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Runswick, OR, Roca, A, Williams, AM, McRobert, AP and North, JS (2018) Why do bad balls get wickets? The role of congruent and incongruent information in anticipation. Journal of Sports Sciences. ISSN 1466-447X

Why do bad balls get wickets? The role of congruent and incongruent information in anticipation

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ACCEPTED FOR PUBLICATION IN JOURNAL OF SPORTS SCIENCES ON 15/08/2018

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Key Words: cricket; context; cognition; perceptual motor performance

Abstract

Skilled anticipation is underpinned by the use of kinematic and contextual information. However, few researchers have examined what happens when contextual information suggests an outcome that is different from the event that follows. We aimed to bridge this gap by manipulating the relationship between contextual information and final ball location in a cricket-batting task. We predicted that when contextual information is *congruent* with the eventual outcome then anticipation would be facilitated. In contrast, when contextual information is *incongruent*, this would lead to a confirmation bias on kinematic information and result in decreased anticipation accuracy. We expected this effect to be larger in skilled performers who are more able to utilise context. Skilled and less-skilled cricket batters anticipated deliveries presented using a temporally occluded video-based task. We created conditions whereby contextual information and event outcome were either congruent or incongruent. There was a significant skill by condition interaction ($p < 0.05$). The skilled group anticipated significantly more accurately than the less-skilled group on the congruent trials. Both groups anticipated less accurately on incongruent trials, with the skilled participants being more negatively affected. Skilled performers prioritise contextual information and confirmation bias affects the use of kinematic information available later in the action.

Introduction

The ability to anticipate is critical when making decisions and executing motor responses under extreme time constraints in dynamic environments. These situations occur regularly in fastball sports such as cricket or baseball, where a batter has to respond to a ball often delivered at extremely high velocities (Gray, 2002). Scientists have identified two broad categories of information that facilitate anticipation in skilled athletes. First, the use of visual information, such as advanced postural cues (i.e., kinematic or biological motion information) from the movements of an opponent, has been shown to underpin skilled anticipation (Mann, Williams, Ward, & Janelle, 2007). Second, the use of contextual information, in visual or non-visual form, such as the score in the game or the positions of fielders, has been shown to contribute to anticipation judgements (Paull & Glencross, 1997; Runswick et al., 2018a; Runswick, Roca, Williams, McRobert, & North, 2018b). However, while empirical evidence is reported to support the involvement of both sources of information, few researchers have examined how these two sources of information interact during anticipation. In this paper, we present a novel approach to examine this issue.

The majority of researchers have predominantly focused on situations where the information presented to participants is *congruent* with event outcome (i.e., the information available from an opponent's kinematics and the context lead to a probable outcome which is then subsequently realised). However, it is likely that in some situations, the kinematic and contextual information presented may be incongruent in predicting the event that actually occurs. For example, in cricket, fielders are located based on tactical plans that aim to decrease the likelihood of runs being scored and increase the likelihood of getting the batsman out. The bowler will aim to deliver the ball to bounce in a location that is appropriate for the position of the fielders. If the game context and bowler's kinematics lead to the delivery location that subsequently occurs then information is congruent. However, through either deliberate deception or poor execution (a bad ball), bowlers can execute deliveries that land in a location that differs from that which may be predicted from the kinematic or contextual information presented; that is, the information presented is incongruent with the eventual outcome. While such instances are regularly picked up by skilled batters to score runs, the adage exists in cricket that on occasion ‘bad balls get wickets’.

Thus far, researchers have focused most of their efforts on identifying the sources of kinematic information (such as those from the bowler’s body) that are most important in allowing skilled performers to accurately anticipate and when these sources of information become available in the display (Abernethy & Zawi, 2007; Müller, Abernethy, & Farrow, 2006; Williams & Davids, 1998). The typical approach has involved the use of film-based stimuli in conjunction with spatial and temporal occlusion methods. For example, researchers have shown that when anticipating at soccer penalty kicks, the position of the standing foot in the final stride is especially informative for goalkeepers (Savelsbergh, Williams, van der Kamp, & Ward, 2002), while in cricket the kinematic information, from locations such as the bowling hand and arm, can be picked up prior to ball release and are utilised earlier in the anticipation process by skilled batters (Müller et al., 2006).

