CrossMark

ORIGINAL PAPER

In a Flash: Thin Slice Judgment Accuracy of Leading and Trailing in Sports

Philip Furley[1] · Geoffrey Schweizer[2]

Abstract Humans can detect whether athletes are leading or trailing based on thin slices of athletes' nonverbal behavior, presumably because communicating and interpreting status has evolved to be highly beneficial for humans. The goal of the present research was to examine this evolutionary perspective on nonverbal behavior in sports. First, in Experiment 1 ($N = 40$), we investigated if leading athletes are rated higher on dimensions related to social status than are trailing athletes. Experiment 1 showed that perceivers rated leading athletes as more dominant, more proud, and more confident than trailing athletes, without being aware of the actual score. Second, we were interested in the role of head-related versus body-related information and in the role of dynamic versus static information. In Experiment 2, 120 participants watched short videos from basketball matches and rated whether athletes were leading or trailing. We occluded either athletes' faces, athletes' bodies, or showed both faces and bodies. Experiments 2 and 3 ($N = 160$) showed that very scarce information was sufficient for differentiating between leading and trailing athletes, even when faces or bodies were occluded. These findings are in line with ecological approaches to person perception and evolutionary accounts of nonverbal behavior.

Keywords Sport · Emotion expression · Nonverbal behavior · Thin slices of behavior

Introduction

People are constantly making judgments and forming impressions of other people based on observable cues. Two related dimensions that have considerable ecological importance are social status (Schmid Mast and Hall 2004) and social dominance (Mazur 2005; Rule et al. 2012;

✉ Philip Furley
  p.furley@dshs-koeln.de

[1] Institute of Cognitive and Team/Racket Sport Research, German Sport University Cologne, Am Sportpark Müngersdorf 6, 50933 Cologne, Germany

[2] Department of Sport and Exercise Psychology, University of Heidelberg, Im Neuenheimer Feld 720, 69120 Heidelberg, Germany

Zebrowitz and Collins 1997). Because status and dominance can reliably be judged from nonverbal behaviors (e.g., Schmid Mast and Hall 2004), even if only minimal, degraded information is available (Rule et al. 2012), individuals might be predisposed towards evaluating status and dominance (Mazur 2005). In line with this view, Furley and Schweizer (2014b) found that observers of sport competitions—a modern form of status or dominance contests (Llaurens et al. 2009; Lombardo 2012; Mazur 2005; Mehta et al. 2008)—can reliably judge who is leading or trailing simply from the behavior of the players. Furley and Schweizer suggested that these behavioral changes probably occur because they had been adaptive in our evolutionary past. Specifically, sending submissive signals when losing an antagonistic encounter increased the chances of avoiding further potential life threatening attacks for primates (de Waal 2007). Likewise, sending dominant cues helped primates to save valuable resources by communicating high status and their superiority over the opponent (Archer 2006; de Waal 2007).

This evolutionary process fits well with the ecological theory of person perception (McArthur and Baron 1983; Zebrowitz and Collins 1997) that assumes the perceptual abilities of humans have been shaped by their ecological utility. As a result, people have become especially attuned to perceptual cues that facilitate adaptive behavior. Thus, nonverbal cues related to the social status dimension, including pride and shame (Martens et al. 2012) and dominance and submissiveness (Carney et al. 2010; Carney et al. 2005) are particularly important in situations of competition and conflict. It is not clear, however, in the Furley and Schweizer (2014b) study what dimensions were critical in forming judgments of leading or trailing. Although it is likely that nonverbal behaviors related to social status dimensions were salient in judging leading or trailing, there is currently no empirical support for this assumption. Therefore, we first investigated whether leading athletes' behaviors were rated higher on social status dimensions than were trailing athletes' behaviors.

If leading and trailing athletes indeed change their nonverbal behavior signaling social status, then the ecological theory of person perception (McArthur and Baron 1983; Zebrowitz and Collins 1997) suggests that people should be very efficient in making accurate judgments about leading and trailing athletes. This hypothesis was supported using posed expressions of dominance and submission, leading Rule and colleagues to conclude that "people possess a pronounced capacity for perceiving displays of dominance under very challenging conditions and constraints" (Rule et al. 2012, p. 688). Nevertheless, they further suggest "that it would also be valuable to measure these effects using naturally-occurring stimulus cues." (Rule et al. 2012, p. 703). Consequently, our second goal in the present research, was to investigate how well people can judge who is leading or trailing when the range of behavioral cues is limited and only very scarce information is available. Brunswik's (1956) lens model is one approach that describes how perceivers infer traits or dispositions from observable cues. Given the results of Furley and Schweizer (2014b), athletes must have displayed some valid cues that were used by observers to form accurate estimates about who was currently leading or trailing. It is currently not clear, however, what the most informative cues were that athletes displayed and observers used. Specifically, we tested whether face-related and body-related cues are equally valid for score estimations and whether kinematic information is necessary to arrive at accurate score estimates.

The Present Research

In Experiment 1, we used the video stimulus material from Furley and Schweizer (2014b) derived from professional basketball games and investigated how observers would rate the leading and trailing athletes on items linked to status, i.e., dominance, pride, and

confidence (Driskell and Salas 2005; Hall et al. 2005; Mazur 2005). Experiment 1 investigated whether the accurate score estimates found in Furley and Schweizer (2014b) might be due to the contrasting behavior patterns of leading and trailing athletes reflecting differences in status dimensions. Status competitions may be viewed as a fitness-relevant feature of social life that establishes the vertical dimension of social relationships (see Hall et al. 2005 for a review). The vertical dimension of status in social relations stands in contrast to the horizontal dimension of emotional closeness of relationships (Burgoon and Hoobler 2002; Hall and Friedman 1999; Trivers 1985). In modern societies, sport competitions can be considered an institutionalized form of status contests (Llaurens et al. 2009; Lombardo 2012; Mazur 2005; Mehta et al. 2008). In these contests, signaling cues associated with social status, such as dominance, pride, and confidence (Driskell and Salas 2005; Mazur 2005) serve the adaptive function of navigating the status hierarchy by letting other people know who deserves high or low status (Henrich and Gil-White 2001). Although this theorizing has received some empirical support within the context of competitive sports (e.g., a prototypical triumph expression after victory in Olympic judokas, Matsumoto and Hwang 2012), it is currently not clear if this process also accounts for the accurate score estimates reported in Furley and Schweizer (2014b). If the above theorizing holds for leading and trailing athletes during competition, then leading athletes should not only be identified as such, but should also be rated higher on social status dimensions than are trailing athletes.

In a second series of comparisons (Experiment 2 and 3), we investigated what the most informative cues were that athletes displayed and observers used. Specifically, we were interested in face-related and body-related cues. In Experiment 2, we used video stimuli and either occluded all facial information of the athletes while only displaying the bodily information during the video (body-only-condition), or occluded the bodily information of the athletes while only displaying the heads and faces of the athletes (head-only-condition), or displayed the entire video (head-and-body-condition). In Experiment 3, we tested whether kinematic information was necessary for accurate score estimates by selecting frozen frames from the video clips. In order to avoid any kind of selection bias when deriving the frozen frames from the video clips, we took the median frame of each video clip and used this frame to create the three occlusion conditions: head-only, body-only, and head-and-body.

