Experts in Offside Decision Making Learn to Compensate for Their Illusory Perceptions

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In association football, the flash-lag effect appears to be a viable explanation for erroneous offside decision making. Due to this spatiotemporal illusion, assistant referees (ARs) perceive the player who receives the ball ahead of his real position. In this experiment, a laboratory decision-making task was used to demonstrate that international top-class ARs, compared with amateur soccer players, do not have superior perceptual sensitivity. They clearly modify their decision criterion according to the contextual needs and, therefore, show a higher response bias toward not responding to the stimulus, in particular in the most difficult situations. Thus, international ARs show evidence for response-level compensation, resulting in a specific cost (i.e., more misses), which clearly reflects the use of particular (cognitive) strategies. In summary, it appears that experts in offside decision making can be distinguished from novices more on the cognitive or decision-making level than on the perceptual level.

Keywords: compensation strategy, perception, cognition, decision making, expertise

Elite sport provides a unique opportunity to examine the limitations of the human information-processing system under dynamic, unpredictable, and time-constrained circumstances. In association football (also known as soccer in North America), for example, two major hypotheses have been proposed to explain the perceptual-cognitive mechanisms underlying erroneous offside decision making. The offside law (Law 11; FIFA, 2012, p. 35) states that “A player is in an offside position if he is nearer to his opponent’s goal line than both the ball and the second-last opponent at the time when the ball is passed to that player.”

First, Oudejans et al. (2000, 2005) suggested the optical error hypothesis. According to these authors, an inappropriate position of the assistant referee in relation to the offside line (i.e., leading or trailing) and the corresponding incorrect viewing angle results in erroneous offside judgments. In a recent study of Mallo, Frutos, Juarez and Navarro (2012), however, it has been demonstrated that the absolute distance of the assistant referee to the offside line and the corresponding view angle did not have an impact on the quality and the correctness of the offside decisions. Along the same lines, Barte and Oudejans (2012) showed that only 35.3% of the incorrect decisions appeared to be fully consistent with the optical error hypothesis, suggesting that in approximately two thirds of the errors other factors must play a more prominent role.

Therefore, other researchers (Baldo, Ranvaud, & Morya, 2002; Gilis, Helsen, Catteeuw, & Wagemans, 2008; Gilis, Helsen, Catteeuw, Van Roie, & Wagemans, 2009; Helsen, Gilis, & Weston, 2006) identified the “flash-lag effect” (FLE) as the major and driving contributor for incorrect offside decisions. Importantly, none of these authors rejected the idea of optical error, but they all suggested an alternative explanation for incorrect offside decision making or an explanation that includes a combination of factors. The original FLE refers to the illusory perception of a moving object as being ahead of a stationary flashed object, when in fact both stimuli are physically aligned (Baldo & Klein, 1995; Nijhawan, 1994). In addition, it has been shown that the FLE is not restricted to comparisons between moving and static stimuli but can also occur between two moving stimuli, when one of them is used as the abrupt event (Cravo & Baldo, 2008). Although the mechanisms causing this effect are not entirely known, several studies showed that the magnitude of the FLE depends on low-level visual attributes such as luminance (e.g., Purushothaman, Patel, Bedell, & Ögmen, 1998) and eccentricity (e.g., Baldo,
Kihara, Namba, & Klein, 2002), as well as on more high-
level processes. Namba and Baldo (2004), for example,
showed that the allocation of visual attention to either
the moving or the flashing stimulus can modulate but
not eliminate the FLE.