It is also possible for an opponent to use kinematic information, such as postural cues, to deceive the responder or disguise the intentions of an action (Güldenpenning, Kunde, & Weigelt, 2017). The effect of using postural cues to disguise action intention has been shown across multiple sports including rugby (Jackson, Warren, & Abernethy, 2006), basketball (Kunde, Skirde, & Weigelt, 2009), tennis (Rowe, Horswill, Kronwall-Parkinson, Poulter, & McKenna, 2009), and handball (Cañal-Bruland & Schmidt, 2009). Kunde et al. (2011) showed that a ‘head fake’ (turning the head in the opposite direction to delivering a pass) in basketball negatively affected the ability to judge pass direction and increased the time needed for an opponent to responsed. However, skilled performers can still use kinematic information that arises late on in the process to make judgements above chance, even when deception is taking place (Rowe et al., 2009). It appears important for skilled performers to be able to use kinematic information that emerges late in the anticipatory process to make judgements, albeit they may also utilise earlier information from other sources to inform initial judgements regarding likely event outcomes (Müller & Abernethy, 2012; Rowe et al., 2009).

More recently, researchers have started to focus on the importance of using contextual information that is available early in the anticipation process (Loffing & Cañal-Bruland, 2017). Murphy et al. (2016) reported that skilled performers outperform less-skilled individuals even when kinematic information is completely absent from the display, suggesting that the use of contextual information is critical for accurate anticipation. Context has been used to describe a number of different information sources in the literature such as the action preferences of opponents (Loffing, Stern, & Hagemann, 2015; Mann, Schaefers, & Cañal-Bruland, 2014), the game score (Farrow & Reid, 2012), the position of teammates and opposing players on the field (Paull & Glencross, 1997) and the sequencing of events (McRobert, Ward, Eccles, & Williams, 2011). Typically, researchers have presented sources of contextual information that are congruent with the event outcome and manipulated the amount of context available to the participant. McRobert et al. (2011) displayed the same cricket deliveries in and out of sequence and found that when deliveries were in sequence, anticipation accuracy improved and that skilled performers made more verbal report statements relating to the use of higher-order cognitive processes. Runswick et al. (2018a) replicated these findings while adding information about the game situation and field placement and showed, using verbal reports, that skilled performers were better able to make use of contextual information to aid anticipation. Similarly, Runswick et al. (2018b) occluded footage at different time points and reported that skilled cricketers could make more accurate judgements based solely on the context available prior to the presence of any kinematic information. In these studies, performers could build on already established probabilities based on the context presented in order to make more accurate predictions. Several researchers have already reported that when contextual information is present and this information is congruent with the event outcome then anticipation performance improves (McRobert et al., 2011; Murphy et al., 2016; Runswick et al., 2018a). However, few researchers have manipulated the relationship between context and event outcome by presenting certain game situations and controlling event outcomes in an effort to examine whether context can either deliberately or accidentally have a negative impact on anticipation.

Several situations arise in sport where the outcome that would be predicted based on access to contextual information alone is incongruent with the event that actually occurs. Cañal-Bruland, Filius, and Oudejans (2015) showed that contextual knowledge of opponents' action capabilities could have a negative impact on performance. Participants completed a baseball batting task and were informed that the pitcher had a good 'fastball', yet on trials when a 'fastball' was not delivered, hitting performance decreased due to movements being initiated too quickly. Gray (2002) showed that information gained from situation-specific context (e.g., the sequence of pitches and pitch count in baseball) could negatively affect performance if the expected outcomes did not occur on the following pitch, suggesting that, like kinematic cues contextual information could cause deception (Güldenpenning et al., 2017). While these studies provide an insight into how context can potentially impair anticipation, both are limited by their failure to include a less-skilled group. Previously, researchers investigating high- and low-order cognitive processes in anticipation through the use of verbal reports have shown that skilled performers are able to use the high-order contextual information, whereas both skilled and less-skilled use lower-order kinematic cues (McRobert et al., 2011; Murphy et al., 2016; Runswick et al., 2018). Therefore, while skilled players anticipate more accurately when information is congruent there is likely to be an interaction between congruence and expertise where only skilled participants are susceptible to context deception; albeit, a less-skilled group is necessary to directly test this hypothesis. In addition, researchers have previously isolated the exchange between batter and pitcher without accounting for the effect that other sources of contextual information that would be available in a performance environment, such as position of opposition fielders and game score might have on performance (Paull & Glencross, 1997).

In this paper, we suggest that *confirmation bias* can explain why contextual information can have both positive and negative effects on anticipation performance. Confirmation bias postulates that once a decision has been made, people prefer to attend to supporting information and avoid information that conflicts with that presented originally (Jonas, Schulz-Hardt, Frey, & Thelen, 2001; Nickerson, 1998). This phenomenon has previously been applied to decision-making in medicine (Pines, 2006; Tschan et al., 2009). If skilled batters develop outcome expectations based on contextual information early in the anticipation process, this could lead to confirmation bias and affect the use of kinematic information arising later in the process. In congruent situations, a judgement is made based on contextual information and supported with later arising kinematic information leading to accurate anticipation. However, in incongruent situations, the later arising kinematic information may not be used because it suggests an outcome that contrasts with the original decision, leading to a decrease in anticipation accuracy. Furthermore, confirmation bias could be exacerbated by skilled batsmen relying more heavily on sources of contextual information than less-skilled counterparts. In contrast, less-skilled performers are less able to utilise contextual information and rely more heavily on kinematic information to inform decisions (Runswick et al., 2018a). Consequently, less-skilled performers, while more likely to be deceived by kinematic cues (Güldenpenning et al., 2017), are less likely to suffer from confirmation bias and deception caused by contextual information.