Experiment 1: What Dimension of Nonverbal Behavior is Informing Score Estimates?

Although, Matsumoto and Hwang (2012) have provided convincing evidence for an evolved nonverbal expression of triumph distinct from other positive emotion expressions, such as pride, it remains unclear what type of behavior changes during competitions when athletes are leading or trailing. We did not expect that athletes would show a distinct nonverbal expression of leading or trailing during ongoing competition as no victory or defeat has occurred yet. Because the quality and diversity of the sampled stimulus material of Furley and Schweizer (2014b; first footnote) rendered behavioral coding difficult, the present investigation solely focused on whether leading and trailing athletes would be rated differently by untrained observers on dimensions associated with social status, i.e., dominance, pride, and confidence (Driskell and Salas 2005; Hall et al. 2005; Mazur 2005).

Method

Participants

Forty college students without any particular basketball experience took part in the study (20 women and 20 men; $M_{age} = 24.5$, $SD = 3.9$). Written informed consent was obtained from every participant before commencing the experiment. The study was carried out in accordance with the Helsinki Declaration of 1975.

Stimuli

We utilized the basketball stimuli from Furley and Schweizer (Experiments 1 and 2, 2014b). Therefore, the following descriptions of stimulus selection and measures are highly similar to the ones in Furley and Schweizer (2014b). We selected video footage of televised basketball games from the NBA and the highest German league (Seasons 2010–2012). In order to ensure that the ratings were not influenced by score-induced changes in sport specific tactics, we chose video stimuli that involved breaks during the game, time outs, and free throws. We did not select videos showing obvious nonverbal signals associated with pride or shame, such as raising both fists above the head or hiding the face behind the hands (cf. Tracy and Matsumoto 2008), that are linked to the final outcome in sport and therefore would be too informative for estimating the score. Selected videos had a mean duration of 3.9 s ($SD = 2.8$; $Mode = 1$).

Experimental Manipulation (within-participants)

The within manipulation in the study was based on the actual score of the game during the video. We chose five different categories of scores: (1) far behind, displaying a team trailing substantially, defined as at least fifteen points behind. Moreover, in this category the team shown always lost the game in the end; (2) close behind, showing a team losing in a fairly close game situation, defined as no more than five points behind; (3) a draw in which the score was equal; (4) close lead, showing a team leading in a fairly close game situation, defined as no more than five points ahead; (5) high lead, displaying a team leading substantially, defined as at least fifteen points ahead. Moreover, in this category the team shown always won the game in the end.

We aimed at finally having a battery of 20 videos in each experimental category (100 video clips in total). The selection of videos was done by student research assistants according to the following guidelines. Research assistants were instructed to review all videos of a convenience sample of 30 basketball games one after the other. They were to select each video that fit the above mentioned criteria (breaks during game, no obvious nonverbal signals that have empirically been linked to victory and defeat [Tracy and Matsumoto 2008]), until each category of scores contained 20 videos (see hyperlinks to the utilized stimulus material[1]).

---

[1] In order to maximize transparency in the conducted research we provide hyperlinks to the stimulus material utilized in the studies. Note that the software randomly selected and displayed the stimulus material from the video stream according to the described procedure and not as shown in the video streams: Videoclips (*head-and-body-group*): http://youtu.be/kDuLEpqLZ7c. Videoclips (*head-only-group*): http://youtu.be/sQzjxr2pY4E. Videoclips (*body-only-group*): http://youtu.be/6LxtNZgyRnc. Frozen frames (*head-and-body-group*): http://youtu.be/YZgZQfFSpVQ. Frozen frames (*head-only-group*): http://youtu.be/hdDd_hSIlJI. Frozen frames (*body-only-group*): http://youtu.be/kNwBx8In8XU.

Measure and Procedure

Perceivers rated the video scenes on three 11 point digital semantic differential scales after every video. Similar to the dependent measure in Rule et al. (2012) on dominance participants rated how "*submissive—dominant*", "*ashamed—proud*", and "*not confident–confident*" the displayed athletes appeared. Participants moved a mouse cursor from the middle of the scale towards either pole of the scale and logged in their rating by clicking the left mouse button. The software converted the ratings into a value (with 3 decimals) between 0 reflecting the left pole of the scale with the respective labels "*submissive*", "*ashamed*", and "*not confident*" and 1 reflecting the right pole of the scale with the respective labels "*dominant*", "*proud*" and "*confident*".

Results

The descriptive results are displayed in Fig. 1. ANOVAs were run to examine the main effects of score category (far behind, close behind, draw, close lead, and high lead) for each of the dependent variables. The results reveal significant main effects on the dominance scale ($F[3.239, 126.332] = 8.517$, $p < .001$, $\eta_p^2 = .179$), pride scale ($F[4, 156] = 10.077$, $p < .001$, $\eta_p^2 = .205$), and confidence scale ($F[2.965, 115.628] = 8.105$, $p < .001$, $\eta_p^2 = .172$).

Polynomial linear trend analyses demonstrated a linear relationship between score category and dominance ratings ($F[1, 39] = 39.656$, $p < .001$, $\eta_p^2 = .504$), pride ratings ($F[1, 39] = 48.864$, $p < .001$, $\eta_p^2 = .556$), and confidence ratings ($F[1, 39] = 47.803$, $p < .001$, $\eta_p^2 = .551$), highlighting that dominance ratings, pride ratings, and confidence ratings corresponded in a linear manner to the actual score categories.
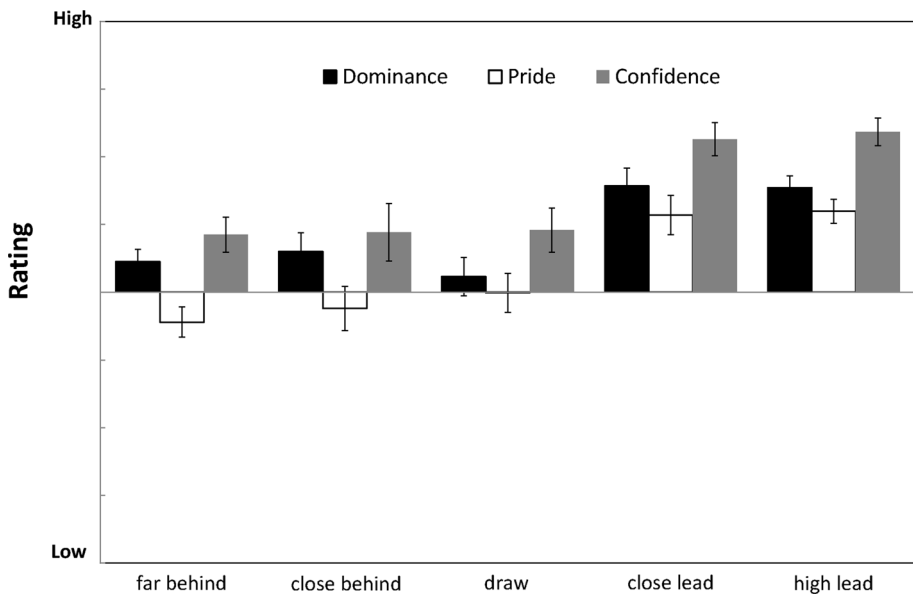
Fig. 1 Mean dominance, pride, and confidence ratings as a function of score category in Experiment 1. *Error bars* represent standard errors

Pairwise comparisons revealed that high trailing, close trailing, and drawing athletes differed significantly from close leading and high leading athletes on the dominance scale, the pride scale, and the confidence scale. None of the other comparisons reached significance.

