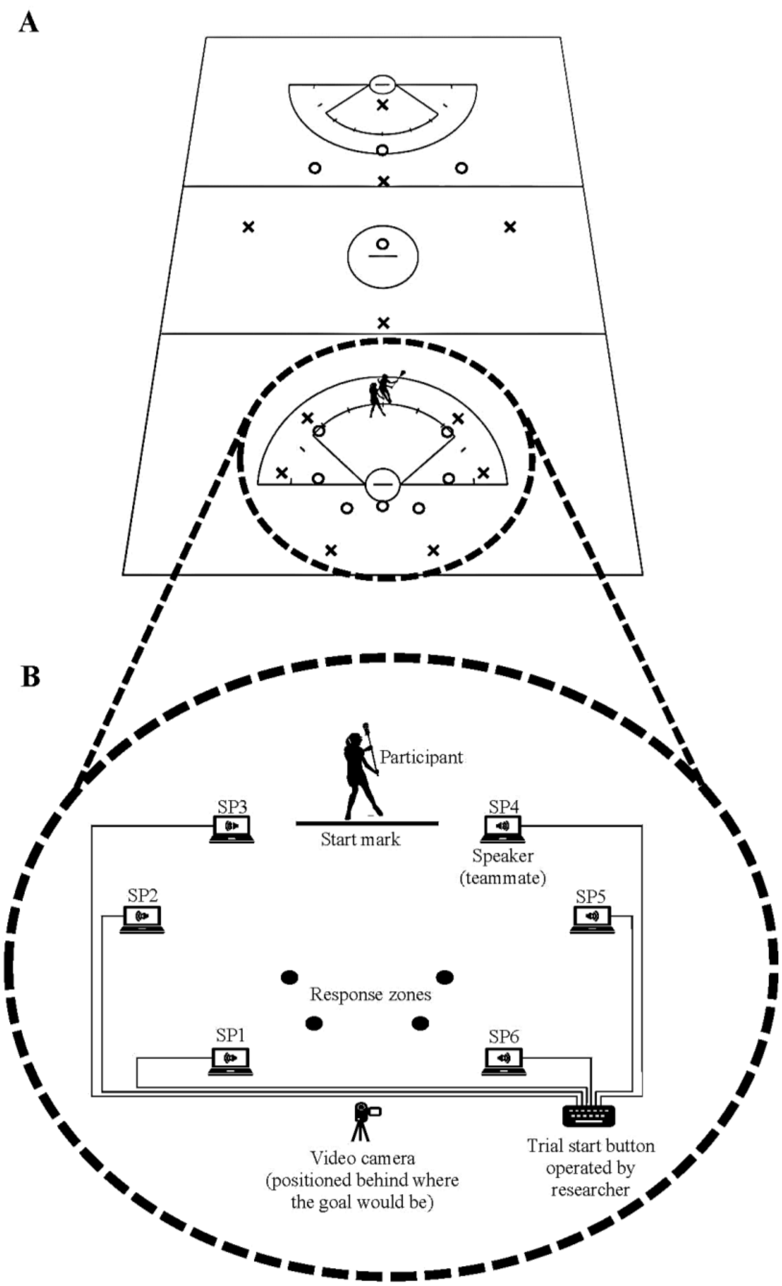

Figure 1. (A) An example of a lacrosse field setup in a settled position in the near end zone. O = defensive players, X = attacking players. (B) The laboratory setup which is representative of the lacrosse field setup in Figure 1A.

Note: This set up is representative of the game when twelve players were allowed on the field, before England Lacrosse changed the rules in 2019 to only ten on-field players.

Experimental Procedure

Participants were first given a lacrosse stick, asked to stand at the start point, and given an explanation of the procedure. Participants were told that each of the six speakers represented a different defensive teammate, who was marking an opposition attacker, and that the recorded voices of each teammatee could play in a pattern that is representative of what could be heard in an actual lacrosse match. Participants were told to use this information to respond as quickly and as accurately as possible to the "Red" call by turning and running to the corresponding crash zone (i.e., one of the four cones). Participants were instructed to act as though they were in a real-life game scenario but to remain at the start point until they decided to respond and move to the crash zone. Participants then completed two familiarization trials followed by the test trials with approximately one minute between trials to reset the speakers and for the participant to return to the start point. Total time for testing was approximately 30 minutes.

Trials were video recorded (iPhone 8, Apple Inc. Foxconn, China) for subsequent analysis. Each participant completed the test trials in the same randomised order. After each trial, participants rated on a scale of 1-10 how confident they were that they moved to the correct crash zone. Confidence ratings were included to accompany the response accuracy scores and provide an indication of the participants' conscious awareness of the information available (Rosenthal, 2001). Researchers have previously used this approach, predicting that high levels of accuracy coinciding with high confidence indicates awareness of the information being used to make accurate responses, whereas low confidence associated with high levels of accuracy indicates a lack of awareness (Murphy et al., 2018; Jackson & Mogan, 2007).

