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Does Teammate Recognition Accuracy Influence Movement Time in Ice Hockey?

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Abstract
Background: Biological motion affords the observer a significant amount of relative information that allows the recognition of various features specific to an individual. These include; movement signatures based on locomotion, and gender, in addition to deception and intention. Recent research has also demonstrated it is possible to discriminate teammates from non-teammates when viewing brief (<500msec) video footage of locomotion specific movement signatures. Further, correlations between recognition, familiarity, liking, reaction time, and movement time were present when observing familiar gait types (swimming and running). However it is not known whether these trends are also present for less common forms of gait such as ice-skating. Objective: The purpose of the present study was to investigate if; 1) ice hockey players could recognize teammates vs non-teammates from brief visual displays within sport relevant time and, 2) ice hockey players were influenced by factors such as familiarity and liking when making decisions associated with accuracy and latencies (RT, MT). Methodology: Participants (N=13) were required to determine the affiliation of skaters in a randomised video sequence of 23 skaters by indicating teammate or not using a latency device. The device captured choice accuracy, reaction time (RT) and movement time (MT). They were then asked to complete two ranking tasks based on level of liking for each skater (social liking and pass choice liking). Results: Data analysis demonstrated that MT was significantly (p<0.05) longer when players perceived the skater as a non-teammate, regardless of decision accuracy, however no other analyses were significant. Conclusion: The results suggest that the perception of a less familiar (non-teammate) individual presents a level of hesitation that affects MT. While this is less problematic within existing teams, newly formed representative teams may be more vulnerable to factors of familiarity or liking thus exaggerated MTs and consequently lost scoring affordances.
Keywords: affordances, biomotion, ice hockey, perception, teammates, visual cues

1. Introduction

A significant body of research exists in the area of biological motion (BM) perception that has demonstrated humans can accurately recognize deception, emotion, gender, identity, and intention (Johnson and Shiffrar, 2013). The research suggests that information is extracted as temporal and spatial cues from movements such as gait, hand gestures and facial expressions (Vinciarelli, Pantic, and Boulard, 2009). Perception of this information is crucial to social interactions as it affords time to prepare appropriate engagement. Specifically, perceiving the intention or identity of an individual from a distance affords a person the opportunity to pre-determine, to some degree, their verbal and movement interaction (Davies, Matthews, Westerman, and Stammers, 2000). One example may include a police officer who can use BM cues to determine the psychological state of a suspect, thus allowing appropriate presentation of movement and verbal cues to minimize the likelihood of aggressive interactions. This type of information is also used in security environments as the idiosyncratic nature of gait and the overall perception of intention and deception from movement, can be stored in computer databases. These databases can then be used for biometric software programs which are designed to identify known offenders (Boyd and Little, 2003). Alternatively some researchers have found that gait can portray vulnerability to potential offenders endeavouring to select victims. Consequently there has been an attempt to develop methods of training gait to decrease vulnerability to assault (Johnson, 2006).

The unique characteristics of movement have also been explored in other real world settings such as safety apparel used in the workplace or sport (cycling, running) (Sayer and Mettford, 2004). Early research demonstrated that reflective markers worn on key joints (knees, elbows) by pedestrians or runners increased their visibility (Owens, Antonoff, and Francis, 1994), as a result drivers' decreased speed in their presence and consequently fewer collisions occur. More recently research has attempted to determine if biological motion affords sports people additional information in order

to distinguish teammates from non-teammates (Steel, Adams, and Canning, 2006, 2007). Like point-light display based studies Steel and colleagues have found that recognition derived from more ecologically valid displays (video) provides the required visual cues needed for discrimination despite the observer only receiving brief glimpses. Therefore, team sport players were able to discriminate teammates from non-teammates at levels significantly above chance when viewing video footage (<500msec) of individuals swimming or running (Steel, Adams, and Canning, 2006, 2007). Data analysis from additional investigations have also demonstrated that these decisions, in addition to (RT) and (MT) were carried out in sport relevant time which is an important factor in time pressured contexts. Moreover, the emotional attribute of liking impacted MT as demonstrated from analysis using MT and a ranking task (Steel, Adams, and Canning, 2012). Here, when an individual was ranked at the lower end of a liking task their MT was significantly longer for that person. This may suggest that in a game scenario if the least liked person were a passing option, hesitation may result. Liking however was measured on a one-dimensional basis rather then separately for social and passing option preference. It is conceivable that participants may have responded differently if a differentiation between social and game ability perceptions were offered

Factors such as accurate recognition, liking, MT and RT contribute to efficient decision making processes for athletes as a failure to move quickly when executing a pass during a game, results in either a lost scoring opportunity, or a 'hospital pass' that may result in injury. To date research has explored recognition from familiar styles of gait (walking, running, and swimming) however examination of more novel forms of gait may provide further details related to the information extracted from biomotion. Further, previous research has only examined liking using a one-dimensional approach that does not consider the delineation between social and game preferences. Therefore to investigate these characteristics ice hockey was chosen due to its use of a unique gait, ice-skating, and its classification as an invasion sport. Further, ice hockey utilizes helmets as part of their standard uniform providing ecologically valid masking which encourages the viewer to extract other features for recognition purpose (Gibson, 1986). Thus the purpose of this study was two fold; firstly is teammate discrimination significantly greater than chance in regard to choice accuracy, RT and MT, when viewing less familiar gait-based movement signatures. And secondly, do athletes delineate social liking from game liking (pass option bias) (Johnson, 2006) and does this influence MT?