Discussion

The data show that perceivers rated leading athletes as more dominant, more proud, and more confident as trailing athletes without being aware of the actual score. All of these dimensions have been associated with social status in the past (Driskell and Salas 2005; Hall et al. 2005; Mazur 2005) and suggest that athletes change their nonverbal behavior along the verticality dimension when they are leading or trailing (Burgoon and Hoobler 2002; Hall and Friedman 1999).

The present results warrant some caution, however, as previous research has indicated that the specific rating labels influence participants' judgments. For example, nonverbal behavior previously thought of as representing pride was better characterized as a distinct expression of triumph, when participants were given different response options (Matsumoto and Hwang 2012). Hence, it is still not clear what specific behavioral changes constitute leading and trailing cues in on-going sport competition. The present results, however, are consistent with the existence of an evolved adaptation for signaling leading and trailing during agonistic encounters (de Waal 2007; Furley and Schweizer 2014b). Nevertheless, we acknowledge that future behavioral coding research is needed to identify the specific behavioral changes during sport competitions that inform these ratings. In a step toward that goal, Experiment 2 examines a more general question of whether face or body cues may be more important in these judgments.

Experiment 2: Face versus Body in Dynamic Displays

According to a recent review of nonverbal communication research, the face can be considered the single most prominent nonverbal channel as it is the most intricate (Matsumoto and Hwang 2013, p. 15): "It is the most complex signaling system in our body. […] And arguably it is the seat of the greatest amount of information that is conveyed nonverbally. That's why we have "face-to-face" interactions." Similarly, Cozolino (2006, p. 154) states "the faces of others may be the single most important source of information in our world". These statements highlight the critical role of the human face in broadcasting internal states to the social world. Therefore, it seems feasible that participants in the Furley and Schweizer (2014b) study, and observers in sports more generally, primarily use facial signals to infer the score differences.

Of particular relevance to the present research, a recent study by Rule and colleagues (2012) showed that observers could accurately discern dominance and submission from very briefly presented (1/25 of a second) posed bodily and facial displays. Nevertheless, observers were more accurate in their judgments based on faces than on bodies, suggesting a primary role for facial cues in signaling dominance. These findings are in line with a large body of research demonstrating the high predictive validity of facial cues in making accurate inferences of both dispositions (e.g., Todorov et al. 2005; Willis and Todorov 2006) and mental states (e.g., Baron-Cohen et al. 1996).

In light of the critical role of the human face in nonverbal communication (e.g., Matsumoto and Hwang 2013) and the findings of Rule et al. (2012) we hypothesized that observers will be more accurate in estimating the score when having access to facial information than when this information is missing. Further, we explored whether facial information alone would be sufficient for arriving at accurate judgments, or whether face and body information was necessary for higher accuracy.

Method

Participants

One hundred twenty college students (62 women and 58 men; $M_{age} = 22.1$, $SD = 2.71$) took part in the study. Eighty four participants reported that they did not play basketball at all ($Mode_{number\ of\ occasions\ basketball\ is\ played\ per\ year} = 0$; $Md_{minutes\ of\ basketball\ on\ TV/year} = 0$), twenty nine reported playing basketball occasionally ($Mode_{number\ of\ occasions\ basketball\ is\ played\ per\ year} = 1$; $Md_{minutes\ of\ basketball\ on\ TV/year} = 80$) and seven participants reported playing basketball regularly ($Mode_{number\ of\ occasions\ basketball\ is\ played\ per\ year} = 12$; $Md_{minutes\ of\ basketball\ on\ TV/year} = 720$). Participants were randomly assigned to one of three experimental groups: the head-and-body-group ($n = 41$), the head-only-group ($n = 39$) or the body-only-group ($n = 40$). After randomization, groups did not differ significantly with regard to age, gender, and basketball experience. Written informed consent was obtained from every participant before commencing the experiment. The study was carried out in accordance with the Helsinki Declaration of 1975.

Experimental Manipulation (within-participants)

We used the same 100 video clips from Experiment 1 as stimuli in Experiment 2. The experimental within-groups manipulation was exactly the same as in Experiment 1 and involved the five differed score categories.

Experimental Manipulation (between-participants)

We created three versions of all 100 basketball videos (see hyperlinks to the utilized stimulus material (see footnote 1)). One version included all videos without any further editing so that athletes depicted in the videos were fully visible. These videos were shown to perceivers in the *head-and-body-group*. For a second version, athletes' bodies were masked so that only their heads were visible. Bodies were masked in such a way that bodily posture was not recognizable. These videos were shown to perceivers in the *head-only-group*. For a third version, athletes' heads were masked so that only their bodies were visible. These videos were shown to perceivers in the *body-only-group*. As a consequence of these modifications, perceivers in the head-and-body-group could use nonverbal cues related to both athletes' heads and bodies for their estimations. Conversely, perceivers in the head-only-group could only use cues related to athletes' heads whereas perceivers in the body-only-group could only use cues related to athletes' bodies.

Dependent Measure

Perceivers rated the video scenes on an 11 point digital semantic differential scale after every video. In order to give their ratings, perceivers moved a mouse cursor from the

middle of the scale that represented a tied score towards either pole of the scale and logged in their rating by clicking the left mouse button. The software converted the ratings into a value (with 3 decimals) between 0 reflecting the left pole of the scale with the label "*far behind*" and 1 reflecting the right pole of the scale with the label "*high lead*." The utilized scale was continuous, ranging from .000 to 1.000 and was visually presented as 11 points in order to assist participants in providing a clear indication of their ratings.

Procedure

Perceivers were instructed that they had to estimate who was leading or trailing based on the video footage presented to them by moving a mouse cursor to either the "*high-lead*" or "*far-behind*" pole of the semantic differential scale. They were further instructed to answer as accurately as possible, while speed was not emphasized. E-prime 2.0 professional (Psychological software tools 2007) was used to present the stimuli and collect the estimations. All videos were presented silently to ensure that ratings were based on the visual information and not, for example, crowd noise. For every perceiver the software randomly chose twelve videos from the categories far behind and high lead. For the other three categories close behind, draw, and close lead only four videos were randomly chosen so that twelve videos were also presented for the combined category "close score." Hence, every perceiver viewed 36 videos out of the 100 video clip battery in random order. In other words, different perceivers were randomly assigned to different sets of videos. This approach was intended to ensure that results do not depend on specific combinations of stimuli. After every video clip perceivers had to give their rating by clicking the left mouse button on the score estimation scale described above. After completing the testing procedure, perceivers filled out a questionnaire gathering demographic data and were informed about the purpose of the experiment.