Data Analysis

The independent variable was the skill group (i.e., skilled, less skilled). The dependent variables were response accuracy, confidence rating, decision time, and movement time. Response accuracy referred to whether the participant moved to the correct cone in the crash zone. Accuracy scores were converted into percentages (%). Confidence ratings for how confident participants were in their responses were scores between 1 and 10. Decision time was defined as the time period from the "Red" call to the initiation of the participant's movement (ms). Movement initiation was defined as the first frame where there was an observable and significant lateral motion of the hips, shoulders, or feet to the right or left, assuming the movement was to the future location in the crash zone. This definition is comparable to similar analyses completed in tennis (Broadbent et al., 2015; 2017). Movement time was defined as the time period from the "Red" call to the participant's touching the selected cone in the crash zone (ms).

Video footage that captured both the sound of the "red" call and the participant's movement was analyzed by the lead researcher using video editing software (Adobe Premier CS5, San Jose, USA). Measures of inter-observer reliability were obtained for decision time and movement time by using intraclass correlation techniques (Atkinson & Nevill, 1998). Two independent researchers were provided with the definitions above and analyzed data from two participants each (i.e., four participants in total; two skilled and two less-skilled participants). Correlation coefficients for inter-observer measures were all above .85.

Z scores and box plots identified two outliers for decision time and movement time. These were on one specific trial, for one skilled and one less-skilled participant. The outliers were removed and replaced by the average time in each case. Kurtosis and skewness for all dependent variables fell within the normal range, and data sets were found to be normally distributed, except for response accuracy, for which non-parametric versions of the tests were given. Independent *t*-tests were used to compare the skilled and less-skilled group on all of the dependent variables. Finally, d_{unbiased} was used as a measure of effect size with 95% confidence intervals (CI) reported on *d*. The alpha level for significance was set at .05.

Results

Independent *t*-tests revealed that the skilled group displayed significantly quicker decision times, $t(18) = 4.56$, $p < .01$, $d_{unb} = 1.95$, 95% CI [.92, 3.12], and movement times, $t(18) = 2.47$, $p = .03$, $d_{unb} = 1.04$, 95% CI [.13, 2.02], compared to the less-skilled group (see Table 3). However, a Mann-Whitney U test revealed no significant difference between the two groups for response accuracy, U = 49.00, z = -.08, $p = .94$, $d_{unb} = .14$, 95% CI [-1.02, .74]. Finally, no significant difference between the two groups in confidence ratings was observed, $t(18) = .52$, $p = .61$, $d_{unb} = .22$, 95% CI [-.65, 1.11].

Table 3. Mean (SD) response accuracy (%), confidence rating (out of 10), decision time (ms), and movement time (ms) for the skilled and less-skilled groups.

	Response Accuracy	Confidence Rating	Decision Time*	Movement Time*
Skilled	90.67	7.81	570.88	2682.82
	(7.17)	(1.50)	(95.24)	(226.21)
Less Skilled	89.33	8.11	754.48	2899.10
	(10.98)	(1.02)	(84.71)	(166.33)

*Significant difference found between the two groups for this variable ($p < .05$)

Discussion

This study provided a novel examination of skill-based differences in the use of verbal information from intrateam communication during anticipation in sport. Lacrosse was selected as the focus of this study because of the constraints defenders often experience due to restricted visual information relating to the ball and to opposition players. It was predicted that skilled lacrosse players would be better able to utilize the verbal communication from teammates to develop a greater shared awareness resulting in greater accuracy and confidence in their judgements than less-skilled players, as well as demonstrating quicker decision and movement times.

Contrary to our predictions, response accuracy did not differ between the skill groups. All participants achieved around 90% accuracy, which suggests there was a ceiling effect. This was most likely a function of the speed-accuracy trade-off which is inherent in previous research on the use of visual information when tasks include responses high in fidelity, such as in field-based tests (e.g., Broadbent et al., 2015, 2017). However, we also have to consider whether the task was too easy. In the current study, participants could wait to respond until after the final call, ensuring the zone they ran to was correct. Therefore, the accuracy aspect of the task may have been easy even for the less skilled lacrosse players. This is supported by the confidence ratings, which were high for both skill groups. The high levels of confidence in conjunction with high accuracy scores suggests that all participants were consciously aware of the information being used to make accurate responses (Murphy et al., 2018; Jackson & Mogan, 2007). Camponogara et al. (2017) also found limited skill-based differences in response accuracy when examining the use of auditory information from an opponent’s movements and argued that response initiation time is a more critical variable.

