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## **Imperceptibly Off-Center Goalkeepers Influence Penalty-Kick Direction in Soccer**

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The penalty kick generates a variety of strong emotions in soccer (Carroll, Ebrahim, Tilling, Macleod & Smith, 2002), and places the goalkeeper at such a disadvantage that only approximately 18% of penalties are saved (Kropp & Trapp, 1999). We asked whether a goalkeeper can, by standing marginally left or right of goal center, bias a penalty taker implicitly to kick to the side with greater area, thus allowing the goalkeeper to dive in that direction to make a save. We show that the penalty taker is unlikely to be mindful that the goalkeeper is off center, but nevertheless can identify the side with greater area and will be more likely to direct the penalty kick to that side than to the other side.

Observation of 200 clips of penalty kicks, including those in World Cups, African Nations Cups, European Championships, and Union of European Football Association (UEFA) Champions League matches, indicated that goalkeepers stood marginally left or right of goal center on 96% of occasions. The mean displacement of the goalkeeper was 9.95cm, resulting in a

difference of 2.9% between the areas to the left and right of the goalkeeper (i.e., 2.9% was the difference between the two areas expressed as a percentage of total area around the goalkeeper,  $(\Delta\text{Area}/\text{Area} \times 100)$ ). There was no association between the position of the goalkeeper and the side to which he dived (94 out of 190 dives were to the side with smaller area),  $\chi^2(1, N = 190) = 0.06$ , which suggests that the displacement was not a purposeful strategy. Nevertheless, regardless of the many factors that contribute to kick direction, more kicks were directed to the side on which there was greater area (103 out of 174),  $\chi^2(1, N = 174) = 3.45$ ,  $P_{\text{rep}} = .905$ ,  $\phi = 0.141$ .

In an experimental study, we asked 51 participants to view 300 slides on a 15.4-in. Samsung wide-screen XGA monitor, from a distance of approximately 50 cm. In each slide, a filled block was positioned on the goal line at one of 14 displacements to the right or left of center (the block and goal were scaled to 3% of the normal size of the German goalkeeper, Oliver Kahn, and a soccer goal, respectively). Participants were asked to judge on which side of the block there was greater area and to indicate the extent of their confidence in the judgment on a scale from 50% (low confidence) to 100% (high confidence). At differences in area as small as 0.5% participants showed low confidence in their perceptual judgment, yet indicated the side with the greater area at above-chance levels,  $t(50) = 7.70$ ,  $P_{\text{rep}} > .999$ ,  $d = 1.078$  (see Fig. 1b).

In a more real-world replication, we replaced the block with an image of Oliver Kahn (e.g., Fig. 1a), and asked 20 participants to kick a football from a penalty spot (distance to screen = 4.8 m) to the side with the greater area and also to indicate their confidence that they had selected the correct side. The stimuli were projected on to a screen and were scaled to 44% of real life size. At differences in area of 0.5% and greater, participants' accuracy was at above-chance levels,  $t(19) = 2.70$ ,  $P_{\text{rep}} = .959$ ,  $d = 0.604$  (see Fig. 1c), but only when the differences were at least 3.0% did participants show significantly increased confidence in their perceptual judgments ( $P_{\text{rep}} = .999$ ,  $d_s > 0.482$ ).

Our data are compatible with Weber's Law in that the smallest difference in area at which participants showed reliably above chance discrimination was constant ( $\sim 0.5\%$ ) regardless of the

scaling of the stimuli (i.e., 3% vs. 44% of real life size). The ability to discriminate differences as small as 0.5% is consistent with the demonstrated ability to discriminate differences as small as 0.1 to 0.8% in visual line-bisection tasks (e.g., McCourt & Olafson, 1997; Porac, Searleman & Karagiannakis, 2006; Scarisbrick, Tweedy & Kuslansky 1987). Such tasks require judgments of line length that are comparable with the relative area judgments in the present studies.