Results

The descriptive results of Experiment 1 are displayed in Fig. 2. A 3×5 [cue visibility (head-and-body vs. head-only vs. body-only) by score category (far behind, close behind, draw, close lead, and high lead)] ANOVA[2] revealed a significant main effect of score category on perceivers' score estimations ($F[3.236, 378.564] = 24.796$, $p < .001$, $\eta_p^2 = .175$), meaning that perceivers were able to distinguish between trailing and leading athletes. The ANOVA did not reveal a significant main effect for cue visibility ($F[2, 117] = 1.109$, $p = .333$, $\eta_p^2 = .019$), meaning that perceivers did not generally assign higher scores in one cue-visibility condition than in the other. Importantly, there was no significant interaction, meaning that perceivers' ability to distinguish between trailing and leading athletes did not depend on which cues were visible for perceivers ($F[6.471, 378.564] = .803$, $p = .576$, $\eta_p^2 = .014$).

Follow-up polynomial linear contrasts indicated a strong linear relationship between score category and score estimates ($F[1, 117] = 115.089$, $p < .001$, $\eta_p^2 = .496$), meaning that score estimates corresponded in a linear manner to the actual score categories. At least descriptively speaking—although the respective interaction term is far from being significant—the polynomial linear contrast is largest for the head-and body-group

---

[2] Where the assumption of sphericity was violated, we used conservative Greenhouse-Geisser corrections for calculation of degrees of freedom in all ANOVAs.
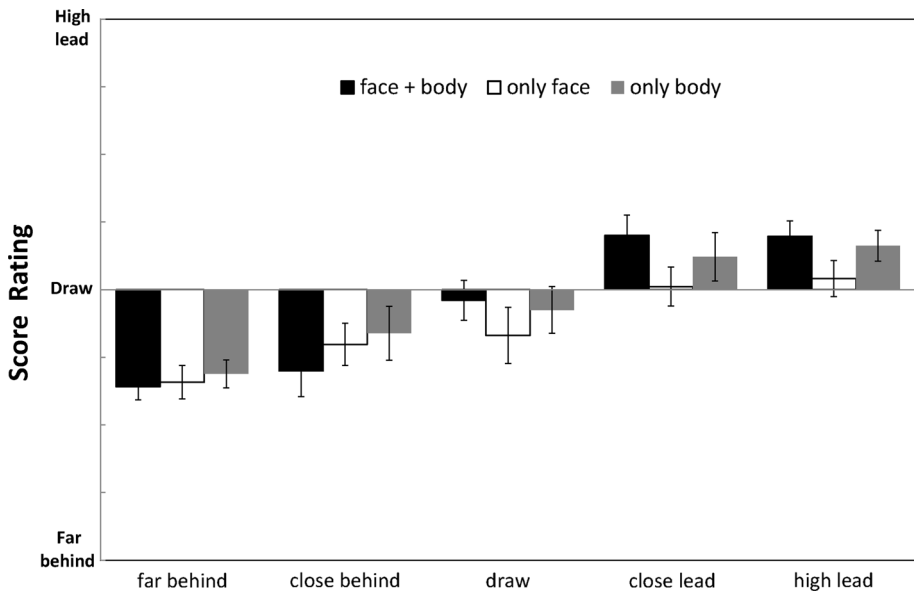
Fig. 2 Mean score (0 = far behind; 1 = high lead) estimates as a function of score category and cue visibility in Experiment 1 (video stimuli). *Error bars* represent standard errors

($\eta_p^2 = .655$), and somewhat smaller for the head-only-group ($\eta_p^2 = .438$) and the body-only-group ($\eta_p^2 = .392$). However, all of them are highly significant (all $ps < .001$).

Discussion

Our data did not confirm our hypothesis and instead suggest that perceivers are able to distinguish trailing from leading athletes based on athletes' nonverbal behavior, even when either athletes' heads or bodies were not visible. Effect sizes can be considered large (Clark-Carter 1997). This finding is remarkable since it suggests that neither head-related cues nor body-related cues are indispensable to arrive at rather accurate score estimates. In other words, both athletes' bodies and their heads seem to signal whether athletes are currently leading or trailing. Thus, internal states (emotions or motivations) that occur as a consequence of trailing or leading apparently affect both athletes' bodies and heads. The process of perceivers substituting one set of cues for another set that is not accessible is an example of the general principle of *vicarious functioning* (Brunswik 1952; Doherty and Kurz 1996).

Perhaps the most interesting finding was that the head-and-body condition did not lead to (significantly) better estimates than either of the other conditions. There are two possible explanations for the finding that the combined head and body cues did not result in greater accuracy than either the head alone or body alone cues. First, perceivers in the head-and-body condition may have only used a subset of available cues; second, the two types of cues may be highly correlated. When cues are highly correlated, taking more cues into account does not necessarily lead to more accurate judgments (Brunswik 1952; Doherty and Kurz 1996). The latter explanation seems more likely, given the existing literature on the evolutionary importance of nonverbal cues related to social status (Matsumoto and

Hwang 2012). In the next experiment, we examined whether static displays, that is, without kinematic information, were sufficient in making accurate judgments of leader and trailer.

Experiment 3: Face versus Body in Static Displays

Studies comparing interpersonal judgments based on dynamic-video and static-image displays show that motion or kinematic information is important in making accurate inferences (Ambady et al. 1999; Atkinson et al. 2004). Specifically, static images sampled from dynamic video material carry significantly less useful information. Hence, it seems feasible that kinematic information is an important visual cue informing observers who is leading or trailing in sports. Ecological studies of person perception suggest that accurate person perception judgments are predicated on the information specified by the movement kinematics of the observed person (Runeson and Frykholm 1983). Besides replicating the results from Experiment 2 with static displays, we tested whether kinematic information would lead to a higher accuracy in score ratings in Experiment 2 compared to Experiment 3. Given the research emphasizing the important role of motion or kinematic information (Ambady et al. 1999; Atkinson et al. 2004; Runeson and Frykholm 1983) in making accurate inferences, we hypothesized that observers might be more accurate in the video condition than in the static-image condition.

Method

Participants

One hundred twenty college students without any particular basketball experience took part in the study (53 women and 67 men; $M_{age} = 24.3$, $SD = 4.5$). Participants were randomly assigned to one of three experimental groups: the head-and-body-group ($N = 40$), the head-only-group ($N = 40$) or the body-only-group ($N = 40$). Written informed consent was obtained from every participant before commencing the experiment. The study was carried out in accordance with the Helsinki Declaration of 1975.

Stimuli

We used the non-modified versions of the 100 video clips from Experiment 1 as basis for the stimuli in Experiment 3. Our goal was to derive frozen frames from the video clips. However, we attempted to avoid any kind of selection bias when deriving the frozen frames from the video clips. Every video clip obviously presents many possible frames and thus many possibilities for biased stimulus selection (e.g., rejecting certain frames because they are not expressive enough or not appropriate for other reasons). Therefore, we took the median frame of each video clip and used this image as the frozen frame. We applied this rule to all video clips, regardless of the quality of the selected frame (see the hyperlinks to the utilized stimulus material (see footnote 1)).

Experimental Manipulation (within-participants)

The experimental within-groups manipulation was exactly the same as in Experiment 1 and involved the five different score categories.