We compare skilled and less-skilled batters using a temporal occlusion paradigm to uncover how the degree of congruence between contextual information and event outcome affects anticipation performance. Specifically, we used a cricket-batting task that involved a novel manipulation that kept context consistent throughout. We presented participants with deliveries that were occluded immediately prior to ball release and in which the outcome of the delivery was either executed correctly and congruent, or executed incorrectly and incongruent with this context. We predicted that when contextual information was congruent with the event outcome, the skilled group would anticipate more accurately than the less-skilled group due to a superior ability to use both kinematic and contextual information to facilitate anticipation. However, when contextual information was incongruent with event outcome a skill by congruence interaction was expected, which would have a greater negative effect on anticipation performance in skilled compared with less-skilled participants. We predicted that the enhanced ability to use contextual information in skilled performers would lead to confirmation bias and reduce emphasis on using up-to-date kinematic information.

Method

Participants

Altogether, 18 skilled cricket batsmen (M age = 25.7 ± 7.8 years) who played at a minimum of club level (M competitive experience = 14.9 ± 9.3 years) and 18 less-skilled participants (M age = 27.8 ± 9.6 years) with no experience in playing competitive cricket volunteered to participate. Six of the skilled players had experience at national representative level (minor county or above, which makes up the top three tiers of domestic cricket competition in the UK). The less-skilled group all resided in a cricket-playing nation and therefore could have experienced some exposure to non-competitive cricket in a physical education or street-sport context. As a result, this group was labelled as less-skilled rather than novice. The research was conducted in accordance with the ethical guidelines of the lead institution and written informed consent was obtained from all participants at the outset.

We used the same stimuli as previously employed by McRobert, Williams, Ward, and Eccles (2009). Ten (M age = 19.5 ± 2.5 years) county-level cricket bowlers (six fast; four spin) were recruited to create the video-based test stimuli. A camera was positioned on the batting crease at a height of 1.7 m and in line with middle stump so that it represented a typical viewing perspective while batting. The different bowlers were instructed to bowl to a specified location (outside off stump) and were recorded delivering a full over (six deliveries), yielding 60 unique deliveries.

Procedure

Two of the original deliveries were selected from six of the bowlers who, alongside ‘good balls’ that had been correctly delivered to the specified location, had also delivered a ‘bad ball’ that had not gone to the requested location. This meant a realistic hypothetical game situation could be created that was congruent with the outcome of one of the deliveries, but that would be incongruent with the outcome of another delivery from the same bowler. The six bowlers selected consisted of two right arm over seam bowlers, two right arm over spin bowlers, and two left arm over seam bowlers. A panel of three qualified cricket coaches viewed non-occluded footage and agreed upon a game situation and field setting that would be tactically appropriate for the outcome of the good delivery and inappropriate for the bad delivery. Figure 1 shows an example of the contextual information participants received prior to viewing the bowler; this example represents the first over of the match. The good delivery, in which the ball location (event outcome) was tactically appropriate for the game situation and field setting (contextual information) was designated as *congruent*. The bad delivery, in which the ball location (event outcome) was not tactically appropriate for the game situation and field setting (contextual information) was designated *incongruent*. The contextual information presented varied across each of the six bowlers, but remained consistent across conditions.

Since it has been reported that skilled performers can pick up kinematic cues prior to ball flight (e.g., Müller et al., 2006; Müller & Abernethy, 2012), all clips were occluded immediately prior to ball release and duplicated to make six trials from each bowler; three congruent and three incongruent. Participants were unaware that they were viewing repeated clips. The congruent and incongruent trials were arranged into blocks of six trials per bowler as would be seen in a game (one over) and the order of trial types was balanced to negate effects of possible familiarisation. Participants were seated square on to a large screen (minimum size 2006mm x 1192mm Clevertouch 4k) and viewed 36 trials, with one block of six deliveries from each of the six bowlers. For every trial, participants received information on the game score, including the number of overs bowled, runs scored and wickets taken prior to seeing the delivery (as looking at a scoreboard) and were informed that the format was a one-day international (50 over) match. The field settings were displayed on a schematic representation prior to seeing the bowler (Runswick, Roca, Williams, Bezodis, & North, 2017).