In a third study, we assessed whether penalty direction is biased even when the kicker is unaware of the goalkeeper's displacement. To this end, we presented stimuli identical to those of the second study (again scaled to 44% of real life size) and instructed participants ( $N = 32$ ) to take a penalty kick only when Kahn was standing in the center of his goal. At differences in area ranging from 1.6 to 3.0% participants directed their penalty kicks to the side with the greater area at above-chance levels ( $P_{\text{reps}} > .926$ ,  $d_s > 0.378$ ) despite kicking only when they believed that the keeper was in the exact center of the goal (Fig. 1d). The number of kicks dropped considerably at percentages greater than 3.0%, which suggests that participants were mindful of the fact that the goalkeeper was displaced to the left or right of center.

In summary, we have shown that it is feasible for a goalkeeper to influence perceptions of area and consequently the direction of penalty kicks by standing marginally to one side or another of the goal center; the goalkeeper can then strategically dive to the side with greater area. Extrapolation of our data indicates that the optimum displacement of the goalkeeper in real life is from 6 to 10 cm. The penalty taker is unlikely to be mindful of a displacement in this range, but is at least 10% more likely to direct the penalty kick to the side with greater area than to the side with smaller area.

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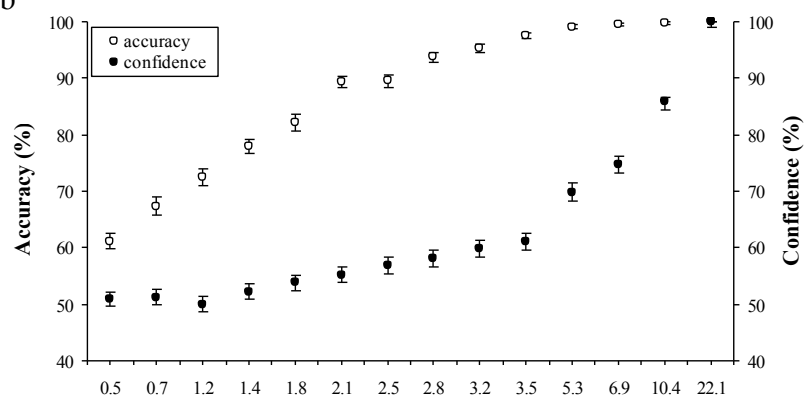
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**Fig. 1.** Influence of the goalkeeper's position (displacement from center) on perception and direction of penalties in soccer. An example of a stimulus display used in Studies 2 and 3 is shown in (a); in this particular display, there is proportionally more area (2.2%) on the right side of the goalkeeper than on the left. The graphs in (b) and (c) show results from the first two studies: participants' accuracy in choosing (Study 1) or directing a kick toward (Study 2) the side with greater area and participants' mean confidence in their judgment, normalized to the difference between the lowest and highest levels of confidence. The graph in (d) presents results from the third study, in which participants kicked only if they believed the goalkeeper was in the center. The graph shows the percentage of trials on which participants took a kick (black squares). All results are graphed as a function of the difference between the areas on the left and right sides of the goalkeeper, expressed as a percentage of total area around the goalkeeper,  $\Delta\text{area}/\text{area} \times 100$ . Error bars indicate standard errors.

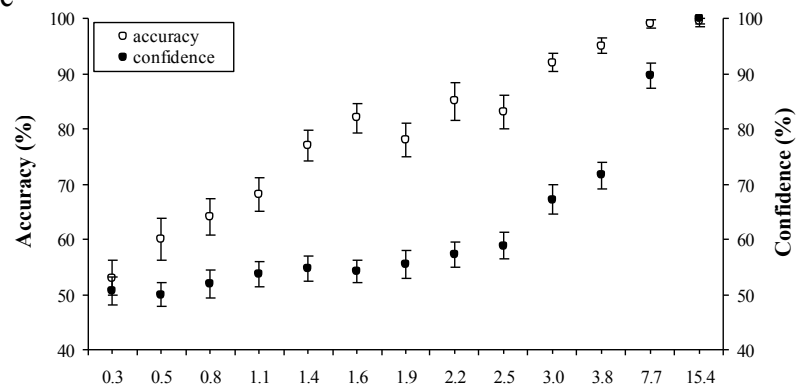
a



b



c



d