Experimental Manipulation (between-participants)

Again, we created a version of the images in which athletes' bodies were masked so that only their heads were visible. These images were shown to perceivers in the *head-only-image-group*. Bodies were masked so that bodily posture was not recognizable. For another version, athletes' heads were masked so that only their bodies were visible. These videos were shown to perceivers in the *body-only- image-group*. In the *head-and-body-image group* the entire image was visible.

Measure and Procedure

We used exactly the same measure and procedure as in Experiment 1. The only difference regarding the procedure was that we displayed the frames for 500 ms per stimulus instead of video clips.

Results

Head versus Body Analysis

The descriptive results for the 500 ms image version are displayed in Fig. 3. A 3 × 5 [cue visibility (head-and-body vs. head-only vs. body-only) by score category (far behind, close behind, draw, close lead, and high lead)] ANOVA (see footnote 2) revealed a significant main effect of score category on perceivers' score estimations [$F(3.533, 413.339) = 34.355$, $p < .001$, $\eta_p^2 = .227$], demonstrating that perceivers were accurate at distinguishing between trailing and leading athletes. The ANOVA did reveal a significant main
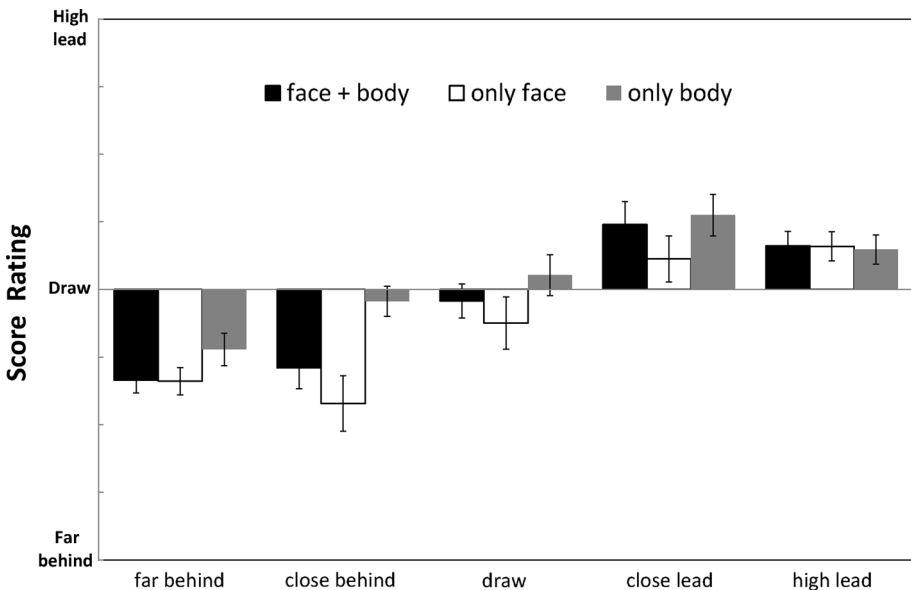
Fig. 3 Mean score (0 = far behind; 1 = high lead) estimates as a function of score category and cue visibility in Experiment 2 (500 ms image condition). *Error bars* represent standard errors

effect for cue visibility [$F(2, 117) = 4.999$, $p = .008$, $\eta_p^2 = .079$], mainly resulting from overall lower scores in the head-only condition compared to the other two conditions. Importantly, there was no significant interaction, meaning that perceivers' ability to distinguish between trailing and leading athletes did not depend on which cues were visible for perceivers [$F(7.066, 413.339) = 1.201$, $p = .297$, $\eta_p^2 = .020$].

Follow-up polynomial linear contrasts indicated a strong linear relationship between score category and score estimates [$F(1, 117) = 185.492$, $p < .001$, $\eta_p^2 = .613$], highlighting that score estimates corresponded in a linear manner to the actual score categories over all cue-visibility groups. Although the interaction term is far from significant, descriptively the polynomial linear contrast was somewhat larger for both the head-and body-group [$F(1, 117) = 78.748$, $p < .001$, $\eta p^2 = .669$] and for the head-only-group [$F(1, 117) = 87.536$, $p < .001$, $\eta p^2 = .692$] than for the body-only-group [$F(1, 117) = 32.046$, $p < .001$, $\eta p^2 = .451$]. In all of the conditions, however, score ratings corresponded in a highly linear manner to the actual score categories.

Control Condition

In order to investigate whether a longer stimulus presentation time resulted in more accurate score estimations we additionally tested 40 participants (15 women and 25 men; $M_{age} = 23.4$, $SD = 2.3$) for whom the head-and-body stimuli were presented for 3000 ms per stimulus. A 2×5 [presentation duration (500, 3000 ms) by score category (far behind, close behind, draw, close lead, and high lead)] ANOVA only revealed a significant main effect of score category on perceivers' score estimations [$F(4, 312) = 39.238$, $p < .001$, $\eta_p^2 = .335$]. The ANOVA did not reveal a significant main effect for presentation duration [$F(1, 78) = .226$, $p = .636$, $\eta_p^2 = .003$], meaning that perceivers did not generally assign higher scores to one presentation-duration category than to the other. Importantly, there was no significant interaction, meaning that perceivers' ability to distinguish between trailing and leading athletes was independent of presentation duration [$F(4, 312) = 2.133$, $p = .077$, $\eta_p^2 = .027$]. This is supported by the similar follow-up polynomial linear contrasts which hardly differed between the short-presentation ($\eta_p^2 = .669$) and the long-presentation-group ($\eta_p^2 = .696$).

Discussion

Our data suggest that perceivers are able to distinguish trailing from leading athletes based on freeze frames depicting athletes' nonverbal behavior. Effect sizes for all experimental conditions, head-and-body (500 and 3000 ms), head-only, and body-only can be considered large (Clark-Carter 1997). Presentation duration did not have an influence on perceivers' ratings. This means that perceivers can arrive at rather accurate estimates based on very short presentations of stimuli (500 ms). Importantly, and in line with Experiment 2, neither head- related cues nor body-related-cues are indispensable to arrive at rather accurate score estimates when briefly viewing images of athletes' nonverbal behavior. The interaction term was far from significant, providing further evidence for *vicarious functioning* in using expressive behavior to judge leading and trailing athletes. (Brunswik 1952; Doherty and Kurz 1996).

Although Rule et al. (2012) found that response accuracy increased with prolonged exposure time of posed displays of dominance and submission, their differences were

between exposure times of 27 and 40 ms. Furthermore, Rule et al. found that increased accuracy plateaued at 100 ms, far below our lower rate of 500 ms. Thus, our finding of no differences between 500 and 3000 ms is consistent with the pattern found by Rule et al. Finally, we were also interested in additional comparisons between Experiment 2 and Experiment 3 regarding the result for dynamic versus static stimuli.

Comparing Experiments 2 and 3 Results

For both experiments, we calculated confidence intervals for the effect sizes of the polynomial linear contrasts that depict the linear relationship between the score estimates and the score categories (Cumming 2012). From Experiment 1, we considered the separate linear contrasts for the head-and body-group, the head-only-group, and the body-only-group. From Experiment 2, we took the separate linear contrasts for the head-only-image-group, the body-only-image-group, the head-and-body-image-group, and the control condition (head-and-body 3000 ms). We transformed partial eta-square into the effect size r using the calculations provided by Cohen (1988) and then computed the 95 % confidence intervals for all effect sizes (Cumming 2012). Effect sizes and confidence intervals for all experimental conditions are depicted in Fig. 4 (see Table 1 for exact values).