Translated to offside situations in association foot-
ball, the FLE implies that the attacker who receives the
ball and often moves forward at high speed (i.e., moving
stimulus) is perceived ahead of his position at the moment
of the pass (i.e., flash). Due to this perceptual illusion,
an overall bias toward flag errors compared with nonflag
errors is observed, even when the assistant referees are
positioned on line. In other words, they more often raise
the flag while the attacker is not in an offside position
(flag errors, or false alarms) than that they fail to flag
while the attacker was in an offside position (nonflag
errors, or misses). Previous studies have shown that the
FLE can explain the majority of incorrect offside deci-
sions, in particular flag errors, in laboratory-controlled
tasks (Catteeuw, Helsen, Gilis, Van Roie, & Wagemans,
2009; Gilis et al., 2008, 2009), on-field offside exercises
(Gilis et al., 2009) and in real-match situations (Cat-
teeuw, Gilis, Garcia-Aranda, et al., 2010). In a detailed
analysis of the accuracy of offside judgments of assistant
referees in the English Premier League, for example, it
was shown that in this specific study all flag errors could
be explained by the FLE (95 out of 95) and a smaller
proportion of these errors could be explained by both
the optical error hypothesis and the FLE (39 out of 95)
(Catteeuw, Gilis, Wagemans, & Helsen, 2010a). Thus, the
FLE explains errors that cannot be elucidated by optical
error. Evidently, this observation should not be interpreted
as arguments for the general validity of the FLE in all
cases of (flag) errors made by assistant referees. Indeed,
the argument is that most flag errors can be explained by
the FLE, while the optical error applies less generally.
Of course, there is much more to be discovered about the
attentional, perceptual, and decisional processes leading
to errors in offside judgments, and the current study aims
to contribute to this line of work. Furthermore, the bias
toward flag errors was identified for each position (i.e.,
behind, on, or ahead of the offside line) of the assistant
referees (Catteeuw et al., 2010a; Gilis et al., 2009).
This observation is in disagreement with the theoretical pre-
dictions (i.e., symmetrical distribution of flag errors and
nonflag errors) of the optical error hypothesis.

From the findings discussed so far, it is clear that
there is no unique factor responsible for incorrect deci-
sions during offside decision making. Both optical error
and flash-lag already received some debate concerning
their contribution in explaining errors or types of errors
of assistant referees. However, a convincing base of litera-
ture clearly designates the FLE as the driving contributor
to explain incorrect offside decisions; therefore, the per-
ceptual error hypothesis will be the premise of this study.

Because of the huge impact of these erroneous
decisions on the final outcome of the game, along with
all of its financial implications for the teams and the emo-
tional reactions among their fans and the media,
perceptual sensitivity and response bias of both groups in a parametric laboratory-controlled variant of the real perceptual-cognitive task. We anticipated that experts and novices would differ in their response bias but not in their perceptual sensitivity, since each participant is likely to be equally subjected to the perceptual consequences of this visual illusion. In addition, we hypothesized that experts, compared with novices, would use a different criterion for making their decisions depending on the difficulty of the task. Assistant referees are expected to apply a more conservative criterion in the most difficult situations, resulting from years of practice and experience (cf. Cañal-Bruland & Schmidt, 2009). Finally, we predicted that the decision-making behavior of both groups would change across conditions—that is, the aligned condition will result in a better overall performance (e.g., fewer false alarms and more hits) than the nonaligned condition.

Method

Participants

Eleven international assistant referees (10 males, 1 female; mean age 39.9 years; SD = 5.2; range = 29.3–46.3) and 20 male amateur soccer players (mean age = 19.9 years, SD = 0.7, range = 19.2–21.4) participated in the experiment. The international assistant referees were on the FIFA list for 5.2 years on average (SD = 3.0) and performed at the highest level of the Belgian professional football league for 8.2 years on average (SD = 3.4). All amateur players were familiar with the laws of the game, including the offside rule, but had no experience in assessing offside situations from a typical assistant referee perspective. All participants were completely naïve with respect to the particular hypotheses being tested.

Written consent was obtained from the Belgian referees’ committee before testing according to the Declaration of Helsinki. The experimental protocol received approval from the local ethical committee of the University of Leuven.

Stimuli, Task, and Procedure

Each participant was seated in front of a Tobii T120 Eye Tracker (Tobii Technology AB, Sweden) with the head fixated on a chin rest to standardize the 60 cm distance between the screen and the eyes. At the start of each trial, a reference stimulus (RS; 0.1° × 0.1° of visual angle) was presented in the center of the screen. Next, a stimulus started to move horizontally (MS; radius = 0.5°) across the screen with a constant speed of 14°·s⁻¹ (cf. Cravo & Baldo, 2008) and with a starting position on the left side of the visual field, always 3° below the RS. At a certain moment along the MS trajectory, an abrupt-onset stimulus (i.e., flash; radius = 0.5°) was presented 7° below the RS. The flash was presented when the MS was at one of eleven possible eccentricities relative to the RS (see Figure 1). Depending on the condition, the flash was presented with a horizontal eccentricity of 0° (Condition 1: Aligned) or −12° (Condition 2: Not Aligned). The luminance of all stimuli was 40 cd·m⁻², displayed on a green background (i.e., 20 cd·m⁻²).

