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Trust My Face: Cognitive Factors of Head Fakes in Sports

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In many competitive sports, players try to deceive their opponents about their behavioral intentions by using specific body movements or postures called fakes. For example, fakes are performed in basketball when a player gazes in one direction but passes or shoots the ball in another direction to avert efficient defense actions. The present study aimed to identify the cognitive processes that underlie the effects of fakes. The paradigmatic situation studied was the head fake in basketball. Observers (basketball novices) had to decide as quickly as possible whether a basketball player would pass a ball to the left or to the right. The player's head and gaze were oriented in the direction of an intended pass or in the opposite direction (i.e., a head fake). Responding was delayed for incongruent compared to congruent directions of the player's gaze and the pass. This head fake effect was independent of response speed, the presence of a fake in the immediately preceding trial, and practice with the task. Five further experiments using additive-factors logic and locus-of-slack logic revealed a perceptual rather than motor-related origin of this effect: Turning the head in a direction opposite the pass direction appears to hamper the perceptual encoding of pass direction, although it does not induce a tendency to move in the direction of the head's orientation. The implications of these results for research on deception in sports and their relevance for sports practice are discussed.

Keywords: sport psychology, deception, motor response, reaction time

Among the most important considerations for a human actor are the actions of other people nearby. For example, other humans may become confederates in a social relationship, or alternatively, they may be rivals who compete for a limited resource. It is thus not surprising that evolution has furnished humans with sensitive mechanisms to efficiently encode and interpret the actions of others (Blakemore, Winston, & Frith, 2004). For example, human observers can infer the identity (Cutting & Kozlowski, 1977) or affective state (Dittrich, Troscianko, Lea, & Morgan, 1996) of another person based on his or her movements. Also, we can infer from subtle body cues such as gaze direction or head orientation the behavioral intentions of social partners, such as where a person is attending or planning to move. It has been shown that gaze direction and head orientation are automatically encoded and lead to a corresponding orienting of attention in the observer (Ansorge, 2003; Langton, 2000; Langton, Watt, & Bruce, 2000; Zorzi, Mapelli, Rusconi, & Umiltà, 2003). Sometimes other people's actions can affect our own actions in a direct manner, as is the case in imitation. Even infants of only a few weeks old tend to spontaneously imitate body movements that they observe in others (Meltzoff & Moore, 1977), and these spontaneous imitative tendencies remain in adulthood (Iacoboni et al., 1999; Stuermer, Aschersleben, & Prinz, 2000). Thus, the perception of a certain motor action is (under certain circumstances) directly transferred into a corresponding motor response of the observer (Heyes, 2009).

Organisms sometimes use body cues deliberately to *misinform* others about their own intentions. Such nonverbal deception occurs in animals, for example, when a rabbit tries to deceive a dog about its direction of escape by making unpredictable movement changes, but the intentional use of deception appears to be confined to humans from an age of approximately 4 years onward (e.g., Hala & Russell, 2001). Deception by body cues are particularly widespread in sports, where they are called fakes or feints (Ripoll, Kerlirzin, Stein, & Reine, 1995). In general, feints are motor actions that are generated to intentionally misinform an opponent about one's own behavioral intentions. There are different kinds of feints depending on the specific sport considered. For example, boxers often fake a punch, which opponents sometimes react to, putting themselves out of position to defend the actual punch that comes a moment later. Likewise, basketball players often fake a shot before actually shooting the ball to induce a premature defensive action by the opponent. In these types of feints, the irrelevant and misguiding action precedes the relevant action. There are also other types of feints where the irrelevant and relevant actions occur more or less simultaneously. Perhaps the

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most prominent example of this kind of feint are so-called head fakes, where the player looks in one direction while passing or shooting the ball in another direction.

In competitive play, sportsmen use feints quite frequently, which is at least anecdotal evidence for their efficiency. Also, many textbooks on motor control and sport psychology contain chapters or paragraphs on feint effects (e.g., Schmidt & Lee, 2005; Schmidt & Wrisberg, 2008). It is therefore surprising that, so far, very little experimental research has been devoted to examining deception effects directly. Some recent studies have investigated whether experts and novices differ in their ability to detect deceptive movements (Canal-Bruland & Schmidt, 2009; Canal-Bruland, van der Kamp, & van Kesteren, 2010; Jackson, Warren, & Abernethy, 2006; Morris & Lewis, 2010; Sebanz & Shiffrar, 2009). In the temporal occlusion paradigm, experts and novices are shown video sequences of a feint or nonfeint action that is stopped at a certain time before the crucial event becomes accessible. Then, a judgment is required on whether the observed action is real or faked (e.g., whether a handball penalty shot is real or faked or whether a rugby player is going to move to the left or to the right). The standard finding is that experts outperform novices, whose performance sometimes does not exceed chance levels. This expertise advantage seems to be attributable to experience in both perceiving and performing the observed actions (Canal-Bruland, van der Kamp, & van Kesteren, 2010).

Although there is some evidence that expertise helps an athlete to consciously detect deceptive actions by an opponent (e.g., Canal-Bruland & Schmidt, 2009; Jackson, Warren, & Abernethy, 2006; Sebanz & Shiffrar, 2009), little is known about the reasons why deception works in the first place. Why does a feint distract the observer? Which cognitive processes underlie feint effects? For example, do fake actions induce inadequate motor responses in the observer, which then interfere with the selection of more appropriate defensive actions, or do they hamper the perceptual encoding of body cues that signal the actor's true intention? Furthermore, if an observer has just encountered a feint, will this reduce the impact of a subsequent feint? These are important questions for practical purposes, such as for understanding when to use fakes and when not or how to prevent their detrimental impact for defenders. But studying such questions might also help to evaluate current theories on the relation between perception of others' behavior and one's own actions, such as theories of imitation and common representations of perception and action (Prinz, 1997).

Studies in which observers make their judgments about the presence or absence of a feint without time pressure (e.g., Canal-Bruland & Schmidt, 2009; Sebanz & Shiffrar, 2009) might be of limited use for studying these issues; tasks requiring speeded responses may be more appropriate. First, responding without time pressure is unrealistic in many sports contexts. In real sports scenarios, successful performance often depends on selecting the appropriate response within a few hundred milliseconds (if not less). For example, a goalkeeper cannot hesitate to initiate his or her dive for a penalty shot in soccer because otherwise he or she would be too late to save the shot. Second, motor responses and perceptual judgments appear to be driven by different processes and are constrained by different factors (e.g., Ganel & Goodale, 2003; Kunde, Landgraf, Paelecke, & Kiesel, 2007). Using the same example of the penalty shot in soccer, it has been shown that soccer players intuitively kick a ball to that side of a goal (left or right side) where the distance between the goalkeeper and the goal post is larger, but at the same time they cannot indicate the side with the larger distance in a conscious perceptual judgment task (Masters, van der Kamp, & Jackson, 2007). Third, cognitive psychology offers a rich repertoire of inferential tools for the fine-grained assessment of information processing stages, such as additive factors logic (Sternberg, 1969) and locus of slack logic (McCann & Johnston, 1992; Paelecke & Kunde, 2007), that are available only when responding is speeded and response time serves as the dependent measure. These tools may be well suited to uncovering the mechanisms underlying feints in sports and are thus employed here.

Overview of the Study

The present study was carried out as a first step to identify the relevant cognitive factors of feint effects using the example of head fakes in basketball. Experiment 1 introduces the basic paradigm, in which the observers were required to make a speeded response to indicate the passing direction of a basketball player presented on a computer screen. The head (and gaze) orientation of the model player either corresponded (no feint) or did not correspond with the intended passing direction (feint). Importantly, participants were instructed to ignore the head orientation of the model. As it turned out, participants were unable to do so: Performance dropped with incongruent compared to congruent directions of pass and head orientation. Several additional analyses confirmed the robustness of the effect. A series of subsequent experiments was performed to explore the cognitive causes of this feint effect. Experiment 2 investigated whether the player's head orientation is the driving factor for the present feint effect by controlling for the impact of other bodily cues as well as some aspects of the stimulus material. Experiments 3–6 then tried to isolate the information processing stage at which the feint effect occurs. Two hypotheses were considered, namely that a model's head orientation induces motor responses in the same direction on behalf of the observer (the motor hypothesis) or that a head fake hampers the perceptual encoding of the relevant pass direction (the encoding hypothesis). In Experiment 3, the removal of spatial overlap between head orientation and response location left the feint effect almost unaltered, which provides preliminary evidence against the motor hypothesis. In Experiments 4 and 5, additive factors logic was used to scrutinize the stage of processing that feints affect more directly (Sternberg, 1969). These experiments showed that a manipulation of the perceptual encoding stage interacts with the feint effect, whereas a manipulation of the response selection stage does not. This result clearly suggests a perceptual locus of the feint effect and precludes a motor-related locus. Finally, the locus-of-slack logic (McCann & Johnston, 1992) was exploited in Experiment 6, which also suggests a perceptual locus of the feint effect. These results are discussed in terms of their theoretical and practical implications.

Experiment 1

Experiment 1 introduces the basic paradigm. Participants were shown static images of a basketball player passing a ball to the left or to the right and were required to indicate the passing direction by pressing a left or right response button. Importantly, the player's head and gaze were oriented either in the same direction as the intended pass or in the opposite direction (cf. Figure 1). Participants were instructed to ignore the head orientation of the model as much as possible. The main prediction was that observers' responses would still be slower and less accurate when the direction of the pass and the head orientation are incongruent as compared to when they are congruent. Such a finding would signify a feint effect.

The motivations for using static images (rather than dynamic video scenes) were twofold: First, we wanted to make use of classical methods from the response time literature to isolate the relevant stages of processing at which the feint effect arises. These methods require a clear definition of the response time interval and hence of stimulus onset and response onset. With static images, the stimulus onset time is clearly defined, but it becomes fuzzy with quasi-realistic (e.g., video-taped) movement sequences. This advantage of static images comes with a cost because we cannot study the additional impact that dynamic cues may have on response selection. Still, as we will show, these static cues were clearly sufficient to induce replicable feint effects. Moreover, basketball novices of the type studied here seem to rely exclusively on static cues when detecting fake passes in basketball because their performance does not improve with the addition of movement cues from dynamic videos (Sebanz & Shiffrar, 2009). Therefore, it seems likely that even static images contain the most relevant stimulus aspects used by novices for fake detection. Second, the use of the stimuli shown in Figure 1 renders the task conceptually equivalent to other so-called interference tasks in cognitive psychology in which there is a response-relevant stimulus feature (here, pass direction) and another irrelevant feature (here, head orientation). This task is thus similar to the Stroop color-naming task (Stroop, 1935), where word color is the relevant task feature while word meaning is irrelevant. The same applies to the Simon task (Simon and Rudell, 1967), where, for example, stimulus color is relevant while stimulus location is not. This structural similarity enabled us to explore to what extent the feint effect is subject to boundary conditions similar to those that are known from other interference phenomena.