Confidence intervals for all effect sizes overlap. This means that even when omitting certain cues or kinematic information, perceivers are similarly accurate at estimating who's leading or trailing. Therefore, we could not confirm our hypothesis that kinematic
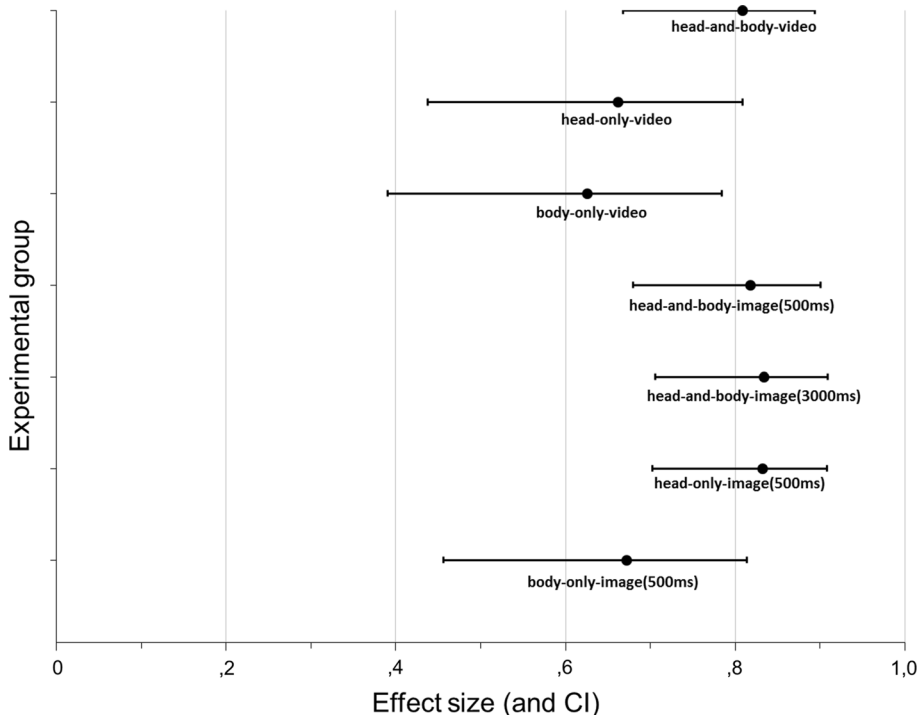
Fig. 4 Effect sizes r and 95 % confidence intervals for the 7 experimental groups in Experiment 2 and 3

Table 1 Comparison of effect sizes between experiments

	n	r	95 % CI
Head-and-body (video)	41	.809	[.668, .894]
Head-only (video)	39	.662	[.438, .809]
Body-only (video)	40	.626	[.391, .785]
Head-and-body- short (image 500 ms)	40	.818	[.680, .900]
Head-and-body-long (image 3000 ms)	40	.834	[.706, .909]
Head-only (image 500 ms)	40	.832	[.703, .908]
Body-only (image 500 ms)	40	.672	[.454, .813]

CI confidence interval. Numbers in brackets indicate lower limits and upper limits

information should lead to higher accuracy in score estimates. It is particularly interesting that the effect sizes for the head-and-body-video-group and the two head-and-body-image groups are nearly identical. This suggests that the kinematic information present in the head-and-body-video-group, but absent in the frozen-frame groups does not add any predictive value above the information contained in still pictures. The effect sizes for the head-only-video, the body-only-video, and the body-only-image group are somewhat smaller than for the other groups, but they still substantially overlap. Taken together, these comparisons provide evidence that perceivers are able to distinguish trailing from leading athletes based on both dynamic and static stimuli of athletes' nonverbal behavior.

General Discussion

The aim of the present studies was to investigate if leading and trailing athletes would be rated differently across measures associated with social status and whether certain sources of information are indispensable for estimating who is leading or trailing in a sports competition. Our results suggest that leading athletes change their nonverbal behavior compared to trailing athletes along the verticality dimension of social relations (Burgoon and Hoobler 2002; Hall et al. 2005; Hall and Friedman 1999) by showing more dominance, more pride, and more confidence. Further, perceivers can arrive at accurate score estimates equally well with head-and-body cues, only head-related cues, and only body- related cues.

The presence of kinematic information does not lead to better score estimates. These findings suggest that leading or trailing is reflected in nonverbal changes in both the head and the body. Head-related cues and body-related cues seem to be highly correlated, a finding in line with the concept of emotion response system coherence (Matsumoto and Hwang 2013). Generally, very scarce information is sufficient for accurate score estimates (e.g., frozen frames presented for 500 ms with partially occluded stimuli), indicating that humans are extremely well equipped for interpreting nonverbal changes along the vertical dimension of social relations occurring with leading or trailing in sports competitions. This process is consistent with ecological approaches to person perception (McArthur and Baron 1983; Zebrowitz and Collins 1997). Specifically, nonverbal behavioral changes in sports competitions occur because signaling winning or losing during an agonistic encounter among group-living primates has evolved as an important means for communicating status and facilitating intergroup coordination within dominance hierarchies (de Waal 2007).

These status-related judgments are important to survival (Schmid Mast and Hall 2004) and can be made in "a blink" from very scarce information. In this respect, the pattern of

results is in line with previous research showing high levels of accuracy in judging status: effect sizes range from $r = .55$ to $.80$ (Schmid Mast and Hall 2004), substantially larger than the typical effect sizes in inferring personality characteristics from nonverbal behavior ($r = .18$–$.45$; Gifford 1994). In addition, Schmid Mast and Hall (2004) found that only very few cues (downward head tilt, formal dress, and forward lean) stood out when assessing status, indicating that, "…impression formation of status is generally more of a Gestalt-like process. Under an ecological perspective, perceivers might rely more on configural cues rather than on single cues…" (p. 159).This suggestion is well aligned with the present results showing that omitting certain sources of information still resulted in accurate score estimates related to social status, including dominance, pride, and confidence. Furthermore, the combination of face and body cues does not result in higher accuracy of score estimation (cf. Fig. 4), suggesting redundancy of cues across the face and body.

Another line of research emphasizes the role of dynamic or kinematic information (Runeson and Frykholm 1983) in judging nonverbal displays (Ambady et al. 1999; Atkinson et al. 2004). Based on this position, one might assume that perceivers would make more accurate estimates in the video condition than in the frozen frame condition. This assumption seems to make sense particularly in the domain of sports, considering the dynamic nature of sports. Nevertheless, we did not find differences between estimates based on dynamic and static stimuli.