Participants were instructed to press the space bar when they perceived the MS entirely ahead of the RS (i.e., 0.35°, 0.70°, 1.05°, 1.40°, 1.75°) at the moment of the flash while they fixated on the RS. To certify that the participants were focusing on the correct stimulus (i.e., RS), their eye movements were simultaneously shown on a second screen. This was visible only for the experimenter who immediately instructed the participant to refocus on the correct stimulus whenever the RS was not fixated adequately. In

![Figure 1](image_url) — Schematic representation of the experimental task. Condition 1: aligned—horizontal eccentricity of 0° of visual angle; Condition 2: not aligned—horizontal eccentricity of −12° of visual angle. The 11 potential positions of the moving stimulus (MS) relative to the reference stimulus (RS) are represented: 0°, ±0.35°, ±0.70°, ±1.05°, ±1.40°, ±1.75°. All MS positions left of the reference line are called behind; all positions right of the reference line are called ahead. The sign refers to the MS being behind or ahead of the RS (minus or plus, respectively).
addition, the participants were asked to respond as accurately as possible but definitely before the MS had disappeared from the screen. The participants were not informed that the task was a simulation of a possible offside situation. The software program E-prime 2.0 Professional (Schneider, Eschman, & Zuccolotto, 2002) was used to generate the visual displays and register the responses. Before the actual test, standardized instructions were provided, followed by a short practice period. The test consisted of 3 blocks of 44 trials, with the location of the MS at the moment of the flash pseudo-randomized across blocks. Each eccentricity was judged 4 times per block. The experiment consisted of 2 test sessions (one for each condition), 45 min each, separated by 1 week. The starting condition was counterbalanced across participants.

Data Analysis

The proportion of (in)correct decisions was calculated per eccentricity for both conditions (aligned and nonaligned). For the correct decisions, a distinction was made between a hit (participants pressed the space bar when the MS was ahead of the RS at the moment of the flash) and a correct rejection (participants did not press the space bar when the MS was behind or in line with the RS). For the incorrect decisions, a distinction was made between a false alarm (i.e., flag error—participants pressed the space bar although the MS was ahead of the RS) and a miss (i.e., nonflag error—participants did not press the space bar when the MS was behind or in line with the RS). For each eccentricity, 5 difficulty levels were created by combining the equal eccentricities before and after the RS. For certain analyses, 6 difficulty levels were created by combining the equal eccentricities before and after the RS: Level 1, very easy: ±1.75°; Level 2, easy: ±1.40°; Level 3, moderate: ±1.05°; Level 4, difficult: ±0.70°; Level 5, very difficult: ±0.35°.

Signal detection theory (SDT; Macmillan & Creelman, 2005) was used to analyze the performances of both groups in further detail. A sensitivity index, reflecting the perceptual origins of SDT (Stanislaw & Todorov, 1999), was calculated. More specifically, we used d', which is defined as the difference in internal responses at which maximum probability of hits and of false alarms occur, in units of the standard deviation. When d' was 0, participants were not able to discriminate above chance level between the MS being behind or in line with the RS on the one hand and ahead of the RS on the other hand. Conversely, when d' differed significantly from 0, the participants were able to make this distinction. In other words, sensitivity is described as the observer’s ability to accurately discriminate between two classes of stimuli. Response bias (reported as criterion c) was calculated to investigate decisions in doubtful situations, and it reflects the general tendency to respond yes or no. If c was 0, the false alarm rate and the miss rate were equal. When c was positive, the response bias indicated that the participants tended not to press in doubtful situations.

Statistical Analysis

Both SDT measures (i.e., d' and c), including false alarm rate, hit rate, and accuracy, violated the assumption of normality as tested by the Shapiro-Wilk normality test. Therefore, nonparametric tests were used in the current study.

For the outcome measures of the present laboratory task (i.e., false alarm rate, hit rate, sensitivity, and response bias), a Friedman test was performed to compare the dependent variable on the levels of difficulty (i.e., Level 1, very easy: ±1.75°; Level 2, easy: ±1.40°; Level 3, moderate: ±1.05°; Level 4, difficult: ±0.70°; Level 5, very difficult: ±0.35°). Statistical comparisons of both conditions (i.e., aligned or nonaligned) were performed by using Wilcoxon signed-rank tests.