2. Methods

2.1 Participants

Participants (*N*=13 (M=22.9 ±3.3)) took part in this study and were from a team who competed in a metropolitan ice hockey competition. A further ten hockey players with similar ability acted as distractors in the test footage but did not take part in the data collection phase of the study. Ethics approval was gained from the University Human Ethics Committee [H9250] with participation proceeding after informed consent was given.

2.2 Methods

Participants in this study were filmed skating as fast as possible past a fixed forward facing digital video camera (Sony HDR FX1000) (Figure 1). They were dressed in full protective equipment (including a helmet), as well as holding their hockey stick in a similar style used in a game situation. The resulting footage was edited into a randomised sequence where skaters appeared for 10 frames (400msec) (Steel, Adams, and Canning 2007). Each 10-frame clip was separated by a title slide and blank slide to provide preparation time for the next clip. Specifically the first task required participants to observe the randomised sequence and indicate whether the individual in each clip was a teammate or not by pressing the appropriate choice key on a latency device (Steel and Eisenhuth, 2012). The latency device was constructed with a home key with six choice keys arranged in a semicircle above it. The three choices on the right side of the device indicated confidence that the skater was a teammate while the keys on the left side were associated with the skater being a non-teammate (HC=Highly certain, MC=Moderately certain, LC=Low certainty).

The latency device recorded decision choice in addition to their level of certainty (high, moderate, and low), reaction time (RT) and movement time (MT). Participants then completed a survey designed to measure their familiarity with each participant. This entailed indicating how they knew each participant (sport, social, or work) and how long they had known that person in each context. Finally, a ranking task was applied in order to determine each participant's level of liking for the individual team members involved in the study. Accordingly, the most liked was themselves followed by the teammate they liked the most through to the person they least liked based on social interactions and then a second ranking based on game liking (do you like this person as an option to pass to during a game).

Figure 1. An example of the range of frames participants viewed in each clip of the test sequence.

2.3 Data Analysis

All data obtained from each subject were collated and various statistical procedures implemented using Statistical Package for Social Science (SPSS, version 22.0). Linear Mixed Models Analyses and t-Tests were conducted on the data for choice, RT, MT, social liking, game liking and familiarity. An alpha level of $p<0.05$ was selected as the criterion for all statistical procedures, with descriptive statistics for all variables reported as mean ± standard deviation (SD).

3. Results

The analyses demonstrated that game liking, social liking and familiarity were not predictors of RT and MT. The analyses further demonstrated no significant difference between choice and RT (0.84 ± 0.29 s for team mate v. 0.85 ± 0.25 s for non-team mate), however, there was a significant difference between choice and MT, where there was a slower movement time when a skater was perceived to be a non-teammate (1.70 ± 0.89 s for team mate v. 1.75 ± 0.81 s for non-team mate) ($p<0.05$).

Table 1. Summary of raw data results, means and standard deviation where applicable.

	Choice accuracy (%)	Familiarity (%?)	Social liking	Game liking
Teammate	70.7	65.4 ± 24.1	7.96 ±4.31	7.92 ± 4.32
Non-Teammate	37.5	28.2 ± 26.0	-	-

*Significantly different from non-teammate ($p<0.05$).