It is interesting to speculate on the functionality of the described phenomenon in modern everyday life. Trailing athletes seem to send submissive cues during competitions. Sending submissive nonverbal cues seems highly functional in primates when losing a fight because submissive nonverbal behavior serves the function of avoiding further attacks (Shariff and Tracy 2011). However, it seems unlikely that leading athletes will go easy on trailing athletes when they are showing submissive nonverbal behavior. Quite the contrary, recent research suggests that when leading athletes perceive "losing-nonverbal behavior" in their competitors, the leaders' self-confidence is enhanced (Furley and Schweizer 2014a). Enhanced self-confidence, in turn, might further motivate leading athletes and increase their chances of winning (Hays et al. 2009). Therefore, showing submissive cues during sports competition might be harmful for trailing athletes (Furley and Dicks 2012; Furley et al. 2012). Submissive nonverbal behavior may have been adaptive in our evolutionary past, and in some areas of modern social life, but may be dysfunctional in sports competitions. Taken together, these results have important practical implications for athletes, coaches, and applied practitioners. Coaches and practitioners should assist athletes in the development of positive self-presentation techniques, especially in situations of high stress or when the opponents seem to have the momentum on their side. In turn, this more desirable self-presentation may increase the probability of a losing team recovering and being more competitive.

The present research approach has some notable strengths and weaknesses. We consider it a strength that our stimulus materials were derived from actual sports competitions, instead of being artificially created. In this respect, we followed a recent call of Rule et al. (2012) of using naturally-occurring stimulus cues. Thus, external validity should be rather high and results are likely to transfer to similar field settings. Furthermore, different participants were randomly shown different subsets of the stimulus material. This reduces the likelihood that results are dependent on one particular set of stimuli. In addition, the present series of experiments are well aligned with the increasing calls for replication in the psychological literature (Pashler and Wagenmarkers 2012; Simons 2014; Yong 2012).

One limitation of the present study is that it is unclear which cues perceivers used in the head-only condition. Although participants could see the facial expressions, they could also see to what degree athletes tilted their heads. And previous studies have demonstrated that the degree of head tilt is an important cue in judging dominance and submission (e.g. Mignault and Chaudhuri 2003; see also Chiao et al. 2008; Hall et al. 2001). In fact, such information is more closely related to posture than to facial expressions. Still, this may be another instance where various cues from the face and body are redundant, and all carry similar valid information.

Further, we chose to use stimuli from only one sport because we wanted to be able to compare effect sizes between studies. However, stimuli from several sports have been used in earlier experiments and effects of nonverbal displays on score estimates were evident in all of them (Furley and Schweizer 2014b). The only difference between different kinds of sports seems to be that main effects for score categories were slightly larger in team sports, perhaps due to emotional contagion between team members (Totterdell 2000). Furthermore, our participants had little experience regarding basketball. We do not consider this a problem as we did not find effects for domain-specific sport experience in earlier experiments (Furley and Schweizer 2014b). In fact, finding significant effects with participants having little experience with basketball points to the clarity of these nonverbal cues.

The main limitation of our research is that score categories might be confounded with some variable other than nonverbal behavior. If scores are correlated with a variable other than nonverbal behavior, then participants might use this variable to arrive at score estimates. Although we tried to make sure that stimulus selection was not biased, we cannot entirely rule out this possibility. Nevertheless, other evidence weighs against such an interpretation. Previous research found similar effects with laypeople (even young children) and experts across different stimulus sets from different sports (Furley and Schweizer 2014b). Furthermore, the alternative variable would have to be one that participants are able to exploit within split seconds. Besides nonverbal behavior, it is hard to think of another factor in the visual images that might provide relevant information regarding score estimates that lasts only half a second. In order to maximize transparency, we provide hyperlinks to the stimulus material utilized in the studies in the Footnotes.

Further studies might occlude the stimulus material even further, in order to determine what cues are really essential for perceivers' estimates. For example, researchers might occlude all background information in order to rule out alternative explanations or they might occlude certain parts of athletes' faces, such as the eyes. Likewise, further studies might employ nonverbal coding of stimulus material similar to the procedure of Matsumoto and Hwang (2012) in specifying particular behavior changes as a function of leading and trailing in sport.

In conclusion, the present research highlights that people can arrive at score estimates in sports based on very scarce information. Neither body-related nor head-related cues are indispensable, and they seem to be equally valid. Kinematic information does not increase validity of estimates. Taken together, these findings support the idea that experiences of success or failure in contemporary confrontational situations, such as sports competitions, are signaled in specific changes in nonverbal behavior. This subtle signaling has evolved as a means of communicating status in social groups and regulating dominance hierarchies: "… dominance must constantly be proven. An established hierarchy does not maintain itself" (de Waal 2007, p. 138).

References

Ambady, N., Hallahan, M., & Conner, B. (1999). Accuracy of judgments of sexual orientation from thin slices of behavior. *Journal of Personality and Social Psychology, 77*, 538–547. doi:10.1037//0022-3514.77.3.538.

Archer, J. (2006). Testosterone and human aggression: An evaluation of the challenge hypothesis. *Neuroscience and Biobehavioral Reviews, 30*, 319–345. doi:10.1016/j.neubiorev.2004.12.007.

Atkinson, A. P., Dittrich, W. H., Gemmel, A. J., & Young, A. W. (2004). Emotion perception from dynamic and static body expressions in point-light and full-light displays. *Perception, 33*, 717–746. doi:10.1068/p5096.

Baron-Cohen, S., Riviere, A., Fukushima, M., French, D., Hadwin, J., Cross, P., et al. (1996). Reading the mind in the face: A cross-cultural and developmental study. *Visual Cognition, 3*(1), 39–60. doi:10.1080/713756728.

Brunswik, E. (1952). *The conceptual framework of psychology*. Chicago: Chicago University Press.

Brunswik, E. (1956). *Perception and the representative design of psychological experiments* (2nd ed.). Berkeley: University of California Press.

Burgoon, J. K., & Hoobler, G. D. (2002). Nonverbal signals. In M. L. Knapp & J. A. Daly (Eds.), *Handbook of interpersonal communication* (3rd ed., pp. 240–299). Thousand Oaks, CA: Sage.

Carney, D., Cuddy, A., & Yap, A. (2010). Power posing: Brief nonverbal displays affect neuroendocrine levels and risk tolerance. *Psychological Science, 21*, 1363–1368. doi:10.1177/0956797610383437.

Carney, D. R., Hall, J. A., & Smith LeBeau, L. (2005). Beliefs about the nonverbal expression of social power. *Journal of Nonverbal Behavior, 29*, 105–123. doi:10.1007/s10919-005-2743-z.

Chiao, J. Y., Adams, R. B., Peter, U. T., Lowenthal, W. T., Richeson, J. A., & Ambady, N. (2008). Knowing who's boss: fMRI and ERP investigations of social dominance perception. *Group Processes & Intergroup Relations, 11*, 201–214. doi:10.1177/1368430207088038.

Clark-Carter, D. (1997). *Doing quantitative psychological research: From design to report*. Hove, UK: Psychology Press.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Erlbaum.

Cozolino, L. (2006). *The neuroscience of human relationships: Attachment and the developing social brain*. New York: WW Norton & Co.

Cumming, G. (2012). *Understanding the new statistics: Effect sizes, confidence intervals, and meta-analysis*. New York: Routledge.

de Waal, F. (2007). *Chimpanzee politics: Power and sex among apes*. Baltimore, MD: Johns Hopkins University Press.

Doherty, M. E., & Kurz, E. M. (1996). Social judgment theory. *Thinking & Reasoning, 2*, 109–140. doi:10.1080/135467896394474.