To determine group differences (i.e., international assistant referees and amateur soccer players) on each dependent variable, Mann–Whitney U-tests were used. Effect sizes were calculated as follows: $r = \sqrt{z^2/\pi}$. Effect sizes below .30 criterion represents a small to medium effect, whereas an effect size above the .50 threshold indicates a large effect. Significant main effects of group were further explored per difficulty level and per condition, using post hoc Mann-Whitney U-tests. Bonferroni corrections for multiple comparisons were made, hence $p$ values < .005 were considered significant.

A chi-squared test was used to examine whether the ratio of correct to incorrect decisions was uniformly distributed across the alignments in both conditions.

All statistical analyses were performed with Statistica 10.0 (StatSoft, Inc., USA). Unless otherwise stated, the $p$ value was set at $\alpha = .05$.

Results

Rate of False Alarm

The results yielded a significant effect for group ($U = 27.5, z = -3.41, p < .001, r = -0.61$) and difficulty level ($\chi^2 (4) = 58.9, p < .001$), whereas no effect of condition was found ($z = -0.28, p = .78$). As can be seen from Figure 2, post hoc tests revealed that experts showed significantly fewer false alarms than novices in Level 4 (difficult) and Level 5 (very difficult) ($pcorr < .005$), both in Conditions 1 and 2. Furthermore, a chi-squared test revealed that novices demonstrated the highest error percentage or most false alarms (i.e., $C(\text{condition})1$, $C(\text{condition})2$: 39.6%) when the MS was in line with the RS, that is, 0° of visual angle ($C1: \chi^2 = 217.8, p < .001$; $C2: \chi^2 = 188.16, p < .001$).

Hit Rate

The results demonstrated a significant effect for group ($U = 21.0, z = -3.67, p < .001, r = -0.66$) and difficulty level ($\chi^2 (4) = 94.4, p < .001$), but no effect of condition was observed ($z = -1.20, p = .23$). Post hoc tests demonstrated that experts showed significantly fewer hits than novices
in Level 3 (moderate), Level 4 (difficult), and Level 5 (very difficult) \((p_{\text{corr}} < .005)\), both in Conditions 1 and 2 (see Figure 2). In addition, a chi-squared test revealed that experts showed most errors or fewest hits \((C1: 64.4\%, C2: 73.5\%)\) in the alignment just ahead of the RS, that is, 0.35° of visual angle \((C1: \chi^2 = 328.79, p < .001; C2: \chi^2 = 406.15, p < .001)\).

Perceptual Sensitivity

The \(d'\) values of all the difficulty levels of both the experts and the novices were significantly different from zero \((p < .05)\), indicating that both groups were able to discriminate above chance level between the MS being behind or in line with the RS on the one hand and ahead of the RS on the other hand. The results demonstrated an effect of difficulty level \([\chi^2 (4) = 101.4, p < .001]\), whereas no significant effects for group \((U = 79.0, z = −1.28, p = .20, r = −.23)\) and condition were found \((z = −0.08, p = .94)\), indicating that experts and novices were equally sensitive in discriminating between these spatial positions (see Figure 3).

Response Bias

The results demonstrated a significant effect for group \((U = 12.0, z = −4.05, p < .001, r = −.73)\) and difficulty level \([\chi^2 (4) = 22.4, p < .001]\) but no effect of condition \((z = −0.14, p = .89)\). Post hoc tests demonstrated that experts showed significantly higher \(c\) values than the novices in Level 3 (moderate), Level 4 (difficult), and Level 5 (very difficult) \((p_{\text{corr}} < .005)\), indicating a strong bias toward not responding in case of doubtful situations. Particularly, with increasing task difficulty, experts showed a significantly higher response bias than the novices (see Figure 3).