Participants were informed how to use response sheets for ball location predictions. Less-skilled players were given no instruction about cricket batting. However, they were informed that in cricket the bowler can bowl a legal delivery anywhere between the wide lines marked on the crease, the ball does not have to be aimed at the stumps and can bounce once before reaching the batter. For each trial, when the screen occluded, participants were asked to mark the predicted point the ball would have passed the stumps on a scaled diagram eight × smaller than game size to fit a single A4 sheet. The radial error from correct ball location was measured and scaled back up to quantify anticipation accuracy at game scale (i.e., how far the bat would have been from the ball). The participants did not receive feedback on their performance at any point during testing.

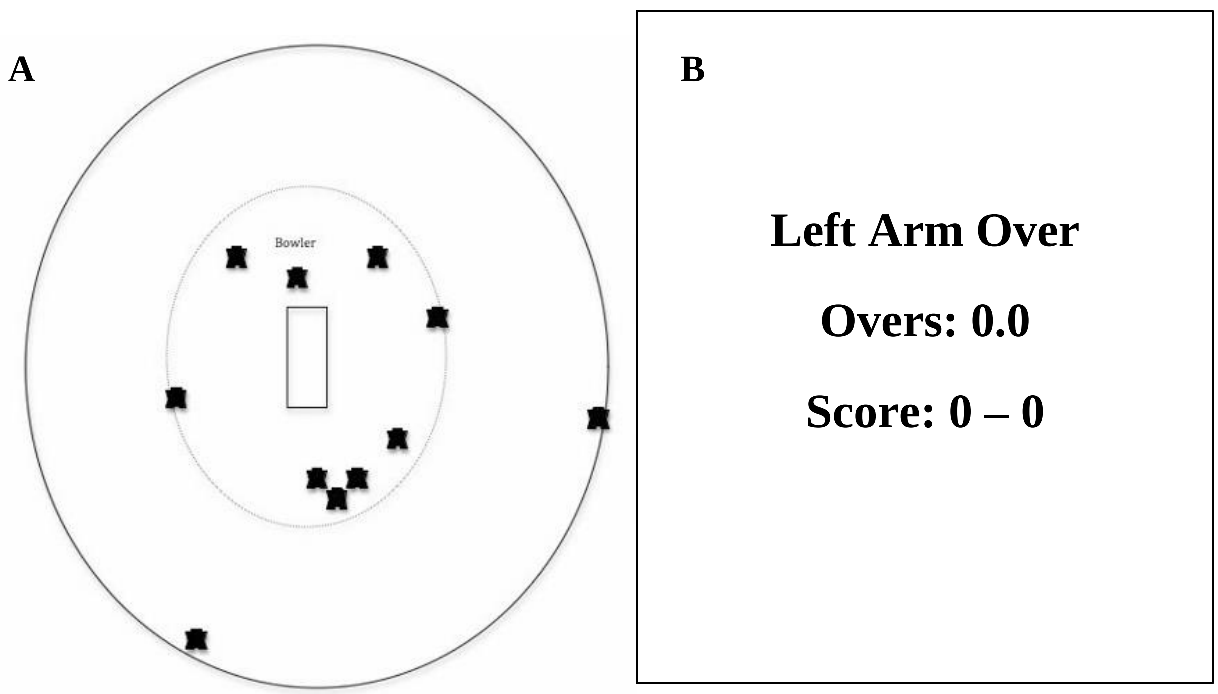

Figure 1. An example of the context displayed to participants (A) Field setting. (B) Bowler type and game situation.

Data Analysis

A two-way mixed design ANOVA was used to analyse the effect of group (skilled, less-skilled) and condition (congruent, incongruent) on anticipation accuracy. Any violations of sphericity were corrected for by adjusting the degrees of freedom using the Greenhouse-Geisser correction when epsilon was less than 0.75 and the Huynh-Feldt correction when greater than 0.75. Partial eta squared (η_p^2) was used as a measure of effect size for all analyses. The alpha level (p) for statistical significance was set at 0.05.

Results

There was a significant effect of congruence on the anticipation accuracy across groups ($F_{1, 34} = 85.34$, $p < 0.01$, $\eta_p^2 = 0.72$). The skilled group were significantly more accurate at predicting ball location on the congruent ($M_{\text{radial error}} \pm SD$; 28.4 ± 4.9 cm) compared to incongruent (51.4 ± 4.1 cm) trials. Also, the less-skilled players were significantly more accurate at predicting ball location on the congruent (36.9 ± 5.9 cm) compared to incongruent (42.1 ± 7.1 cm) trials. There was no significant overall effect of skill across conditions ($F_{1, 34} = 0.10$, $p = 0.75$, $\eta_p^2 = 0.01$). However, there was a significant skill × congruence interaction (Figure 2; $F_{1, 34} = 33.63$, $p < 0.01$, $\eta_p^2 = 0.50$). The skilled group ($M_{\text{radial error}} \pm SD$; 28.4 ± 4.9 cm) were more accurate at anticipating ball location than the less-skilled group (36.9 ± 4.1 cm) on congruent trials, but the skilled group (51.4 ± 4.1 cm) were significantly less accurate than the less-skilled group (42.1 ± 7.1 cm) when contextual information was incongruent with the event outcome. Figure 3 shows the correct responses to the good and bad deliveries that were displayed following the context presented in Figure 1, alongside the distribution of skilled responses. This schematic represents the largest difference between congruent and incongruent deliveries in the study.