Driskell, J. E., & Salas, E. (2005). The effect of content and demeanor on reactions to dominance. *Group Dynamics: Theory, Research, & Practice, 9*, 3–14. doi:10.1037/1089-2699.9.1.3.

Furley, P., & Dicks, M. (2012). "Hold your head high". The influence of emotional versus neutral nonverbal expressions of dominance and submissiveness in baseball. *International Journal of Sport Psychology, 43*, 294–311.

Furley, P., Dicks, M., & Memmert, D. (2012). Nonverbal behavior in soccer: The influence of dominant and submissive body language on the impression formation and expectancy of success of soccer players. *Journal of Sport & Exercise Psychology, 34*, 61–82.

Furley, P., & Schweizer, G. (2014a). "I'm pretty sure that we will win!" The influence of score-related nonverbal behavioral changes on the confidence in winning a basketball game. *Journal of Sport and Exercise Psychology, 35*, 316–320. doi:10.1123/jsep.2013-0199.

Furley, P., & Schweizer, G. (2014b). The expression of victory and loss: Estimating who's leading or trailing from nonverbal cues in sports. *Journal of Nonverbal Behavior, 38*, 13–29. doi:10.1007/s10919-013-0168-7.

Gifford, R. (1994). A lens-mapping framework for understanding the encoding and judgment policy of interpersonal dispositions in nonverbal behavior. *Journal of Personality and Social Psychology, 66*, 398–412.

Hall, J. A., Coats, E. J., & LeBeau, L. S. (2005). Nonverbal behavior and the vertical dimension of social relations: a meta-analysis. *Psychological Bulletin, 131*, 898–924. doi:10.1037/0033-2909.131.6.898.

Hall, J. A., & Friedman, G. B. (1999). Status, gender, and nonverbal behavior: A study of structured interactions between employees of a company. *Personality and Social Psychology Bulletin, 25*, 1082–1091. doi:10.1177/01461672992512002.

Hall, J. A., LeBeau, L. S., Reinoso, J. G., & Thayer, F. (2001). Status, gender, and nonverbal behavior in candid and posed photographs: A study of conversations between university employees. *Sex Roles, 44*(11–12), 677–692. doi:10.1023/A:1012298230455.

Hays, K., Thomas, O., Maynard, I., & Bawden, M. (2009). The role of confidence in world-class sport performance. *Journal of Sports Sciences, 27*, 1185–1199. doi:10.1080/02640410903089798.

Henrich, J., & Gil-White, F. J. (2001). The evolution of prestige: freely conferred deference as a mechanism for enhancing the benefits of cultural transmission. *Evolution and Human Behavior, 22*, 165–196. doi:10.1016/S1090-5138(00)00071-4.

Llaurens, V., Raymond, M., & Faurie, C. (2009). Ritual fights and male reproductive success in a human population. *Journal of Evolutionary Biology, 22*, 1854–1859. doi:10.1111/j.1420-9101.2009.01793.x.

Lombardo, M. P. (2012). On the evolution of sport. *Evolutionary psychology: An international journal of evolutionary approaches to psychology and behavior, 10*, 1–28.

Martens, J. P., Tracy, J. L., & Shariff, A. F. (2012). Status signals: Adaptive benefits of displaying and observing the nonverbal expressions of pride and shame. *Cognition and Emotion, 26*, 390–406. doi:10.1080/02699931.2011.645281.

Matsumoto, D., & Hwang, H. S. (2012). Evidence for a nonverbal expression of triumph. *Evolution and Human Behavior, 33*, 520–529. doi:10.1016/j.evolhumbehav.2012.01.005.

Matsumoto, D., & Hwang, H. S. (2013). Facial expressions. In D. Matsumoto, M. Frank, & S. H. Hwang (Eds.), *Nonverbal communication: Science and applications* (pp. 15–52). Los Angeles: Sage.

Mazur, A. (2005). *Biosociology of dominance and deference*. Lanham, MD: Rowman & Littlefield.

McArthur, L. Z., & Baron, R. M. (1983). Toward an ecological theory of social perception. *Psychological Review, 90*, 215–238. doi:10.1037//0033-295X.90.3.215.

Mehta, P. H., Jones, A. C., & Josephs, R. A. (2008). The social endocrinology of dominance: Basal testosterone predicts cortisol changes and behavior following victory and defeat. *Journal of Personality and Social Psychology, 94*, 1078–1093. doi:10.1037/0022-3514.94.6.1078.

Mignault, A., & Chaudhuri, A. (2003). The many faces of a neutral face: Head tilt and perception ofdominance and emotion. *Journal of Nonverbal Behavior, 27*, 111–132. doi:10.1023/A:1023914509763.

Pashler, H., & Wagenmarkers, E.-J. (2012). Editors' introduction to the special section on replicability in psychological science. A crisis of confidence? *Perspectives on Psychological Science, 7*, 528–530. doi:10.1177/1745691612465253.

Rule, N. O., Adams, R. B, Jr, Ambady, N., & Freeman, J. B. (2012). Perceptions of dominance following glimpses of faces and bodies. *Perception, 41*, 687–706. doi:10.1068/p7023.

Runeson, S., & Frykholm, G. (1983). Kinematic specification of dynamics as an informational basis for person-and-action perception: expectation, gender recognition, and deceptive information. *Journal of Experimental Psychology: General, 112*, 585–615. doi:10.1037//0096-3445.112.4.585.

Schmid Mast, M., & Hall, J. A. (2004). Who is the boss and who is not? Accuracy of judging status. *Journal of Nonverbal Behavior, 28*, 145–165. doi:10.1023/B:JONB.0000039647.94190.21.

Shariff, A. F., & Tracy, J. L. (2011). What are emotion expressions for? *Current Directions in Psychological Science, 20*, 395–399. doi:10.1177/0963721411424739.

Simons, D. J. (2014). The value of direct replication. *Perspectives on Psychological Science, 9*, 76–80. doi:10.1177/1745691613514755.

Todorov, A., Mandisodza, A. N., Goren, A., & Hall, C. C. (2005). Inferences of competence from faces predict election outcomes. *Science, 308*, 1623–1626. doi:10.1126/science.1110589.

Totterdell, P. (2000). Catching moods and hitting runs: Mood linkage and subjective performance in professional sports teams. *Journal of Applied Psychology, 83*, 848–859. doi:10.1037//0021-9010.85.6.848.

Tracy, J. L., & Matsumoto, D. (2008). The spontaneous display of pride and shame: Evidence for biologically innate nonverbal displays. *Proceedings of the National Academy of Sciences, 105*, 11655–11660. doi:10.1073/pnas.0802686105.

Trivers, R. (1985). *Social evolution*. Menlo Park, CA: Benjamin-Cummings.

Willis, J., & Todorov, A. (2006). First impressions making up your mind after a 100-ms exposure to a face. *Psychological Science, 17*, 592–598. doi:10.1111/j.1467-9280.2006.01750.x.

Yong, E. (2012). Replication studies: Bad copy. *Nature, 485*, 298–300. doi:10.1038/485298a.

Zebrowitz, L. A., & Collins, M. A. (1997). Accurate social perception at zero acquaintance: The affordances of a Gibsonian approach. *Personality and Social Psychology Review, 1*, 204–223. doi:10.1207/s15327957pspr0103_2.