Discussion

The aim of this study was to investigate whether the decision-making processes of experts (i.e., international assistant referees) and novices (i.e., amateur soccer players) may be influenced by the flash-lag effect (FLE), a visual illusion whereby a moving stimulus is perceived ahead of its own position at the moment of a flash (i.e., Baldo & Klein, 1995; Nijhawan, 1994). In the present task, experts performed better than novices when the moving stimulus was just behind \((i.e., −0.70° and −0.35° of visual angle)\) or in line with \((0° of visual angle)\) the reference stimulus. Our findings reconfirm the observation that experts are better able to avoid false alarms (i.e., flag errors) induced by the flash-lag illusion (cf. Catteeuw, Gilis, García-Aranda, et al., 2010; Catteeuw, Gilis, Jaspers, et al., 2010; Gilis et al., 2008, 2009). Consequently, the number of correct rejections was consistently higher for experts than for novices. On the contrary, novices are unaware of the perceptual consequences of this spatio-temporal illusion. They showed a clear forward memory shift in line with the predictions of the flash-lag hypothesis, leading to significantly more false alarms (Baldo, Ranvaud, et al., 2002; Catteeuw et al., 2010a).

When the moving stimulus was situated ahead of the reference stimulus at the moment of the flash, the decision-making accuracy of the novices increased significantly. In these situations, the flash-lag effect clearly favors correct decision making, because the moving stimulus will appear farther ahead than it really is. Surprisingly, the experts perform worst in the eccentricities when the moving stimulus was just ahead of the reference stimulus at the moment of the flash \((i.e., 0.35° and 0.70° of visual angle)\). Thus, for the experts the number of false
alarms fell to an acceptable rate, whereas the number of misses increased significantly.

Contrary to our expectations, the number of false alarms and hits did not differ between both conditions in both groups. As described earlier, the participants were asked to focus at the reference stimulus when performing the task. This instruction guaranteed that the participants were not following the moving stimulus, eliminating the idea that perception could be defined via continued smooth pursuit. Since no differences were observed between the aligned and not aligned condition, participants apparently used peripheral vision to complete the task. If in the not aligned condition the flash would have been presented farther to the left side of the visual field than where it was presented, we would expect saccades to occur. In this case, and in line with our hypothesis, one would expect fewer hits and more false alarms in the not aligned condition in general because the flash will draw the attention away from the reference stimulus.

In line with our hypothesis, signal detection analysis reveals that both groups were equally sensitive with respect to the perceptual dimension of the task, suggesting that there is no difference between experts and novices at the perceptual level. Experts, however, showed different criteria for making their decisions, depending on how close the moving stimulus was to the reference stimulus at the moment of the flash. These findings indicate that experts become more cautious by adopting a stricter and more conservative criterion (i.e., resulting in fewer false alarms) when the situation increases in difficulty, whereas novices continue to adopt a more liberal direction. As hypothesized, experts showed a higher response bias toward not responding to the stimulus. This was particularly the case for the most difficult level, where the reference and moving stimulus are closest together. Therefore, it appears that with years of practice and increased task-specific expertise, international assistant referees have biased their response criterion into a more conservative direction. The processes underlying these differences in response bias may be explained in several ways.

First, in line with earlier studies in other domains, such as traffic (Devos et al., 2009), military combat (Ward et al., 2008), and law enforcement (Helsen & Starkes, 1999), perceptual-cognitive skill training has shown to be an essential part for the acquisition and fine-tuning of decision-making skills (Larkin, Berry, Dawson, & Lay, 2011; Mascarenhas, Collins, Mortimer, & Morris, 2005; Pizzera & Raab, 2012; Schweizer, Plessner, Kahlert, & Brand, 2011). As discussed earlier, it has been demonstrated that only a limited number of training sessions seemed already effective in mediating a compensation strategy to better deal with the illusive effect of flash-lag (Catteeuw, Gilis, Jaspers, et al., 2010; Catteeuw et al., 2010b). Apparently, these authors have suggested that the assistant referees learned to correct their perception and, as a consequence, to (cognitively) overrule this visual illusion. In this study, however, it seems that although assistant referees know about the need to make a compensation for the flash-lag effect, they are not making the adjustment correctly when the moving stimulus was just ahead of the reference stimulus. These findings strengthen the account in terms of overcompensation, that is, suppressing yes (flag) responses for percepts, which they suspect to be caused by the perceptual illusion.

Second, over many years, international assistant referees were given clear instructions to benefit the attacker in case of doubt. In this experiment, however, the
participants were not informed that the task was a simulation of an offside situation; therefore, instruction per se is not a direct explanation for the (cognitive) compensation found. If informed, this would probably indicate a different mind-set by the assistant referees during the task and strengthen the hypothesis that instructions might have directly contributed to the decision making.