In support of our predictions, the skilled lacrosse players displayed faster decision times and movement times than the less-skilled players. This indicates that the ability to utilize verbal information from teammate communication to anticipate the oppositions’ actions is a factor underpinning lacrosse expertise. Based on previous research that examined team cognition, the current findings suggest that the skilled athletes were better able to use ongoing verbal communication from simulated teammates to increase a shared awareness of the situation and enhance the speed of their decision making (e.g., Eccles & Tenenbaum, 2004; Eccles & Tran, 2012). Being able to make a decision, initiate a response, and reach the correct zone, more quickly allows additional time to intercept the opposition player and block the attempted shot. The findings also build on the current anticipation literature (e.g., Williams & Jackson, 2019; Camponogara et al., 2017; Cañal-Bruland et al., 2018) by suggesting that as well as visual and auditory information emanating from the movement of opposition players, verbal communication from teammates that holds semantic content about the current situation can be used to enhance anticipatory judgements. This is especially important in situations where visual information is restricted, constraining players to use alternative information sources.

This initial explorative study is limited by the decision not to incorporate visual information, which would normally be present in a real-life scenario. The focus of the current paper was to provide initial proof of concept for the prediction that there would be skill-based differences in the use of intrateam communication for anticipation in lacrosse. Therefore, it was important that the study design control for all the other information sources. This approach aligns with the large body of previous research on the use of visual information, where typically all auditory information is removed (Williams & Jackson, 2019). As the current study provides evidence for skilled-based differences in the use of intrateam communication, future research should now look to incorporate visual information and other sources of auditory information to examine the relative contribution of various sources of sensory information to anticipation in sport. This multisensory approach has been taken in a few studies (i.e., Allerdissen et al., 2017; Gray, 2008; 2009; Klatt & Smeeton, 2020), and it appears that athletes may employ Bayesian reliability-based strategies to integrate the various types of sensory information during anticipation (for a related review, see Gredin et al., 2020). More research is required to confirm this.

Future research should also examine the use of intrateam communication in more detail. In the current study, the intensity, volume, and number of calls in trials were not systematically manipulated (e.g., Cañal-Bruland et al., 2018; Petri et al., 2020). Using the same lab-based set-up as the current study, it would be interesting to examine how the intensity of teammates' calls influences decision and movement time. Moreover, the semantic content or sequences of calls used in the current study were not controlled. Future research should systematically examine how the actual content of the calls (i.e., directive, tactical or motivational) and the different numbers and sequences of calls influence anticipation in skilled lacrosse players. Similar research has been done in tennis, whereby skilled participants were shown to be able to use contextual information from vision of the preceding shot sequence to anticipate final shot direction more effectively than when this information is not available (Murphy et al., 2018). Moreover, research has examined the impact of disguised or deceptive visual cues on anticipatory performance (Jackson & Cañal-Bruland, 2019), so future research could build on the current project, in which only genuine intrateam communication is used, to investigate the effect of deceptive communication from the opposition on players' awareness of opponent positioning and action anticipation. Indeed, there is scope to investigate how the interaction between two teams, in terms of communication to aid or impede anticipation, affects performance.

From an applied perspective, our findings indicate the potential importance of intrateam communication for anticipation in sport. Previous research has demonstrated that verbal communication and shared knowledge can be enhanced through collective training techniques (e.g., Blaser & Seiler, 2019); therefore, coaches and players could develop specific practices to enhance team communication skills, perhaps focusing on specific match scenarios where communication is critical due to restricted vision. Future research is required to conduct more field-based intervention studies to explore ways in which intrateam communication can be improved to facilitate greater shared awareness and team cognition in actual competition.

Conclusion

In summary, we provided initial evidence for skill-based differences in the use of intrateam communication when anticipating attacking plays in lacrosse. The explorative findings suggest that, particularly when visual information is restricted, communication between teammates is important for building shared awareness about the situation and could play an important role in action anticipation. While previous research provides strong evidence for the use of visual information for anticipatory judgements in sport, and how to enhance these visual skills, we suggest future research investigates other sources of information that may underpin anticipation in sport, such as verbal information, and examine ways to train in game intrateam communication to develop greater shared awareness.

Authors' Declarations

The authors declare that there are no personal or financial conflicts of interest regarding the research in this article.

The authors declare that they conducted the research reported in this article in accordance with the Ethical Principles of the Journal of Expertise.

The authors declare that the dataset is publicly available at https://doi.org/10.17633/rd.brunel.16885426.v1

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