To test for such similarities and thus to scrutinize the nature of the feint effect, several additional analyses were conducted. First, a response time distribution analysis was done to determine the time course of the proposed feint effect (Ratcliff, 1979). Sometimes, interference effects (such as the Simon effect) decrease or vanish with longer response times (e.g., de Jong, Liang, & Lauber, 1994; Rubichi, Nicoletti, Iani, & Umiltà, 1997). This decrease with longer response times may reflect passive decay (Hommel, 1994) or active suppression (Ridderinkhof, 2002) of nominally task-irrelevant and potentially conflicting information. To test whether the influence of the irrelevant head orientation in the present task is similar, it was computed for different proportions of the response time distribution. Second, the feint effect was analyzed as a function of the presence or absence of a feint in the immediately preceding trial ($n - 1$) of the experiment. Several congruency effects (such as Simon, Stroop, and Eriksen effects) decrease or vanish when the preceding trial contained conflicting information (Gratton, Coles, & Donchin, 1992; Kunde & Wühr, 2006; Kunde & Stöcker, 2002; Stuermer, Leuthold, Soetens, Schröter, & Som-

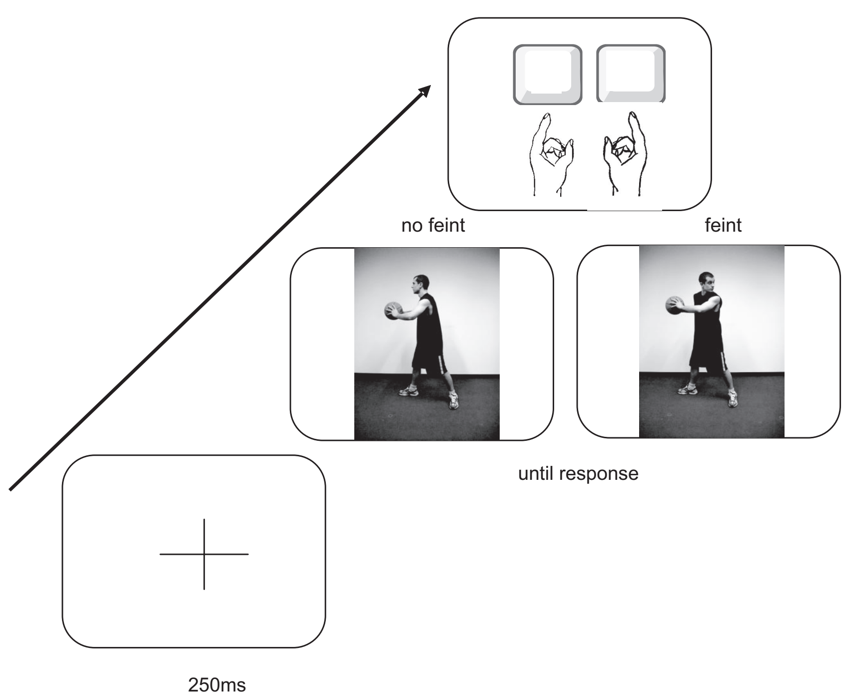

Figure 1. Procedure of Experiment 1. Participants responded to the direction of a basketball pass while ignoring the direction of head orientation. The head orientation of the model person either corresponded or did not correspond to the pass direction.

mer, 2002). It has been argued that such sequential modulations show observers' ability to circumvent interference from conflicting information in a subsequent trial after this conflicting information has proven to be detrimental (after a feint in our case). From a theoretical perspective, it is important to know whether feint effects are subject to sequential modulations as well. Observing no reduction of the feint effect after a feint trial might suggest that it is harder to manage interference from irrelevant body cues than from other irrelevant information, such as irrelevant stimulus position in the Simon task or irrelevant flankers in the Eriksen task. From a practical perspective it would be quite helpful to know whether the experience of a feint does somehow alter the impact of another feint encountered immediately afterward. Third, we analyzed the feint effect as a function of practice. Although the amount of practice in the present experiment was limited, such an analysis may at least provide a hint of whether observers acquire some means to block out irrelevant head orientation during practice.

Method

Participants. Participants were 16 right-handed psychology students (12 female, mean age 24.5 years) from the Technische Universitaet (TU) Dortmund, Germany, who took part in the experiment in partial fulfillment of a course requirement. All participants reported normal or corrected-to-normal vision and had no knowledge of the expected outcome of this experiment. Each participant gave informed consent to participate. The single experimental session lasted about 30 minutes. All rights of the participants were protected, and all experiments were carried out according to the 1964 Declaration of Helsinki.

Apparatus and stimuli. Stimuli were presented and responses and response times (RTs) were recorded by an IBM-compatible personal computer with a 17-inch VGA display. All stimuli were presented in color on a white background and were composed of a male basketball player with a ball in his hands, looking to the right or left, while passing the ball in the same or the opposite direction. Each response was a single key press on a standard computer keyboard. These were carried out with the index fingers of each hand, which rested on the "." key (right hand, for detection of movements to the right) and on the "X" key (left hand, for detection of movements to the left) on the outside of the bottom row of the keyboard.

Procedure and design. Participants were given written instructions to respond to the pass direction (body movement) as quickly and accurately as possible. The first block of 50 trials was considered as practice to familiarize participants with the experiment. During this time, the investigator stayed in the room to answer any questions. Data from this block were not evaluated. The practice block was followed by four test blocks of 100 trials each, which were separated by short breaks if participants wanted to rest. During each test block, the four possible stimulus combinations occurred equally often and in random order, resulting in a total of 200 congruent and 200 incongruent test trials for each participant in the whole experiment. Each trial began with the presentation of a central fixation cross. After a fixed time interval of 250 ms, the stimulus picture was presented and remained on the screen until a response was given. After the trial ended, participants received feedback about their answer. If there was an error, the word "Fehler" (German for "error") appeared on the screen for 500 ms. If the answer was correct, the next trial began immediately with the appearance of the fixation cross.

Results

Only RTs associated with correct responses were analyzed further. RTs below 100 ms were excluded as anticipations, and RTs higher than 1000 ms were excluded as outliers[1] (0.3% of the data).

Response times. A paired-samples t test showed that responses were slower when the head orientation and pass direction were incongruent than when they were congruent [348 ms vs. 326 ms, $t(15) = 5.94$, $p < .005$].

Error rates. Responding was less accurate when the head orientation and pass direction were incongruent (4.7%) than when they were congruent (1.1%), as revealed by a paired-samples t test [$t(15) = 4.74$; $p < .005$].

Distribution analysis. To gain insight into the temporal dynamics of the feint effect, RTs for trials with congruent and incongruent head and pass directions were rank-ordered separately for each participant. Then, each RT distribution was divided into five proportional bins, and the mean RTs within these bins were submitted to an analysis of variance (ANOVA) with bin and pass-head congruency as repeated measures. Aside from trivial main effects of bin [$F(4, 60) = 351.68$; $p < .005$; $\eta_p^2 = .96$] and pass-head congruency [$F(1, 15) = 35.01$; $p < .005$; $\eta_p^2 = .70$], the analysis revealed an interaction of these factors [$F(4, 60) = 13.34$; $p < .005$; $\eta_p^2 = .47$], indicating that the feint did not decrease but slightly increased over response time (cf. Figure 2). The feint effect was significant for all bins (all $p < .05$).

Sequential analysis. To test for a possible modulation of the feint effect as a function of the previous presence of a feint, mean RTs and error rates were computed according to pass-head congruency in trial n and pass-head congruency in trial $n - 1$ (cf. Figure 3). These data were then submitted to an ANOVA with the factors of pass-head congruency in trial n and pass-head congruency in trial $n - 1$. The analysis of RTs revealed a significant effect of pass-head congruency [$F(1, 15) = 34.50$; $p < .005$; $\eta_p^2 = .84$] but no effect of congruency in trial $n - 1$ [$F(1, 15) = .11$; $p = .5$; $\eta_p^2 = .02$] nor of the interaction of these two factors [$F(1, 15) = 1.37$; $p = .3$; $\eta_p^2 = .01$].

The analysis of error rates also revealed a significant effect of pass-head congruency [$F(1, 15) = 22.10$; $p < .005$; $\eta_p^2 = .4$] but no effect of congruency in the previous trial ($n - 1$) [$F(1, 15) = 2.07$; $p = .2$; $\eta_p^2 = .14$] nor of the interaction of these two factors [$F(1, 15) = .24$; $p = .6$; $\eta_p^2 = .001$].

Effects of practice. To test for practice-related variations across the experiment, the data were separated into blocks of 50 trials. An ANOVA of RTs with the factors pass-head congruency and block revealed a significant effect of pass-head congruency [$F(1, 15) = 36.09$; $p < .005$; $\eta_p^2 = .83$] but neither an effect of

[1] We used fixed outlier criteria here, which appear to be no less common than more complex removal procedures (cf. Ulrich & Miller, 1994). The specific values used here appeared to be appropriate to discriminate valid from spurious responses when inspecting the raw data. However, the basic data pattern did not change when using other criteria (e.g., based on standard deviations of RTs).

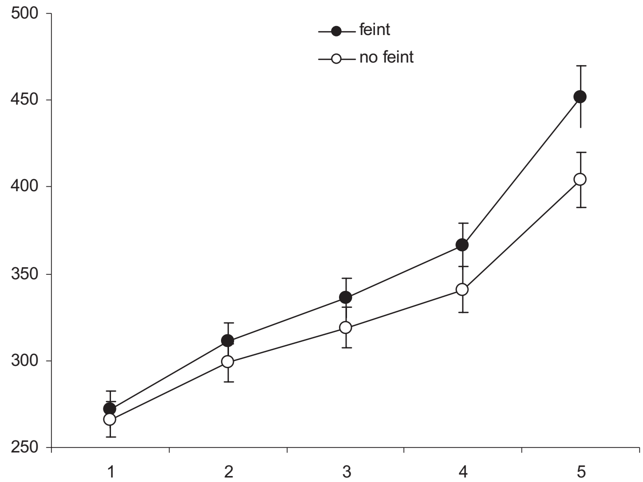

Figure 2. Reaction times as a function of RT bin and pass–gaze congruency in Experiment 1. Reaction times for all participants were organized in ascending order and then separated into quintiles. For example, the fastest 20% of RTs lie in the first quintile, whereas the 20% of slowest RTs are in the last quintile. Filled circles indicate feint trials, and unfilled circles indicate nonfeint trials. Error bars represent standard errors.

block nor an effect of the interaction of these two factors (both Fs < 1). The same was true for the analysis of error rates; pass-head congruency had a significant effect [$F(1, 7) = 22.27$; $p < .005$; $\eta_p^2 = .43$], but block [$F(1, 7) = 1.14$; $p = .3$; $\eta_p^2 = .12$] and the interaction [$F(1, 7) = 1.50$; $p = .2$; $\eta_p^2 = .04$] did not.