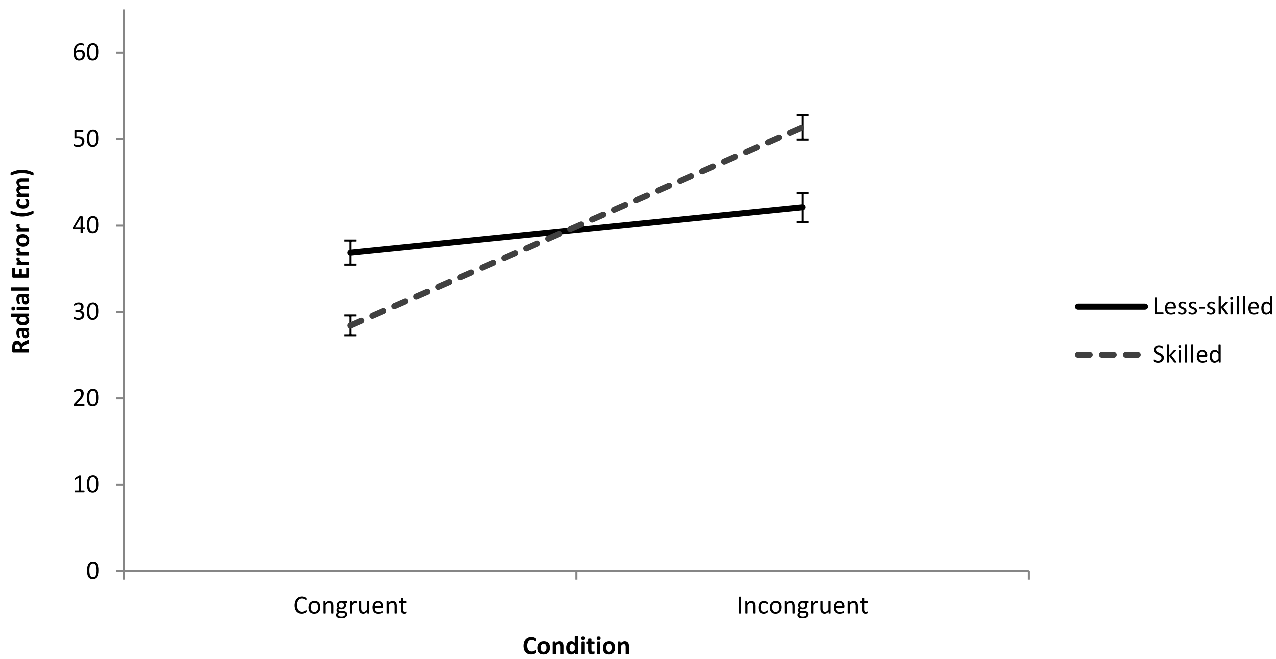

Figure 2. Anticipation accuracy for skilled and less-skilled groups in congruent and incongruent conditions (SE).