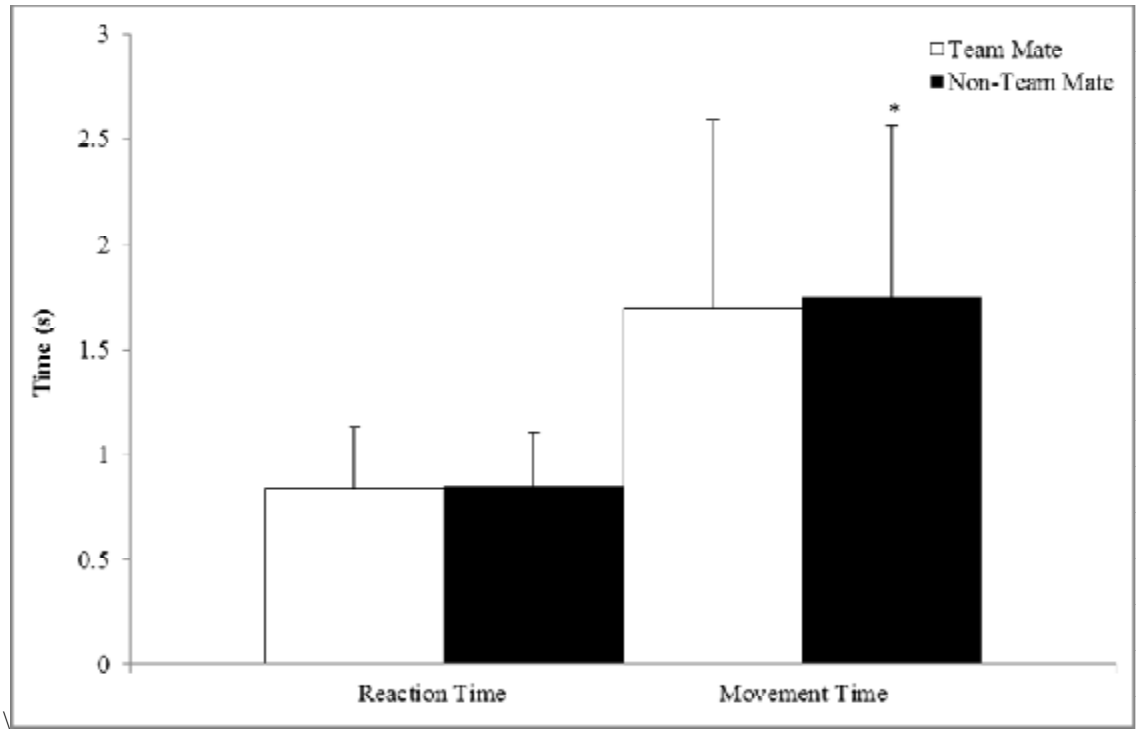

Figure 2. Comparison of Reaction and Movement Times (s) when the observed skater was perceived as teammate or non-teammate.

* Significantly different from Team Mate ($p<0.05$)

4. Discussion

The analysis of teammate recognition data for invasion sports in previous studies demonstrated that participants were able to distinguish teammates from non-teammates at levels significantly above chance (Steel, Adams, and Canning, 2006; 2007; 2008). However these trends were not replicated in this current investigation as participants performed the choice accuracy discrimination task at a chance level. This may be a result of the difference in efficiency of the gait mode used as unlike running and swimming; skating is a more biomechanically efficient form of locomotion (Saibene and Minetti, 2003). Consequently fewer gait cycles and less force is required to propel the skater over the same distance (Saibene and Minetti, 2003). In addition the nature of swimming and running requires that upper limb movement is significantly more pronounced compared to skating, therefore it is conceivable that the brief video clips did not provide sufficient visual cues for movement signature differentiation. This would suggest that the movement created by the

upper body provide unique information to the observer in addition to lower body limbs. A future study utilizing ice-skating should aim to film the skater from a marginally greater distance thus allowing a greater time period to view a more complete gait cycle. Further, the video footage could be masked to view the lower versus the upper body in separate clips to determine the types of visual information afforded by the lower and upper regions of the body.

RT and MT data were also captured and analyzed with RTs consistent with previous research demonstrating those relevant to sport contexts, i.e., <500msec (McMorris, 2004). Reaction times within the 500msec range allow the athlete to engage in dynamic tasks in fast flowing games or in penalty shooting situations. For example, a goalkeeper in football (soccer) has less than 500msec to respond to a kicked ball during a penalty shot (McMorris, 2004), thus longer RTs have consequences for both teams. Movement time is also crucial to success as longer MTs could result in a number of less desirable outcomes including lost scoring affordances, and slower passes or tackles. The current results demonstrated significantly longer MTs when participants 'perceived' the skater was a non teammates regardless of whether this decision was correct or not. Dittrich (1999) suggests that three pieces of information are immediately present when viewing others and include; who they are, what they are doing, and how they feel about that person. When applied to a game situation, the hesitation to initiate movement resulting from recognition classification can minimize the chances of passing to a defender thus decreasing the likelihood of an intercept. However, hesitation can be detrimental when new representative teams are formed and members of opposition teams come together as teammates not rivals. It is in these circumstances whereby substandard choice accuracy, RT and MT measures need to be identified in order to minimise any perceptual issues and ensure team (system) cohesion. In doing so, scoring opportunities are maximised in addition to minimizing injuries due to hospital passes.

Finally, unlike Steel, Adams, and Canning (2012) the comparison of the liking and MT data did not demonstrate a significantly longer time if the skater was less liked socially or for game liking. It is possible that in this circumstance smaller nuances in the level of liking existed thus the instances of longer MTs were diminished. This is ideal as increased dislike for teammates will result in the disruption of team cohesion hence performance (Widmeyer and Williams, 1991). Alternatively, familiarity may have been a factor, as most players had known each other for substantially longer compared to players in the previous study. It is therefore possible that duration of familiarity may influence the perception of liking as players have experienced longer periods of time engaged in varied contexts and have a greater sense of knowing their teammates.

5. Conclusions

Sports people rely on fast, accurate decisions in order to execute actions relevant to scoring affordances; consequently factors that decrease perceptual and decision-making abilities, require continued development. Data analysis from the current study suggests that teammates move slower when initiating an action to a player perceived as a defender. This allows for two scenarios 1) decreased incidents of passing to a defender thus less intercepts, and 2) if the player is perceived to be a non-teammate when opposition members come together in representative teams, slower MT will be detrimental to scoring affordances. Therefore although this MT hesitation is beneficial in regular competition, it provides an argument for perceptual training that includes the recognition of teammate's movement signatures in newly formed teams.

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