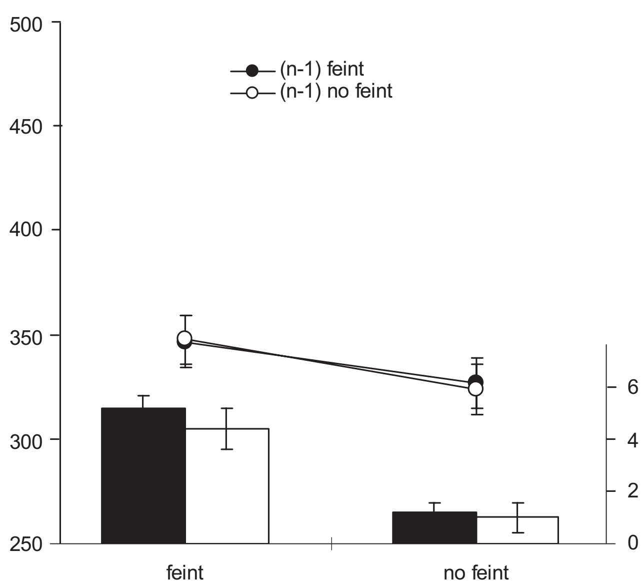

Figure 3. Experiment 1. Reaction times and error rates as a function of congruency of pass and gaze in trial n and trial $n - 1$. Filled circles indicate a feint in the previous trial ($n - 1$), and unfilled circles indicate nonfeint trials in the previous trial ($n - 1$). Filled columns indicate percentages of error when the previous trial was a feint trial, whereas unfilled columns indicate percentages of error when the previous trial was a nonfeint trial.

Thus, the feint effect was stable across the experiment (cf. Figure 4).

Discussion

Experiment 1 showed that responding to the direction of a pass in basketball is affected by the head orientation of the passer. Responses are slower and less accurate when the head orientation does not correspond with the direction of the pass. This test situation is similar to the game situation in which basketball players try to deceive their opponents about their intended pass direction. Importantly, this impact was observed despite the fact that head orientation was task irrelevant and participants were instructed to ignore it. This result suggests that head orientation was processed automatically, as has been previously shown for other body cues (Langton & Bruce, 2000). We note here that in this and all other experiments of the present study, the gaze of the model (i.e., line of sight) was always directed in the same direction as the face. Thus, we cannot tell whether this feint effect was caused by gaze direction or head orientation. Given that the orientation of the head is the more salient feature, we find it reasonable to attribute the effect primarily to head orientation.

Several aspects of this feint effect are noteworthy. First, unlike other sorts of interference effects, such as the Simon effect, the impact of head orientation did not decrease with increasing response time. Such a reduction of interference effects with increasing response time has previously been interpreted as sign of a decay or suppression of conflicting information (Hommel, 1994; Ridderinkhof, 2002). To the extent that this interpretation is correct, the data pattern of Experiment 1 suggests that the representation of head orientation does not decay but remains in an activate state once it has been encoded.

Second, the impact of head orientation was independent of whether the previous trial contained a feint. This observation is remarkable because the present task has a paradigmatic similarity to other interference tasks in which a nominally task-irrelevant

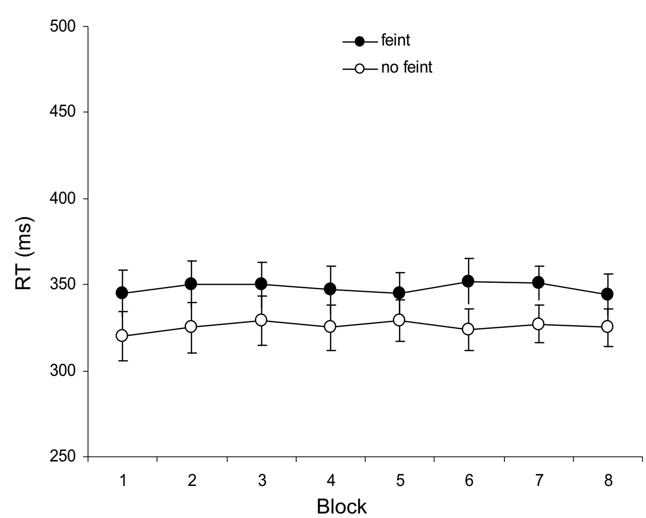

Figure 4. Experiment 1. Effects of practice. Reaction times as a function of practice block (50 trials each) and pass–gaze congruency. Filled circles indicate feint trials, whereas unfilled circles indicate nonfeint trials.

feature (here, head orientation) corresponds or does not correspond to a task-relevant feature (here, pass direction). Most, if not all, of these structurally similar effects, such as the Eriksen effect (Gratton, Coles, & Donchin, 1992), the Simon effect (Stuermer et al., 2002), or the Stroop effect (Kerns et al., 2004), decline when the previous trial contained conflicting information. This so-called conflict adaptation effect is currently under debate (e.g., Hommel, Proctor, & Vu, 2004), but it seems to be taken for granted that it reflects (at least to a considerable degree) the attentional amplification of relevant information and/or suppression of irrelevant information after information conflict (cf. Egner, 2007; Kunde & Wühr, 2006). The observation that the feint effect is not reduced immediately after a feint was observed is of interest from a theoretical as well as from a practical perspective. At a theoretical level, this observation suggests that the attentional weight that is given to head orientation (relative to pass direction) is barely altered after a feint. Head orientation is a highly socially relevant cue, and its processing may therefore be relative immune to attentional modifications. At a practical level, this result suggests that feints may be effective even under situations in which the observer has just encountered a feint from his or her opponent a moment before. Of course, this latter notion must be confirmed in more realistic scenarios.

Third, there was essentially no variation of the feint effect with practice. The absence of a practice effect was limited to the number of trials provided in the present experiment (i.e., a total of 450 trials), however. A full evaluation of this issue would require much larger amounts of practice, which was not within the scope of the present research.

To summarize, Experiment 1 revealed that irrelevant head orientation has an effect on speeded responding to pass direction. This impact was quite robust in three ways: It did not vanish with increasing response time; it did not decrease with preceding incongruence of head orientation and pass direction; and it was not reduced within the amount of practice used here. Yet, before addressing some of the boundary conditions of this effect, alternative explanations must be considered.

Experiment 2

We interpreted the feint effect in Experiment 1 as an impact of the task-irrelevant head orientation on performance. Yet, this conclusion might be premature. In fact, feint and nonfeint pictures differed in other respects that may suffice to explain performance differences as well. First, consider that the stimuli were photographs. There might therefore be differences in low-level visual features between feint and nonfeint pictures, such as their brightness or the accessibility of the pass direction, which could already explain the effect. A second, theoretically more interesting, possibility is that head orientation is not the only task-irrelevant body feature that gives rise to a feint effect. For example, there are also subtle differences in the orientations of the hips and shoulders that could cause interference effects (in addition to head orientation).

Experiment 2 attempted to address all of these alternative interpretations through a simple manipulation. We used the same photographs as in Experiment 1 but masked the model's head with a colored blob so that the head orientation was essentially inaccessible (cf. Figure 5). If head orientation is crucial for the feint effect, this effect should now disappear. If, however, there is some

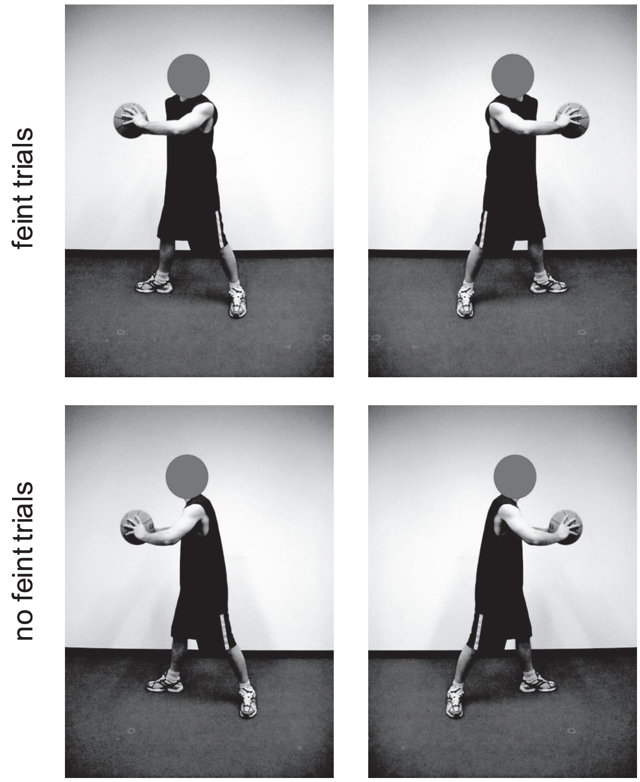

Figure 5. Stimuli used in Experiment 2. The head of the stimulus model was covered with a red dot so that the direction of gaze was no longer visible. The head orientation of the model person could still be either congruent or incongruent with the pass direction. When using this setup, the effect of pass–gaze congruency should vanish if the crucial factor indeed is the direction of gaze, but it will still exist if participants use other body cues (e.g., the position of the feet or shoulders) to decide.

impact of other visual features, such as brightness or orientation of the shoulders and hips, the effect should still be present, though possibly to a smaller extent. All other aspects of Experiment 2 were the same as in Experiment 1.

Method

Participants. Participants were 16 right-handed and one left-handed psychology students (three males, mean age 23 years) from the TU Dortmund, Germany, who took part in the experiment in partial fulfillment of a course requirement. All participants reported normal or corrected-to-normal vision and had no knowledge about this or the previous experiment. Each participant attended a single experimental session lasting about 30 minutes.

Apparatus, task, and procedure. The experimental design and procedure were similar to Experiment 1, with the exception that a red colored blob occluded the player's head from the participant's view.

Results

Participants' RTs for correct responses and their error rates were analyzed. RTs below 100 ms were excluded as anticipations, and RTs above 1000 ms were excluded as outliers (0.5% of the data).

Response times. In contrast to the results in Experiment 1, there was no significant difference in the reaction times between trials in which the orientation of the head and the pass direction were incongruent (349 ms) and trials in which they were congruent (348 ms), as shown by a paired-samples *t* test, [$t(15) = .71$; $p = .5$].