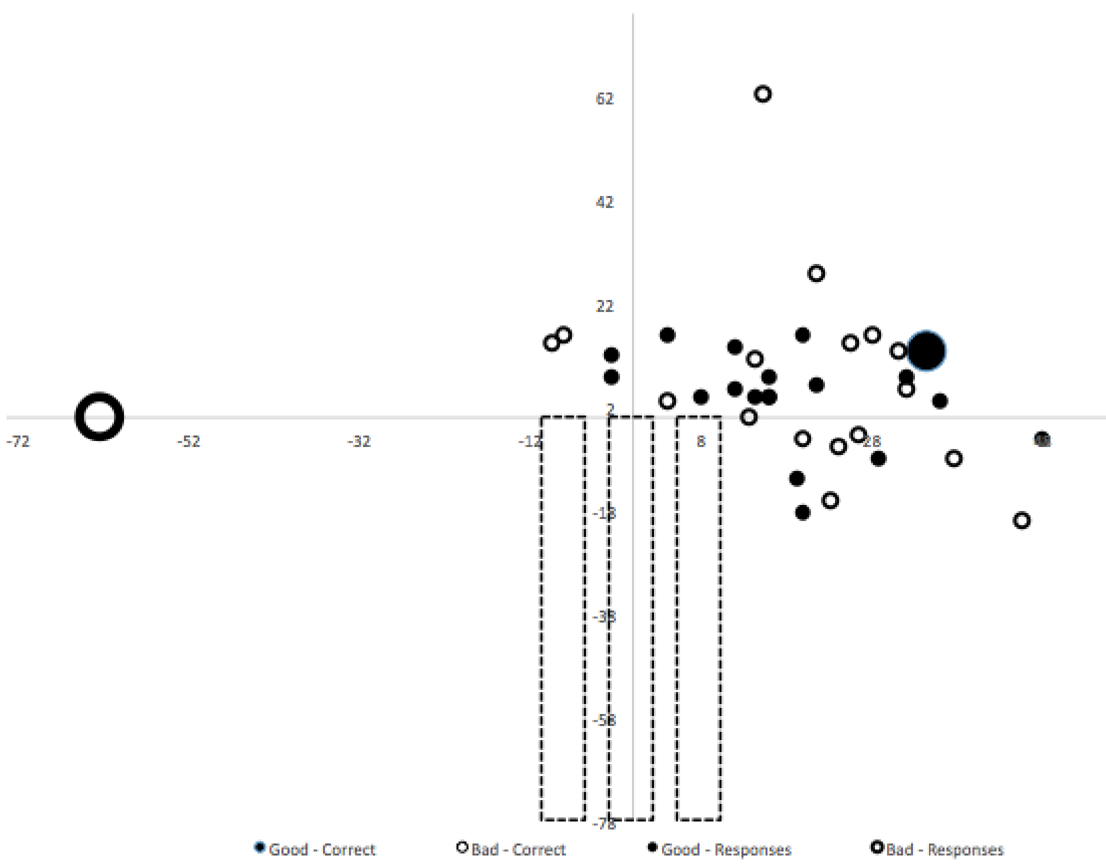

Figure 3. A scale set of cricket stumps with the top of middle representing (0, 0) and axis scales showing distance scaled up to game size (cm) with response distribution shown from skilled performers in response to the one congruent (good) and incongruent (bad) deliveries that were coupled with the context from Fig 1A and 1B.

Discussion

We used a novel, video-based temporal occlusion task to investigate the effect of congruence between contextual information and event outcome on anticipation in cricket. The results showed that both skill groups anticipated more accurately in the congruent condition, suggesting the relationship between information sources available prior to event outcome is important for anticipation. Furthermore, the skilled group anticipated more accurately than the less-skilled group when the contextual information and the event outcome were congruent. This finding supported our prediction and is in line with much of the literature investigating both kinematic (Abernethy, 1990; Müller et al., 2009) and contextual information sources in anticipation (McRobert et al., 2011; Murphy et al., 2016). As predicted, based on the findings of Runswick et al. (2018a; 2018b), there was also a significant interaction between congruence and skill level. The skilled group anticipated more accurately than the less-skilled group when information was congruent with event outcome and less accurately than the less-skilled group when it was not. Similarly, Cañal-Bruland et al. (2015) showed that contextual information of an opponent's action capabilities could harm batting performance in baseball when the information is not congruent with the pitch delivered (event outcome). Gray (2002) showed pitch sequence and count only had a positive influence when it was congruent with the event outcome. However, this is the first study to show that a lack of congruence between contextual information and the outcome of the following event can have a significant negative impact on anticipation and that this decrement in performance is significantly greater for skilled compared with less-skilled participants. This incongruence can arise through deception or poor execution from the bowler and in this study caused the skilled performer's anticipation performance to fall below that of the less-skilled group.

An explanation for why the significant decline in anticipation performance is so dramatic is drawn from confirmation bias, suggesting that once a decision is formed, new information that supports the original decision is prioritised (Pines et al., 2006). Runswick et al. (2018b) had skilled and less-skilled cricket batters make anticipatory judgements at different occlusion points and collected self-reported scores to analyse the use of different sources of information at varying time points in the anticipation process. The skilled performers could make significantly more accurate anticipatory judgements than their less-skilled counterparts at the earliest occlusion point and relied more heavily on contextual information. Murphy et al. (2016) supported these findings by reporting that skilled performers could anticipate more accurately when kinematic information was absent from the display. We suggest that skilled batters made an early judgement as to the probable event outcome based on contextual information. Subsequently, this may have resulted in confirmation bias, with skilled batters prioritising later arising kinematic information that led to the same conclusion. When the later arising kinematic information led to a different outcome, its use was diminished causing a significantly decreased ability to make accurate judgements. Less-skilled performers, who rely on kinematic information, did not suffer from confirmation bias because they are less able to use contextual information and, therefore, there was no early decision to bias the use of up-to-date kinematic information. This application represents an expansion of the confirmation bias literature towards the investigation of information use in the context of temporally-constrained anticipation tasks. Previously, researchers have generally focused on tasks involving more conscious processing and there is, therefore, an opportunity for future work to build on this study and continue to test the application of confirmation bias in more dynamic environments.