Third, the action and omission bias framework might also clarify the difference in the number of false alarms between both groups. The FLE would tend to increase the false perception that an offside offense occurred, and omission bias (i.e., people are biased in favor of inaction) would tend to reduce the probability of raising the flag. Therefore, omission bias possibly compensates for the flash-lag illusion. Less common, action bias has been raised as a possibility, for example, in goalkeeper behavior in defending penalties (Bar-Eli, Azar, Ritov, Keidar-Levin, & Schein, 2007). The main results of this laboratory study can be generalized to offside situations in real games as well. Catteeuw and colleagues (2010a) demonstrated a bias toward nonflag errors for the first time (773 nonflag errors vs. 95 flag errors) in the English Premier League. Hence, these findings clearly confirm that the combination of extensive perceptual-cognitive training on the one hand and the instruction to give the benefit of doubt to the attacker on the other hand can lead to improved decisions in nonoffside situations, but not necessarily in offside situations.

Based on the results of this study, one might suggest that when producing and validating on- and off-field test and training tools, it is important not only to focus on developing a compensation mechanism to better deal with the flash-lag illusion but also to take the overcompensatory behavior into account. Even though FIFA and UEFA recommend giving the attacker the benefit of the doubt, and misses are therefore considered less serious than false alarms, it would certainly be desirable to reduce the incidence of misses. Just recently, Put, Wagemans, Jaspers and Helsen (2013), demonstrated that perceptual-cognitive skill training results in a positive and direct transfer to on-field offside decisions. Importantly, this training intervention did not result in overcompensatory behavior, which was clearly showed by a status quo of the nonflag errors from pre- to posttest, while the number of flag errors significantly decreased following a web-based training protocol.

Finally, a number of limitations need to be considered. First, the current study was performed with a relatively small number of participants. Despite this sample size, the relevant effects were statistically significant and hence we can draw meaningful conclusions. Second, age differences between both samples were present, implying that effects of experience, expertise and age were intermixed in this study. Future research should attempt to study the separate effects of age, expertise and experience in larger samples. In addition, further work should be done to investigate whether the compensation for the flash-lag effect is purely a cognitive strategy or whether it involves superior perception of some kind as well. For instance, it is not impossible that experts are better able to “freeze” the image with all the players in their proper positions at the critical moment of the last pass (i.e., the actual kicking of the ball) than novices are. They could then use their iconic memory to read off the positions and cognitively correct them as a function of the direction and speed of motion and the distance traveled in the period just before the last kick. An isolation of perceptual or cognitive components of the decision-making skills, for example, via verbal reports (Ericsson & Williams, 2007; McPherson & Vickers, 2004) and gaze behaviors (Gegenfurtner, Lehtinen, & Säljö, 2011; Hancock & Ste-Marie, 2013) or other novel ways to zoom in on the supposed factors can be beneficial in addressing this question. At this moment, one can also critically argue that the argument presented on (cognitive) overcompensation can possibly be exchanged by the argument of probability matching (e.g., Gaismaier & Schooler, 2008; Raab, Gula, & Gigerenzer, 2012) or base-rate sensitivity (cf. Abernethy, Gill, Parks, & Packer, 2001), since experts and novices may be differentially sensitive to the base rates of the situation. In addition, it is also worthwhile to investigate the influence of the flash-lag effect for movements going from right to left for which experts are not trained as much.

**General Conclusion**

In this study, international assistant referees showed more misses (i.e., nonflag errors), in particular in the most difficult situations, providing evidence for response-level compensation for a perceptual illusion, not enhanced perceptual sensitivity. This could reflect the use of different strategies, such as cognitive overcompensation, omission bias, and base-rate sensitivity, and corresponds to the real game situations in which a conservative flagging strategy is recommended. As such, they are not less susceptible to the perceptual illusion itself. Instead, they have learned to compensate for it, resulting in a specific cost. It thus appears that experts in offside decision making can be distinguished from novices not so much on the perceptual level but rather on the cognitive or decision-making level. To further improve their off- an on-field performance, assistant referees would be well advised to learn to better deal with this (over)compensation. Therefore, the current study is of interest from both a practical and a theoretical perspective. On the one hand, it reveals the underlying mechanisms of incorrect decision making in soccer, one of the most popular sports worldwide. On the other hand, this study shows that one can probably dissociate the perceptual and cognitive components of successful decision making in cases where perception is affected by a strong illusion.

**References**


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