Error rates. No significant difference was observed for response accuracy. Participants committed equal numbers of errors independent of the congruency of head orientation and pass direction [0.7% vs. 0.7%, $t(15) = .02$; $p = 1$].

Comparison with Experiment 1. To test the reliability of the apparent differences between Experiment 1 and 2, another ANOVA was conducted with pass-head congruency (congruent vs. incongruent) as a repeated measure and experiment (Experiment 1 vs. Experiment 2) as a between-participants variable. In the analysis of RTs, there was no effect of Experiment [$F(1, 30) = 3.18$; $p > .085$; $\eta_p^2 = .15$], but RTs were higher overall with incongruent compared to congruent head orientation and pass direction [$F(1, 30) = 59.85$; $p < .001$; $\eta_p^2 = .66$], and, importantly, a significant interaction of experiment and head-pass congruency was observed, $F(1, 30) = 49.42$; $p < .005$; $\eta_p^2 = .62$. This interaction reflects the fact that a congruency effect was observed in Experiment 1 (22 ms) but absent in Experiment 2 (1 ms).

The same analysis for error rates revealed higher error rates with incongruent head orientation and pass direction [$F(1, 30) = 8.05$; $p < .05$; $\eta_p^2 = .21$] and slightly higher error rates in Experiment 1 than in Experiment 2 [$F(1, 30) = 6.98$; $p < .05$; $\eta_p^2 = .19$]. This increase was largely attributable to the higher error rates with incongruent head-pass directions in Experiment 1, which was not observed in Experiment 2, and which produced a significant interaction of the experiment and pass-head congruency factors [$F(1, 30) = 7.93$; $p < .05$; $\eta_p^2 = .21$].

Discussion

The results of Experiment 2 are clear cut. The feint effect was absent when the head orientation of the model player was not accessible. There was a residual, nonsignificant effect of 1 ms that may be attributable to factors other than head orientation, but this effect appears negligible. It can therefore be concluded that the feint effect demonstrated in Experiment 1 was in fact caused by differences in head orientation rather than by other stimulus-related differences between fake and nonfake pictures. This observation supports recent observations that head orientation is particularly important to directing observers' attention (Hietanen, 2002).

Experiment 3

Head orientation interferes with the generation of a response to the pass direction. But why is this so? To answer this question, a well-known taxonomy of interference effects by Kornblum, Hasbroucq, and Osman (1990) might be helpful. According to this taxonomy, interference can originate from three sources: (1) an overlap of relevant and irrelevant stimulus features, (2) an overlap of irrelevant stimulus features and responses, and (3) an overlap of relevant stimulus features and responses. Applying this taxonomy to the present task reveals that there are two potential sources of conflict. First, the task-relevant stimulus feature (i.e., pass direction) overlaps spatially with the task-irrelevant feature (i.e., direction of the gaze/head). Both vary in the horizontal (i.e., left-right) dimension. The potentially ensuing interference can be characterized as a *stimulus–stimulus* congruency effect because it concerns two stimulus-related features. Interference of this sort presumably occurs at perceptual stages of processing, which relate to input selection, that is, selection of appropriate input for further processing. (e.g., Van Maanen, Van Rijn, & Borst, 2009). Second, there is also spatial overlap between the irrelevant stimulus feature of head orientation and the response, which both also vary on the horizontal dimension. The potentially ensuing interference can be characterized as a *stimulus–response* congruency effect because it arises from both stimulus and response features. Interference of this sort presumably occurs at the response-selection stage of information processing, which relates to output selection, that is, the selection of appropriate motor output (Simon & Berbaum, 1990). There is also spatial overlap between the relevant stimulus feature (i.e., pass direction) and the response (i.e., left vs. right button press), but this overlap cannot give rise to interference in the present task because participants always (except when an error is made) made a response that was spatially compatible with the pass direction. The presence of two potential sources of interference renders the present task conceptually similar to a traditional Stroop task, which involves overlap between task-relevant and task-irrelevant stimulus features (i.e., word color and word name) and between task-irrelevant stimulus features (i.e., word name) and responses (i.e., naming the word color).

Experiment 3 provides a first step toward isolating the origin of the feint effect by varying the response set. Participants in this experiment had to indicate the pass direction with responses that varied on the vertical (top–bottom) dimension rather than the horizontal (left–right) dimension. Thus, the spatial overlap between the task-irrelevant stimulus feature (i.e., head orientation) and the required response was removed. We used two different S-R mappings (left pass–top button, right pass–bottom button and vice versa) so that any residual correspondence between orthogonal stimulus dimensions (e.g., so that the left stimulus features prime bottom responses, Proctor & Cho, 2006) was controlled for. The overlap between irrelevant and relevant features was left unaltered. The predictions are clear: If the feint effect is attributable to overlap between head orientation and response, it should now disappear. If, however, it is attributable to overlap between head orientation and pass direction, it should be of similar size as in Experiment 1.

Method

Participants. Thirty-two psychology students from the TU Dortmund, Germany (seven male, four left-handed), participated in partial fulfillment of a course requirement. The mean age was 23.3 years, and all reported normal or corrected-to-normal vision. The participants did not participate in the previous experiments. Each participant was informed about the task by written instructions and attended a single experimental session lasting about 30 minutes.

Apparatus, task, and procedure. The procedure, stimuli, and apparatus were the same as in Experiment 1, with the exception that the response buttons for the pass direction were no longer on the right and the left sides of the keyboard but arranged with one directly above the other. One half of the participants responded to a pass to the right by pressing the "8" key on the number keypad (the top key) and to a pass to the left by pressing the "2" key (the bottom key), while for the other half of the participants this mapping was reversed. The whole experiment consisted of five blocks: one practice block consisting of 50 trials and four experimental blocks of 100 trials each.

Results

Response times of correct responses and response errors were analyzed separately. RTs below 100 ms were excluded as anticipations, and RTs higher than 1000 ms were excluded as outliers (0.9% of the data).

Response times. Response times for conditions with congruent head orientation and pass direction were faster than those for incongruent conditions [353 ms vs. 364 ms, $t(31) = 46, 10$; $p < .005$].[2]

Error rates. Participants made fewer errors with congruent head orientation and pass direction than with incongruent directions [1.6% vs. 2.5%; $t(31) = 8.51$; $p < .01$].

Comparison with Experiment 1. To detect potential differences in the results between Experiments 1 and 3, another ANOVA was conducted with pass-head congruency (congruent vs. incongruent) and experiment (Experiment 1 vs. Experiment 3) as explanatory variables. Despite a main effect of pass-head congruency, the analysis revealed no significant interaction of the two factors [for RT: $F(1, 46) = 1.79$; $p = .2$; $\eta_p^2 = .04$, for error rates: $F(1, 46) = 1.09$, $p = .3$; $\eta_p^2 = .04$]. Thus, the effect of pass-head congruency was statistically the same in both experiments.

Discussion

The results of Experiment 3 are straightforward. Even after the overlap between head orientation and response key location was removed, the feint effect remained present. It was not even statistically reduced as compared to Experiment 1, where this overlap was present. This outcome clearly suggests that it is not the overlap between head orientation and required response but the congruency between head orientation and pass direction that is responsible for the feint effect.

This outcome is quite surprising. One may have expected that observing someone looking in a certain direction would prompt a tendency in the observer to move in that direction. Such motor priming, however, does not seem to arise in the present paradigm. Rather, it seems that the feint effect does not have a *response-related* origin but conceivably a *perceptual* locus based on the incongruence of two stimulus features.

Still, this conclusion appears somewhat premature; in fact, it is thus far based on a null finding because removing the overlap with the response set did not significantly alter the basic effect. We aimed to gather some more supportive evidence in the following experiments.

Experiment 4

The results so far suggest that the task-irrelevant head orientation interferes with the processing of the task-relevant pass direction rather than with the generation of a motor response. This head-/gaze-related interference may therefore be perceptual in nature and not motor related. Cognitive Psychology provides a well-established tool to test this proposal in the additive factors logic by Sternberg (1969). The basic assumption behind this logic is a stage model of information processing. The model assumes that information is processed in certain sequential stages that operate more or less independently of each other. In its simplest form, three stages are assumed: (1) a perceptual stage concerned with encoding of the stimulus; (2) a central stage concerned with the selection of an appropriate response to the stimulus; and (3) a motor stage concerned with the generation of the selected motor response (e.g., Pashler, 1984). The basic idea is that if two experimental factors affect different stages of processing, they will exert additive effects on RT. If, however, two factors affect the same stage, these factors should interact with each other. Consequently, to confirm that a certain experimental factor exerts its effect at a certain stage, one has to show that this particular factor interacts with other experimental factors that are known to have their effects at this particular stage. Conversely, one also has to show that the considered experimental factor does not interact with factors that are known to exert their effects on other processing stages. Thus, to confirm that the feint effect originates from a perceptual stage of processing, we must show that it interacts with perceptual factors and that it is additive to factors at other stages. Experiments 4 and 5 aimed to provide such confirmation.

Experiment 4 tested whether the impact of irrelevant head orientation interacts with a "perceptual" factor. We used a standard manipulation of the perceptual stage, namely stimulus quality (Miller & Pachella, 1973). The pictures were either of normal intensity, similar to the preceding experiments, or had reduced stimulus intensity. That is, these stimuli were overall reduced in brightness (and slightly lower in contrast, cf. Figure 6). It is predicted that incongruent head orientation and pass direction would delay responding, just as reduced stimulus intensity should. Importantly, if the impact of incongruent head orientation occurs at a perceptual stage of processing, its impact on RTs should interact with that of stimulus quality.

Method

Participants. Sixteen psychology students from the TU Dortmund, Germany (four male, one left-handed), took part in this experiment in partial fulfillment of a course requirement. The mean age was 21.4 years, and all reported normal or corrected-to-normal vision. None of the participants took part in the previous experiments.

Procedure. The procedure was identical to the previous experiments except that the stimuli were displayed with varying luminance. Half of the stimuli were presented with standard contrast (identical to the previous experiments), whereas the other half of the pictures were of reduced luminance and contrast. These pictures were modified with the Microsoft Office Picture Manager

[2] A preliminary analysis with the factors of pass-gaze congruency (congruent vs. incongruent) and stimulus–response (S-R) mapping (left pass–top button, right pass–bottom button and vice versa) revealed neither a main effect nor an interaction of the factor S-R mapping. Therefore, this factor was eliminated from further analyses.