In the present study, an occlusion point immediately prior to ball release and different types of bowler were chosen in order to investigate whether up-to-date kinematic information from the bowler's body is affected by confirmation bias. Runswick et al. (2018b) recently reported that when 80ms of ball flight information was available to skilled cricket batters, prioritisation of information began to switch from contextual information to that arising from the bowler and ball flight. It is therefore possible that skilled batters would be able to rapidly correct responses formulated from the use of incongruent context. Runswick et al. (2018b) used *congruent* contextual information, so early ball flight information always supported the responses that had been established earlier using context and therefore lead to more accurate judgments. However, if confirmation bias is occurring, then, despite the value of early ball flight information, the use of this information will still be biased towards supporting the early judgment because it becomes available after an initial judgment has been made using context. Therefore, the same pattern of results could occur when ball flight is present, with highly accurate predictions in congruent situations but less use of ball flight information and less accurate predictions when context is incongruent. Furthermore, even if the early ball flight information is not subject to confirmation bias then the skilled batter is at a disadvantage because the correct outcome is realised later, meaning less time is afforded to execute a motor response. In the future, researchers should look to investigate whether the effects displayed in this experiment still occur when ball flight information is available and is consistent across different types and speeds of bowler.

While this research has used a novel manipulation to begin to uncover the impact that incongruent contextual information can have on anticipation performance, some further limitations should be noted. This experiment focused solely on incongruent information caused by accidental poor execution rather than deliberate deception and so researchers should investigate occurrences in which incongruent contextual information is used to deliberately deceive the opposition. Furthermore, a simple pen and paper response was used alongside screen-based stimuli, potentially diluting the skilled advantage (Mann, Abernethy and Farrow, 2010) and making it harder to transfer findings to the field setting (cf. Pinder et al., 2011). In future, researchers should investigate the congruence of kinematic and contextual information sources using tasks that necessitate a movement response (e.g., Runswick et al., 2017).

The data presented in this study show that an incongruent relationship between contextual information and the outcome of the following event caused skilled cricket batters to anticipate less accurately than less-skilled counterparts. From an applied perspective, performers in fast-ball sports should make use of contextual information with caution and be aware that the ability to update probabilities with new kinematic information is vital to avoid deception. Practitioners should make sure that training occurs in the presence of both full kinematic and contextual information sources in order to allow both batters and bowlers to learn to use the dynamic relationship between the two and event outcome to both deceive and predict. While previously researchers have highlighted the positive influence context can have on anticipation, such an effect may only occur when the contextual information is congruent with event outcome. If the two sources of information are incongruent, it can have a significant negative effect on the ability of skilled batters to anticipate, thereby providing one argument as to why on occasion 'bad balls get wickets' in cricket.

References

Abernethy, B. (1990). Anticipation in squash: Differences in advance cue utilization between expert and novice players. *Journal of Sports Sciences, 8,* 17-34. doi:10.1080/02640419008732128

Abernethy, B., & Zawi, K. (2007). Pickup of essential kinematics underpins expert perception of movement patterns. *Journal of Motor Behaviour, 39,* 353-367.

Cañal-Bruland, R., Filius, M. A., & Oudejans, R. R. D. (2015). Sitting on a fastball. *Journal of Motor Behavior, 47,* 267-270. doi:10.1080/00222895.2014.976167

Cañal-Bruland, R., & Schmidt, M. (2009). Response bias in judging deceptive movements. *Acta Psychologica, 130*, 235-240.

Farrow, D., & Reid, M. (2012). The contribution of situational probability information to anticipatory skill. *Journal of Science and Medicine in Sport, 15,* 368-373.

Gray, R. (2002). Behaviour of college baseball players in a virtual batting task. *Journal of Experimental Psychology: Human Perception and Performance, 11,* 1131-1148.

Güldenpenning, I., Kunde, W., & Weigelt, M. (2017). How to trick your opponent: A review article on deceptive actions in interactive sports. *Frontiers in Psychology*. doi:10.3389/fpsyg.2017.00917

Jackson, R. C., Warren, S., & Abernethy, B. (2006). Anticipation skill and susceptibility to deceptive movement. A*cta Psychologica, 123,* 355-371.

Jonas, E., Schulz-Hardt, S., Frey, D., & Thelen, N. (2001). Confirmation bias in sequential information search after preliminary decisions: An expansion of dissonance theoretical research on selective exposure to information, *Journal of Personality and Social Psychology, 80,* 557-571.

Kunde, W. Skirde, S., & Weigelt, M. (2011). Trust my face: Cognitive factors of head fakes in sports. *Journal of Experimental Psychology Applied, 17(2)*, 110-127.