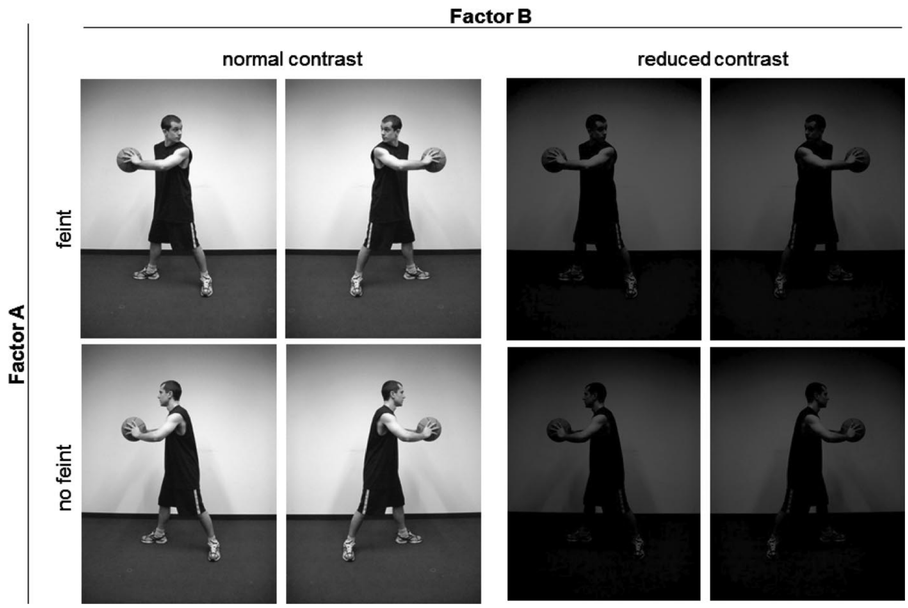

Figure 6. Stimuli in Experiment 4. One half of the stimuli were identical to those used in the previous experiment. For the other half, the stimulus quality was reduced in terms of luminance and contrast (50% less brightness, 10% less contrast). Head orientation either corresponded or did not correspond with the direction of the pass. Participants still had to react to the direction of the pass while ignoring the direction of gaze.

program by reducing the brightness by 50% and the contrast by 10% (cf. Figure 6).

Results

RTs below 100 ms were excluded as anticipations, and RTs higher than 1000 ms were excluded as outliers (1.5% of the data).

Response times. An ANOVA with the factors of pass-head congruency (congruent vs. incongruent) and stimulus quality (normal or degraded) was conducted. This analysis revealed that responding was on average slower when head orientation and pass direction were incongruent relative to when they were congruent [409 ms vs. 367 ms, $F(1, 15) = 34.3$; $p < .005$; $\eta_p^2 = .7$]. Responding was also slower when the stimulus quality was reduced relative to when it was normal [439 ms vs. 339 ms, $F(1, 15) = 48.69$; $p < .005$; $\eta_p^2 = .8$]. Importantly, there was a significant interaction of pass-head congruency and stimulus quality [$F(1, 15) = 5.36$; $p < .05$; $\eta_p^2 = .26$]. The effect of pass-head congruency was larger when stimulus quality was reduced (63 ms) than when it was normal (27 ms). The congruency effects with normal stimulus quality, $t(15) = 5.28$, $p < .01$ and with reduced stimulus quality, $t(15) = 4.30$, $p < .01$ were each significant on their own.

Error rates. Participants made fewer errors when a congruent head orientation and pass direction was shown than when the head and pass directions were incongruent (0.3% vs. 2.6%), $t(1, 15) = 5.80$; $p = .03$. They also made fewer errors when stimulus quality was good than when it was poor (0.9% vs. 2.4%), $t(15) = 4.51$; $p = .05$. The interaction of these two factors revealed no significant interaction [$F(1, 15) = 1.70$; $p = .2$; $\eta_p^2 = .1$].

Discussion

Experiment 4 replicated our previous finding that responding to the direction of a pass is delayed when the passer is depicted with a head orientation incongruent to the pass direction. Also, a reduced stimulus quality delayed participant's responses. Importantly, these two effects produced an overadditive interaction. This interaction had a significant effect on response time, which is the main dependent variable in speeded tasks. The interaction did not show a significant effect on error rates, but at the least a similar interaction was numerically present in error rates as well, so a speed–accuracy trade-off can be ruled out as the cause of the interaction's effect on response times (cf. Figure 7). According to additive factors logic, this result forces us to conclude that the influence of irrelevant head orientation exerts its impact at a perceptual stage of processing.

Experiment 5

Experiment 5 attempts to complement the conclusion of Experiment 4. If we want to argue that the effect of incongruent head orientation operates at a perceptual stage of information processing, we need to show as well that the effect is additive to experimental factors that operate at other stages of processing. Some preliminary hints for the independence of the feint effect from response selection/execution stages of processing can be derived from the observation that the feint effect in prior experiments was independent of the response set, that is, whether the responses did (Experiment 1) or did not (Experiment 3) overlap spatially with the head orientation of the model. Yet, according to additive factors logic, a more systematic manipulation of post-perceptual stages

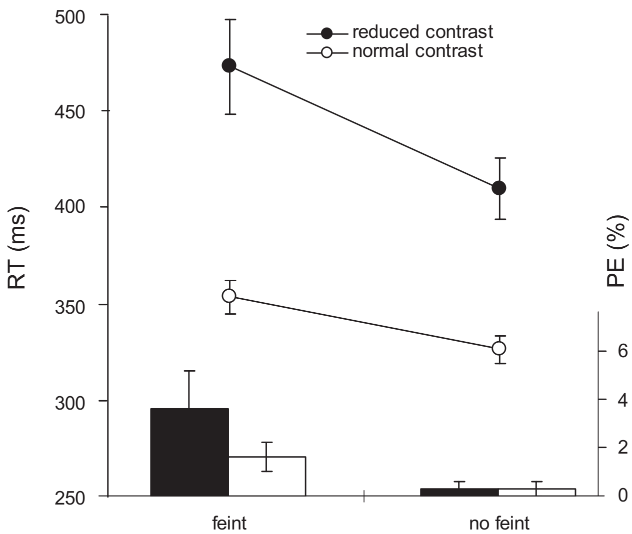

Figure 7. Experiment 4. Reaction times and percentages of errors as a function of stimulus quality and pass-gaze congruency. Filled circles indicate reaction times for stimuli with reduced brightness, whereas unfilled circles indicate reaction times to stimuli with normal brightness for feint and nonfeint trials. Filled columns indicate percentages of errors in responding to stimuli with reduced brightness, whereas unfilled columns indicate percentages of errors in responding to stimuli with normal brightness.

within the same experiment is warranted. In Experiment 5, we used a standard manipulation of the response selection stage, namely stimulus–response (S-R) congruency.

For this purpose the task was modified slightly (cf. Figure 8). Participants were instructed to respond to the color of the ball (either red or green) with a left or right button press, such that, for example, a red ball required a left button press and a green ball required a right button press.[3] This task creates conditions where the location of the ball (to the left or right of the person shown in the stimulus) was either on the same side as the required response (e.g., a red ball to the left of the stimulus person) or on the opposite side (e.g., a red ball to the right of the stimulus person). We expected that responses would be faster when stimulus location and response match than when they do not match (i.e., a spatial Simon effect). It is widely accepted that spatial Simon effects originate from the response selection stage (Hommel, 1995; Lien & Proctor, 2000; Simon & Berbaum, 1990; Simon, Mewaldt, Acosta, & Hu, 1976). We expected that the spatial Simon effect would be additive to the effect of correspondence of head orientation and pass direction, provided that our inference is correct that the former effect occurs at the response selection stage and the latter effect occurs at the perceptual stage.

Remarkably, this manipulation rendered not only head orientation but also pass direction task irrelevant. At first glance, the literature on top-down attentional control may suggest that neither an influence of pass direction nor one of head orientation should be expected because the top-down task set focused on color (Folk, Remington, & Johnston, 1993). However, irrelevant stimulus features affect performance as long as they match the top-down selected codes used to discriminate between alternative responses (Ansorge & Wühr, 2004). Here, these response codes are spatial, namely left and right. Thus, there is reason to predict that the position of the ball, the direction of passing, and the orientation of the head, which can all be described on the left-right dimension, will leave a trace in performance. If we find an effect of correspondence between the direction of passing and head orientation even though they are both nominally task irrelevant, we can infer that both head orientation and pass direction are encoded automatically.[4]

This experimental setup allowed for assessing the functional dissociation of the feint effect and the Simon effect in another way, namely regarding the sequential modulations of the two effects. First, the Simon effect is normally reduced after a trial containing a Simon-like interference (e.g., Stuermer et al., 2002), whereas this was not the case for the feint effect in Experiment 1. Experiment 5 allows us to confirm this dissociation. Second, Experiment 5 represents what Egner (2008) called a factorial task-crossing approach because any given trial contains two types of congruency. Consequently, we can study whether there are sequential effects across different types of congruency (Kunde & Wühr, 2006). Specifically, does an incongruent Simon trial reduce the feint effect in the next trial, and conversely, does a feint trial reduce the Simon effect in the next trial? If such relations were reflected in the data, it would suggest that similar mechanisms are involved in controlling both types of interference. However, if there are no such cross-task effects, it would suggest that different mechanisms are involved in controlling these different types of interference (Egner, 2008).

Method

Participants. Sixteen psychology students from the TU Dortmund, Germany (two male, all right-handed; mean age 22.9 years), took part in this experiment in partial fulfillment of a course requirement. All participants reported normal or corrected-to-normal vision. None of them had participated in any of the previous experiments.

Apparatus, stimuli, and procedure. The stimuli, apparatus, and procedure were the same as in Experiment 1, with one exception. This time, participants were required to react to the color of the ball that the player held in his hands. Each response was a single key press on a standard computer keyboard carried out with the index fingers of both hands. For this purpose, the color of the ball was changed to either red or green using the GNU Image Manipulation Program, version GIMP 2.4.5. The S-R mapping was counterbalanced across participants.

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[3] The manipulation of the balls' colors also involved a manipulation of their brightness and contrast with the background. Such potential differences were controlled for, however, by the counterbalancing of the S-R mappings.

[4] This inference is supported by an experiment, not reported here, where participants responded to the head orientation and had to ignore the direction of passing. Responding was delayed when head orientation was incongruent to the task-irrelevant pass direction, which suggests that pass direction was processed automatically.

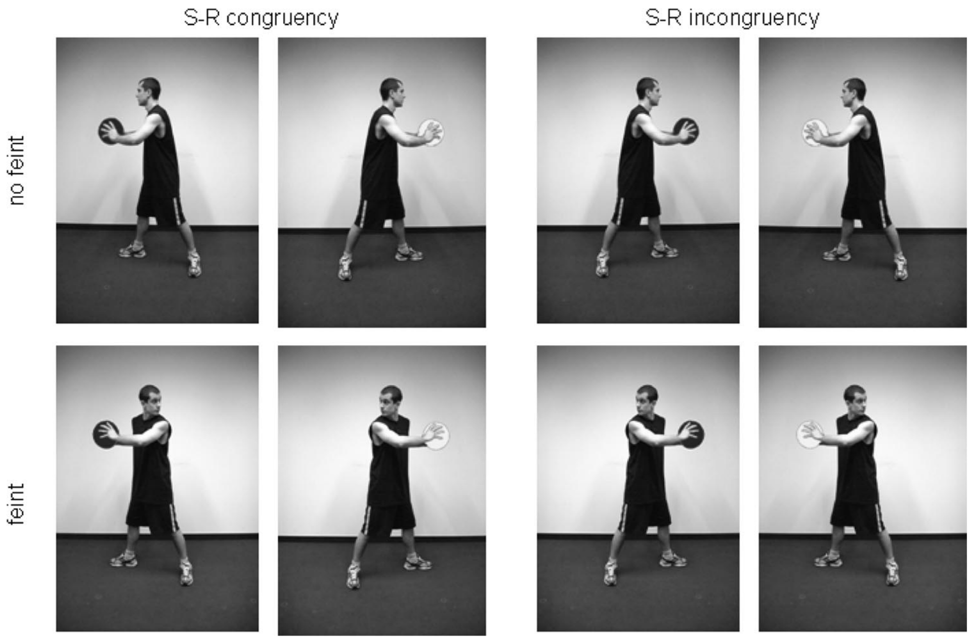

Figure 8. Stimuli in Experiment 5. Stimuli were identical to those in Experiment 1 with one alteration. The color of the ball the player is holding in his hands was changed into either a dark red or a light green. Participants responded to the color of the basketball while ignoring the direction of the pass and the orientation of the head of the player. The colored ball corresponded with the side of the required response button in S-R congruent trials and did not correspond with the side of the response button in S-R incongruent trials. In these examples a dark red ball required a left response and a light green ball required a right response. The head orientation of the model person either corresponded or did not correspond with the direction of pass.

Results

RTs below 100 ms were excluded as anticipations, and RTs higher than 1000 ms were excluded as outliers (4.5% of the data). The RTs and error rates were then submitted to an ANOVA with factors of pass-head congruency and Simon-type congruency.

Response times. Response times with a congruent orientation of head and pass (439 ms) were faster than those for incongruent conditions (461 ms), [$F(1, 15) = 13.55$; $p < .01$; $\eta_p^2 = .43$]. Also, the mean RT to a spatially (Simon-type) congruent trial (434 ms) was faster than the mean RT to a spatially incongruent trial (465 ms) [$F(1, 15) = 14.50$; $p < .01$; $\eta_p^2 = .46$]. Importantly, there was no interaction of these factors ($F < 1$, cf. Figure 9).

Error rates. Participants made nonsignificantly fewer errors with an incongruent compared to a congruent direction of head and pass [2.5% vs. 3.0%, $t(15) = 1.15$; $p = .2$], while they made significantly more errors on spatially incongruent compared to spatially congruent trials (4.6% vs. 1.2%, $t(15) = 3.94$; $p = .001$). As for RTs, there was no interaction between these factors ($F < 1$).

Analysis of sequence effect. Another ANOVA with the factors pass-head congruency, Simon-type congruency, pass-head congruency in trial $n - 1$, and Simon-type congruency in trial $n - 1$ was conducted. In the analysis of RTs, the interaction of Simon-type congruency in trial $n - 1$ and Simon-type congruency reached significance [$F(1, 15) = 30.02$; $p < .01$; $\eta_p^2 = .67$], showing that the Simon effect was reduced after a Simon-incongruent trial (cf. Figure 10). However, replicating the results of Experiment 1, there was no effect of an incongruent pass-head direction in the preceding trial on the feint effect [$F(1, 15) = 1.47$; $p = .2$; $\eta_p^2 = .09$, cf. Figure 10]. Also, all other interactions were nonsignificant (all $p > .2$), which shows that no across-congruency type effects were present. Thus, a feint in trial $n - 1$ did not reduce the Simon effect in the current trial, just as a Simon-incongruent trial in trial $n - 1$ did not reduce the feint effect in the current trial. The same data pattern was apparent for error rates. A sequential modulation of the Simon effect ($F(1, 15) = 10.71$; $p = .005$; $\eta_p^2 = .42$) was observed for the interaction of Simon-type congruency in trial $n - 1$ and trial n. No other interaction reached significance.

Discussion

Experiment 5 showed that spatial S-R congruency exerts an impact on RT (i.e., the Simon effect) that is additive to the effect of faking. This result suggests that the effect of faking occurs at a stage other than response selection. This finding supports the conclusion of Experiment 4 that the fake effect has a perceptual locus. The functional dissociation of the Simon effect and the fake effect is corroborated in another respect. Whereas the Simon effect was subject to sequential modulation, the feint effect was not. Moreover, there were no sequential effects across congruency types: spatially incongruent trials did not reduce the feint effect in the next trial, and feint trials did not reduce the Simon effect in the next trial. It thus appears that these two congruency effects arise from, and are controlled by, functionally dissociable processes.

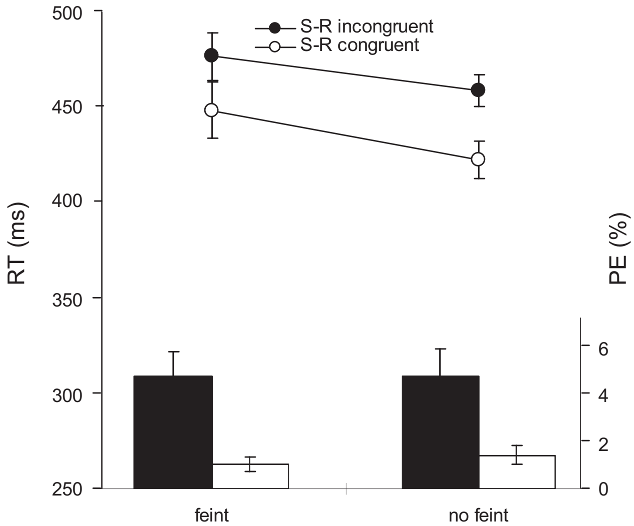

Figure 9. Reaction times and percentages of errors as a function of spatial (Simon-type) S-R congruency and pass–gaze congruency. The color of the ball and the required response button were S-R congruent in 50% of the trials (S-R congruent trials = colored ball and response button are on the same side), whereas the remaining trials were S-R incongruent. Filled circles indicate S-R incongruent trials, whereas unfilled circles indicate S-R congruent trials. Filled columns indicate percentages of errors for S-R incongruent trials, and unfilled columns indicate percentages of errors for S-R congruent trials.

Experiment 6

Experiment 6 provides a final assessment of the processing stage relevant for the fake effect by means of a method known as the "locus of slack" logic. The logic makes use of the psychological refractory period (PRP) paradigm. In the PRP paradigm, participants have to perform two speeded tasks in close temporal succession. Task 1 is often (and is in the present study) a speeded response to the pitch of a tone. Task 2 is another speeded task, in our case the pass direction discrimination task employed in the present Experiments 1–4. The typical finding is that with a decreasing time interval between the two task stimuli (the so-called stimulus onset asynchrony, or SOA), responding in Task 2 becomes more difficult (as signified by longer RTs). This effect is known as the PRP effect proper (Welford, 1952). The common explanation of this effect is that the response selection in Task 2 cannot start before the response selection of Task 1 has been completed. Hence, with a short SOA response, selection in Task 2 has to wait (cf. Figure 11). In other words, when the SOA is short, there occurs a waiting period, a so-called slack, after perceptual processing in Task 2 (which is assumed to run parallel with other processes in Task 1). The interesting prediction is as follows: If an experimental factor in Task 2 lengthens the perceptual stage, this will not have an effect on RT in Task 2 at a short SOA because under these conditions the lengthening of the perceptual stage occurs while Task 2 has to wait anyhow. However, with a long SOA, response selection has not to wait in Task 2, so a lengthening of the perceptual stage will also directly lengthen RT to Task 2. By contrast, experimental factors in Task 2 that affect information processing at the response selection stage or later will have identical effects at all SOA levels because lengthening of processing is insurmountable after the presumed slack. In a nutshell, experimental factors that affect the perceptual stage in Task 2 will show up at long, but not short, SOA. Experimental factors later than the perceptual stage will affect responding at all SOAs. This admittedly complex but well-accepted logic has been successfully applied many times to isolate the loci of various experimental factors

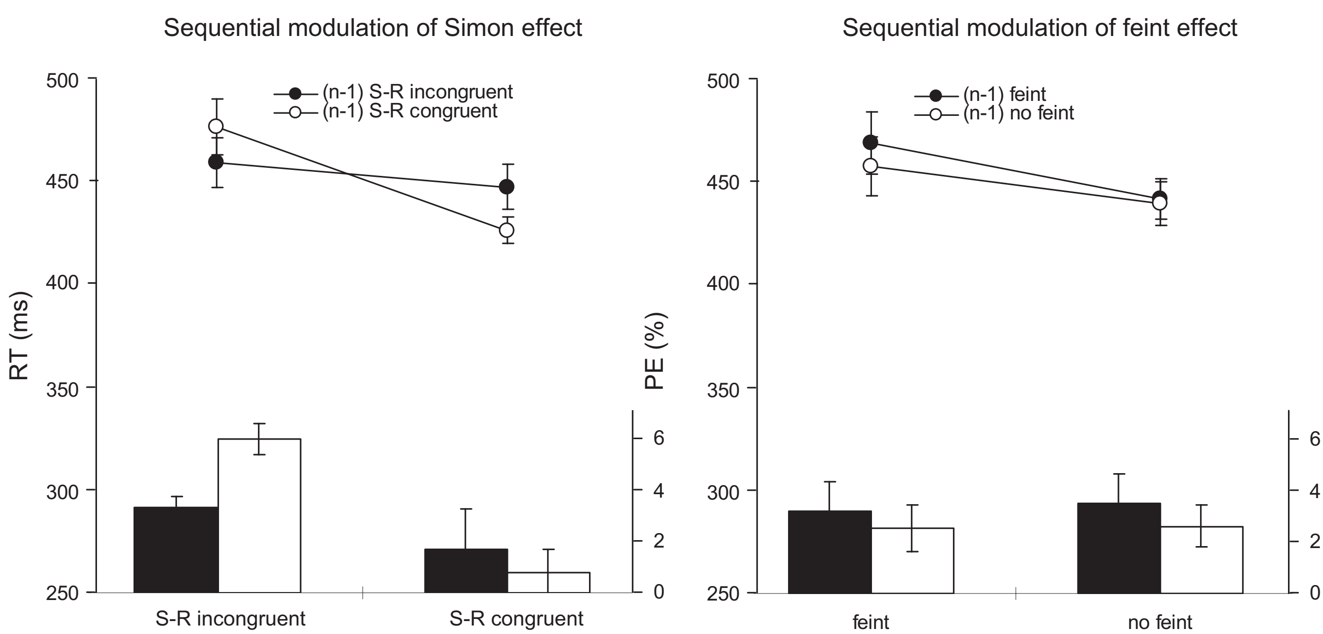

Figure 10. Response times and percentages of errors as a function of spatial (Simon-type) S-R congruency in trial *n* and trial $n - 1$ (left panel) and as a function of pass-gaze congruency in trial *n* and trial $n - 1$ (right panel).