Loffing, F., & Cañal-Bruland, R. (2017). Anticipation in sport. *Current Opinion in Psychology, 16,* 6-11. doi: 10.1016/j.copsyc.2017.03.008

Loffing, F., Stern, R., & Hagemann, N. (2015). Pattern-induced expectation bias in visual anticipation of action outcomes. *Acta Psychologica, 161*, 45-53.

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

Mann, D. L., Abernethy, B., & Farrow, D. (2010). Action specificity increases anticipatory performance and the expert advantage in natural interceptive tasks. *Acta Psychologica*, *135 (1)*, 17-23.

Mann, D. L., Schaefers, T., & Cañal-Bruland, R. (2014). Action preferences and the anticipation of action outcomes. *Acta Psychologica, 152,* 1-9.

McRobert, A. P., Ward, P., Eccles, D. W., & Williams, A. M. (2011). The effect of manipulating context-specific information on perceptual-cognitive processes during a simulated anticipation task. *British Journal of Psychology*, *102,* 519-534.

McRobert, A. P., Williams, A. M., Ward, P., & Eccles, D. W. (2009). Tracing the process of expertise in a simulated anticipation task. *Ergonomics, 52,* 474-483.

Müller, S., & Abernethy, B. (2012). Expert anticipatory skill in striking sports: A review and a model. *Research Quarterly for Exercise & Sport, 83,* 175–187.

Müller, S., Abernethy, B., & Farrow, D. (2006). How do world-class cricket batsmen anticipate a bowler's intention? *The Quarterly Journal of Experimental Psychology*, *59*, 2162-2186.

Müller, S., Abernethy, B., Reece, J., Rose, M., Eid, M., McBean, R., Hart, T., & Abrew, C. (2009). An in-situ examination of the timing of information pick-up for interception by cricket batsmen of different skill levels. *Psychology in Sport and Exercise*, *10,* 644-652.

Murphy, C. P., Jackson, R. C., Cooke, K., Roca, A., Benguigui, N., & Williams, A. M. (2016). Contextual information and perceptual-cognitive expertise in a dynamic, temporally-constrained task. *Journal of Experimental Psychology Applied*, *22,* 455-470.

Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of General Psychology*, *2*, 175-220.

Paull, G., & Glencross, D. (1997). Expert perception in decision making in Baseball. *International Journal of Sport Psychology*, *28*, 35-56.

Pines, J. M. (2006). Profiles in patient safety: Confirmation bias in emergency medicine. *Academic Emergency Medicine, 13,* 90-94.

Roca, A., & Williams, A. M. (2016). Expertise and the interaction between different perceptual-cognitive skills: Implications for testing and training. *Frontiers in Psychology*. doi:10.3389/fpsyg.2016.00792.

Rowe, R., Horswill, M. S., Kronwall-Parkinson, M., Poulter, D. R., & McKenna, F. P. (2009). The effect of disguise on novice and expert tennis players' anticipation ability. *Journal of Applied Sport Psychology, 21*, 178-185.

Runswick, O. R., Roca, A., Williams, A. M., Bezodis, N. E., & North, J. S. (2017). The effects of anxiety and situation-specific context on perceptual-motor skill: A multi-level investigation. *Psychological Research*. doi:10.1007/s00426-017-0856-8

Runswick, O. R., Roca, A., Williams, A. M., Bezodis, N. E., McRobert, A. P., & North, J. S. (2018a). The impact of contextual information and a secondary task on anticipation performance: An interpretation using Cognitive Load Theory. *Applied Cognitive Psychology, 32,* 141-149.

Runswick, O. R., Roca, A., Williams, A. M., McRobert, A. P., & North, J. S. (2018b). The temporal integration of information during anticipation. *Psychology of Sport and Exercise, 37,* 100-108. doi:10.1016/j.psychsport.2018.05.001

Savelsbergh, G. J. P., Williams, A. M., van der Kamp, J., & Ward, P. (2002). Visual search, anticipation and expertise in soccer goalkeepers. *Journal of Sports Sciences, 20*, 279-287.

Sarpeshkar, V., Abernethy, B., & Mann, D. L. (2017). Visual strategies underpinning the development of visual–motor expertise when hitting a ball. *Journal of Experimental Psychology: Human Perception and Performance*, *43(10)*, 1744-1772. doi:10.1037/xhp0000465

Tschan, F., Semmer, N. K., Gurtner, A., Bizzari, L., Spychiger, M., Breuer, M., & Marsch S. U. (2009). Explicit Reasoning, Confirmation Bias, and Illusory Transactive Memory: A Simulation Study of Group Medical Decision Making. *Small Group Research, 40*, 271-300. doi:10.1177/1046496409332928

Williams, A. M., & Davids, K. (1998). Visual search strategy. selective attention, and expertise in soccer. *Research Quarterly for Exercise and Sport*, *69*, 111-128.