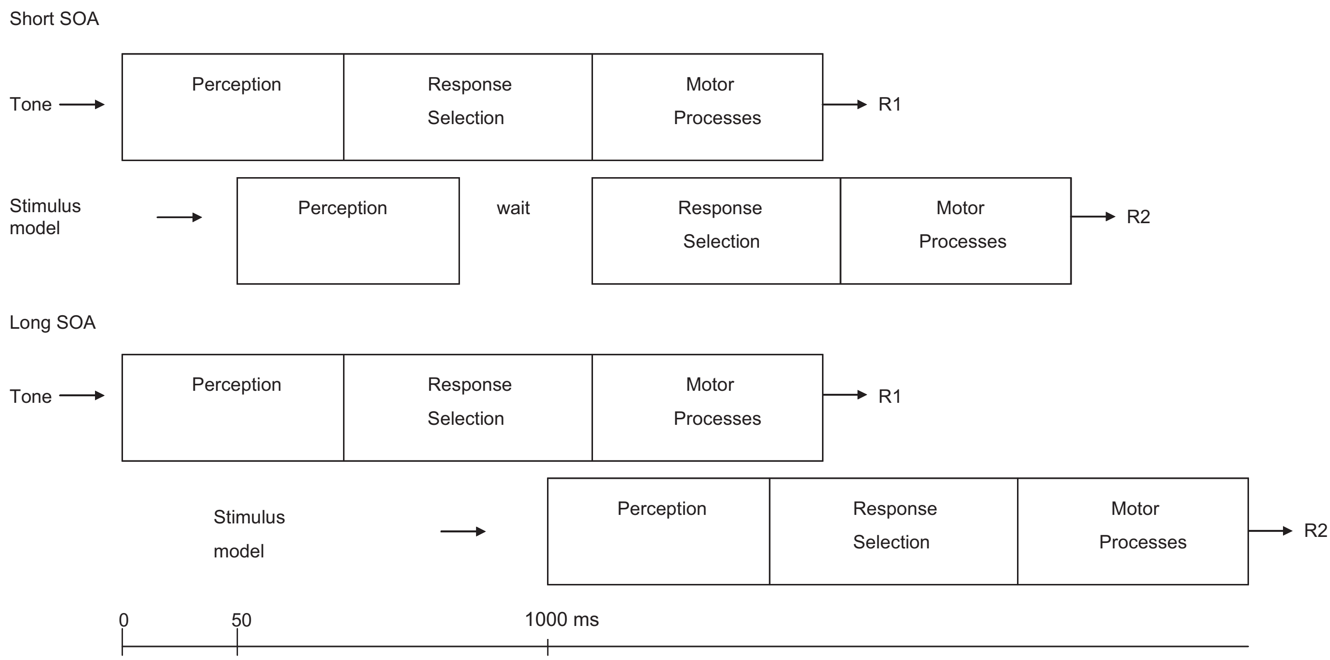

Figure 11. Locus of slack logic. Two stimuli are presented either in rapid succession (short SOA of 50 ms) or with a gap between (long SOA of 1000 ms).

(Paelecke & Kunde, 2007; Kunde et al., 2007; McCann & Johnston, 1992; McCann, Remington, & Van Selst, 2000; Miller & Reynolds, 2003; Pashler, 1984; Pashler & Johnston, 1989).

To apply the locus of slack logic for isolating the processing stage of the fake effect, we used the pass direction discrimination task with and without incongruent head orientations in Task 2, while a tone discrimination task served as Task 1. The stimuli in both tasks were separated by SOAs of 50, 500, or 1000 ms. If the incongruence of pass direction and head orientation lengthens the perceptual stage of processing, this should have an effect at a long SOA but not at a short SOA. If, however, the effect has a post-perceptual locus, it should have an equal effect on all SOAs.

Method

Participants. Sixteen psychology students (14 female, two male, mean age 24.8 years) from the TU Dortmund, Germany, took part in this experiment in partial fulfillment of a course requirement. None of them had participated in any of the previous experiments. Each participant provided written informed consent and attended a single experimental session lasting about 45 minutes.

Procedure and design. After a fixation cross of 250 ms, a high or low tone was presented (1000 Hz or 250 Hz, presented binaurally via headphones at approximately 40 dB) for Task 1. After a variable stimulus onset asynchrony of 50 ms, 500 ms, or 1000 ms, a picture of a basketball player was presented for Task 2. The picture of the basketball player remained on the screen until a second key press was registered. Participants were instructed to first respond as quickly and as accurately to the pitch of the tone with a button press of the index finger or middle finger of the left hand for Task 1. The tone-response mapping was counterbalanced across participants. Then, they had to respond to the pass direction of the basketball player with the index and middle fingers of the right hand for Task 2. Each participant was tested in one practice block and four experimental blocks, with each block consisting of 120 trials. Each trial had one of 24 possible configurations defined by combinations of (a) two tones (high vs. low), (b) three SOA stages (50, 500, and 1000 ms), and (c) four congruency conditions (view left-movement left; view left-movement right; and vice versa) repeated five times. The order of the trials was randomized separately for each block.

After each trial, participants received immediate feedback about the correctness of their answers. If there was an error, the word "Fehler" (German for "error") appeared on the screen for 500 ms. If both responses were correct and were given in the right order, no comment was presented on the screen, and the next trial began immediately with the appearance of the fixation cross.

Data analysis. Only RTs for trials in which both responses were correct (correct answer and correct order) were analyzed further. A trial was marked as an error (1) when the judgment of the pitch was wrong, (2) when the judgment of the direction in which the player was passing the ball was wrong, or (3) when responses were given in the wrong order. RTs below 200 ms were excluded as anticipations, and RTs higher than 2000 ms were excluded as outliers (1.7% of the data).

Results

Task 2

Response times. An ANOVA with the factors pass-head congruency (congruent vs. incongruent) and SOA (50 ms, 500 ms, 1000 ms) was run (cf. Table 1). This analysis revealed that responding was on average slower when head orientation and pass direction were incongruent compared to when they were congruent [601 ms vs. 587 ms; $F(1, 15) = 8.5$; $p = .01$; $\eta_p^2 = .4$]. Also, RTs were faster for longer SOAs [$F(2, 30) = 390.21$; $p < .001$; $\eta_p^2 = .96$]. Although the interaction of congruency and SOA was not significant [$F(2, 30) = .60$; $p > .5$; $\eta_p^2 = .04$], planned *t* tests at each SOA level revealed that there was a significant effect of congruency at the SOA of 1000 ms [$t(15) = 2.76$; $p < .02$], whereas there was no significant effect at SOAs of 50 ms [$t(15) = 1.30$; $p = .21$] and 500 ms [$t(15) = 1.24$; $p = .23$].

Error rates. Participants made fewer errors with congruent compared to incongruent head orientation and pass direction [$F(1, 15) = 5.71$; $p = .03$; $\eta_p^2 = .5$]. No other effect was significant.

Task 1

Response times. An ANOVA with the factors pass-head congruency (congruent vs. incongruent) and SOA (50 ms, 500 ms, 1000 ms) showed that RTs decreased slightly with increasing SOA [$F(2, 30) = 2.95$; $p = .07$; $\eta_p^2 = .2$]. No other effect reached significance.

Error rates. The only significant effect was that of SOA [$F(2, 30) = 22.13$; $p < .005$; $\eta_p^2 = .5$].

Discussion

Experiment 6 used the locus of slack logic to scrutinize the processing stage of the fake effect. The results were generally in line with a perceptual locus of the effect. The feint effect in Task 2 was significant with the long SOA, whereas it was smaller and in fact not significantly different from zero with shorter SOAs. The results were not as clear as desired because the interaction of SOA and the fake effect in Task 2 was not significant. What could be the reasons for the lack of significance? Apart from an increased noise level in the data attributable to the introduction of a dual task, one problem is that the basic fake effect is already small under single-task conditions, which leaves little room for reduction at shorter SOAs. In other words, the underadditive interaction might become more apparent when the basic fake effect is larger. To explore this possibility, we split the sample of participants into those with small and large fake effects at the SOA of 1000 ms, the condition in the present experiment that comes closest to single-task conditions (median split). While there was no interaction of SOA and pass-head congruency in the participants with small fake effects, there was a reliable *underadditive* interaction in those participants with large fake effects [$F(2, 14) = 4.66$; $p < .03$; $\eta_p^2 = .40$]. For these participants, the 43-ms fake effect at the SOA of 1000 ms was significant [$t(7) = 6.05$; $p < .001$], whereas neither the 3-ms effect at the SOA of 500 ms [$t(7) = .35$; $p > .70$] nor the 22-ms effect at the SOA of 50 ms approached significance [($t(7) = 1.74$; $p > .12$]. So, apparently, when there is sufficient room for variation of the fake effect, the predicted underadditive interaction with SOA manifests itself in a significant manner. Still, future research should test the robustness of this data pattern when the basic fake effect is experimentally enlarged, for example, by using pictures with degraded stimulus quality, for which the fake effect is also enlarged (cf. the size of the fake effect under such conditions in Experiment 4).

Table 1
Mean Reaction Times and Percentages of Errors (in Parentheses) for Task 1 and Task 2 In Experiment 6 for Pass-Head Congruent and Incongruent Trials With SOAs of 50, 500, or 1000 ms

	Task 1			Task 2		
	SOA			SOA		
	50 ms	500 ms	1000 ms	50 ms	500 ms	1000 ms
Feint	767 (6.3)	784 (3.0)	826 (2.5)	901 (4.5)	519 (4.8)	382 (3.4)
No feint	760 (6.4)	776 (2.7)	819 (2.1)	887 (3.8)	512 (3.0)	362 (3.4)

General Discussion

The present study constitutes a first step toward understanding the cognitive processes that underlie fake effects in sports. A paradigmatic fake situation, the head fake in basketball, was translated into an experimental task. Participants had to judge whether a model basketball player would pass a ball to the left or to the right. The incongruence of the model's head orientation and pass direction delayed participants' responses. Experiment 1 showed that this effect is remarkably robust. It occurred independent of the response speed, the type of the previous trial (fake vs. no fake), and practice. Experiment 2 gathered further evidence for the fact that head orientation is the driving variable for the fake effect under investigation. Further experiments aimed to identify the underlying mechanism of the fake effect. It occurred independently of the response set (Experiment 3) and of the spatial correspondence of stimulus location and response (Experiment 5). By contrast, the fake effect did depend on the quality of the stimulus image (Experiment 4), and it was possible to remove it through high temporal overlap with another speeded response task (Experiment 6). These results very consistently suggest that the fake effect originates from a perceptual stage of processing and that it is independent of the response selection and motor execution systems.

Costs and Benefits of the Experimental Strategy

The transfer of a typical sport situation to a simple laboratory task comes with both benefits and costs. Of course, the situation in the laboratory task is simplified in many respects compared to the real sport situation. One obvious limitation is that we studied just one fake situation. As noted in the introduction, there are many other kind of fake situations in basketball and in other sports. Although the basic structure of the fake situation—a relevant action of the actors that is accompanied by another misleading fake action—appears similar for all sorts of fakes, it still needs to be shown by future research that the inference effects observed here transfer to other fake situations as well. Another limitation already mentioned concerns the use of static displays. First of all, with every two-dimensional stimulus presentation, be it a static image or a video, certain types of information, such as oculomotor and binocular depth cues, are lost, unlike in a real-world situation. Although films and static images both contain static depths cues, only films have the power to retain dynamic depth cues such as optic flow and movement parallax. More relevant in the present context, there might also be movement cues (such as inferred movement energy or certain step patterns) that differentiate fake from nonfake actions. These were not available from the static images used in the present study. As noted in the introduction, however, Sebanz & Shiffrar (2009, Experiment 1) have shown that for basketball novices, static cues suffice to detect fake passes in basketball. In fact, for basketball novices, fake detection performance was almost the same irrespective of whether static images or dynamic videos were presented. Only basketball experts seemed to additionally rely on information available from videotaped actions. It is therefore tenable to assume that for the nonexpert observers studied here, all information used to discriminate fake from nonfake actions is conveyed by static images. Of course, this assumption has to be tested empirically by using dynamic displays and studying basketball experts, an issue that was beyond of the scope of the present study. On a more general level, it has been shown that presenting the end point of a movement suffices to produce similar interference effects as presenting the entire movement (Stuermer, Aschersleben, & Prinz, 2000), which also points to the importance of postures compared to movement cues as such.

The potential costs of static images are accompanied by benefits. Most notably, it was possible to apply some standard inferential tools of cognitive psychology to this practical situation. Moreover, the structural similarity of the present task with other types of interference tasks (such as Stroop and Simon tasks) allowed us to explore whether both effects are constrained by similar factors, such as sequential modulations or decay of irrelevant stimulus codes. Yet, only a combined research strategy based on laboratory tasks and realistic sport tasks will lead to practical consequences in the end.

Processing Locus of the Fake Effect

Perhaps the most surprising result of the present study was the lack of evidence for motor priming by the head orientation of the model. In fact, no empirical evidence was found for an impact of head direction on the observers' response system in any of the experiments. On one hand, this finding accords with similar observations showing that social cues such as gaze direction affect performance independent of response-related effects such as the spatial Simon effect (Zorzi et al., 2003). Consequently it has been suggested that social cues are processed by an encapsulated processing system (Baron-Cohen, 1984). Evidence for a motor-related locus of the feint may be found under situations in which the stimuli contain actual movement information, which, for methodological reasons, was not the case in the present study. Observing a movement may more readily activate the motoric system than observing a posture does (Aglioti, Cesari, Romani, & Urgesi, 2008; Calvo-Merino, Glaser, Grezes, Passingham, & Haggard, 2005, 2006). For example, Sebanz and Shiffrar (2009) reported an expert advantage over novices in fake detection when videos rather than static slides served as stimuli. This result led them to conclude that only dynamic stimuli activated the experts' motor system to facilitate fake detection, though an expert's advantage may also be attributable to perceptual expertise (Canal-Bruland, van der Kamp, & van Kesteren, 2010). This conclusion is certainly a topic for further research. In any case, the use of static images per se appears to be an unlikely reason for not observing a motor-related locus of the feint effect because ample evidence shows that the perception of static images of human postures has the power to prime corresponding motor structures in the observer under appropriate conditions (e.g., Liepelt, von Cramon, & Brass, 2008; Liepelt, Prinz, & Brass, 2010; Vogt, Taylor, & Hopkins, 2003).

An issue for more detailed future examination concerns the precise mechanisms that drive feint effects and were identified here as being "perceptual" in nature. At present, we suggest two possibilities of such a perceptual processing locus: First, an incongruent head orientation might pose a kind of input selection problem such that it becomes harder to discriminate the relevant stimulus feature (pass direction) from the irrelevant one (head orientation). After all, selection is only necessary in incongruent cases, whereas in congruent cases, the processing of both relevant and irrelevant information converges to the same response. Perhaps the present feint effect falls into a broader class of perceptual context effects. For example, Oberfeld and Hecht (2008) observed that judgments of the point in time when an approaching object is going to collide with the observer are biased by irrelevant distractor objects such that a late-arriving distractor object results in earlier time-to-contact judgments about a target object. Similarly, a pass to the left in our studies may appear not to be aimed as far "leftward" if a distractor object (the head) is oriented to the right. This may in effect make it harder to generate a "left" response. Second, visual attention has to be oriented to specify the spatial location of an object (the position of the ball in our case) (e.g., Treisman & Gelade, 1980). The model's head orientation or direction of gaze might automatically prompt a shift of visual attention in that direction (e.g., Ansorge, 2003). This initial orienting of visual attention would render it harder to specify the location of the ball because doing so would require a reorienting of visual attention in the opposite direction, which, as is known from the premotor theory of attention, is costly to initiate (Rizzolatti, Riggio, Dascola, & Umiltà, 1987). Which of these two (not mutually exclusive) alternatives is correct must be determined by future research.

One may wonder whether there is something special about an irrelevant head orientation as compared to, for example, an irrelevant color word in the Stroop task or simply an irrelevant arrow pointing in a certain direction. From a practical perspective, it is almost trivial to say that there is something special about irrelevant body cues: They are under control of the actor whether or not the interference that they cause for an observer is similar to the interference observed in a Stroop task. However, there are also empirical hints to a special impact of body-related cues. For example, pictures of a human actor throwing a ball orient observers' attention in the direction of the throw (a possible mechanism of the feint effect, as explained above), whereas very similar geometric shapes do not (Gervais, Reed, Beall, & Roberts, 2010). Also, the impact of irrelevant words in the Stroop task or the impact of irrelevant arrows in a left-right button pressing task is reduced when these irrelevant features caused interference in the preceding trial (Kerns et al., 2004; Kunde & Wühr, 2006). Yet, the impact of irrelevant head orientation is always the same, irrespective of whether head orientation caused conflict in the preceding trial (Experiments 1 and 4). Both findings suggest that social cues such as head orientation are particularly powerful cues to direct visual attention. Moreover, whereas in a standard Stroop task overlap both of irrelevant and relevant stimulus features (S-S) and of irrelevant stimulus features and responses (S-R) cause interference (De Houwer, 2003), the feint effect seems to be based on interference of the S-S type alone. Although this debate has not yet been settled theoretically, some findings hint at a special status of irrelevant body cues.

Practical Implications

If we accept that the present experimental setup addresses some relevant aspects of the feint effects encountered under realistic sport scenarios, the present results have certain practical implications regarding instructions and strategy training. As Experiment 1 showed, a feint attempt delays responding independent of whether the observer has just previously encountered a feint. Consequently, there is no reason to recommend the use of feint actions only sparsely (with certain time intervals between feint attempts) during play. This conclusion is complemented by the observation that practice did not change the effect systematically. Of course, the amount of practice was rather limited in the present experiments, and it is important to show whether, for example, extended basketball practice has the power to reduce fake effects. This project is currently underway. Preliminary results suggest that expert basketball players do in fact show a markedly reduced fake effect compared with basketball novices. Thus, although the novices in the present study did not have the means to suppress the impact of irrelevant head orientation, such means might develop with extended practice. Comparisons of experts and novices are always subject to interpretation in terms of self-selection mechanisms (i.e., those sportsmen who are able to ignore fakes are more likely to become expert basketball players). Therefore, it is certainly an important project to test whether extended practice by novices has a moderating impact on fake effects.

Of practical relevance are all aspects that may change the size of the feint effect. Factors that increase the size of the effect are particularly relevant for attackers to increase the benefits of the fakes they produce, while factors that decrease the effect are particularly relevant for defenders who want to get rid of feint effects that may be imposed on them. Of particular interest are those influences that can be conveyed by verbal instruction, which is probably a trainer's most immediate means to improve players' performance. What the present experiments show is, first, that an unspecific instruction to ignore fakes, which was used in all of the present experiments, does not help to get rid of the negative impact of fakes. This finding basically fits with recent evidence showing that observers cannot efficiently prepare themselves for an upcoming incongruent event in a spatial compatibility tasks (Wühr & Kunde, 2008). Indeed, one may wonder whether such instructions might even increase the detrimental impact of fakes. For example, Kleinsorge (2009) has shown that negative, but to-be-ignored, information (pictures of negative valence) can have a more distracting impact when these pictures are cued in advance than when they occur unexpectedly. Therefore, an unspecific instruction not to "fall into the trap" of the opponent is unlikely to be very efficient and might even be counterproductive. If anything, instruction should refer to the means that may help to reduce the fake effect. In view of the perceptual locus of the feint effect suggested by the present results, these means may at best relate to the perceptual intake of information. For example, Experiment 4 showed that the fake effect more than doubles when the stimulus quality is poor. To reduce the impact of fakes, it might be particularly important to maintain high stimulus quality, for example, by preventing peripheral instead of central vision of the attacker. Instructions like "focus on the ball, ignore the offender's head" might be helpful. Given the lack of evidence for a motor component of the fake effect, these strategies might be more helpful than instructions such as "don't respond too quickly to the offensive player's actions." In fact, if we consider the time course of the fake effect observed in Experiment 1, such instruction might be detrimental. Here, we found that the fake effect increases the later the motor response is emitted.

To conclude, the present study took a step toward systematically investigating the factors that mediate fake effects in basketball. The results suggest that the head fakes we studied here alter perceptual processing of fake observers, whereas they leave motor-related processes unaffected. These findings can help to create training procedures or instructions to modify the effectiveness of such fakes in sports. Of course, every procedure derived from such laboratory research must be evaluated in more realistic game situations.

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