

Unwanted effects in aiming actions

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Unwanted effects in aiming actions

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Für Mietta und Odin

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Chapter 1

General introduction



Introduction

Imagine you are a crossbow marksman, your name is William Tell, and you live in the early 14th century in a small village somewhere in the Swiss Alps. One day your tyrannical overlord, the High-Reeve Gessler orders you to shoot an apple off the head of your own son at a distance of 25 meters; if you refuse or miss altogether, both you and your son will be put to death. While holding your crossbow, preceding the trigger pull you may have thoughts going through your mind and generate self-instructions such as “*shoot as accurately as possible, but no matter what: do not miss,*” and – of course – you absolutely wish “*not to shoot my son.*” As you are convinced that your intentions are right and that you have no other choice, you look along the front sight of your crossbow and see that it fluctuates around the target. You see the areas where the bolt should not end, that is, you look at the area next to and above the apple and you look at the beautiful face of your son. It feels like the crossbow weighs tons as you slowly put more and more pressure on the trigger

It does not take a great deal of sophistication to imagine the difficulty that William Tell is facing in this situation. Could we give him now, 700 years later, advice that might increase the chance of a happy ending? It is not only common sense but also suggested in today’s (sport) psychological literature that performance decrements may be expected if athletes use negative self-talk involving negative and self-defeating thoughts and statements (e.g., Murphy, 1994; Van Raalte et al., 1995; Woolfolk, Parrish, & Murphy, 1985). Negatively worded instructions or negative images may even lead to so-called *ironic effects*. That is, someone may ironically do precisely what s/he was instructed not to do (e.g., Beilock, Afremow, Rabe, & Carr, 2001; De la Peña, Murray, & Janelle, 2008; Wegner, Ansfield, & Pilloff, 1998; cf. Wegner, 2009). For example, one may hit the golf ball into the pond following the persistent wish not to let that happen (Wegner et al., 1998) or Tell’s (self-)instruction “*don’t miss*” may ironically increase the probability that he does precisely what he intend to avoid: miss!!! Note, such ironic effects are not the only unwanted effect that may occur in the broad variety of aiming tasks. One may also *overcompensate* and do the opposite of what should be avoided (Beilock et al., 2001; De la Peña et al., 2008). For example, to avoid shooting within reach of the keeper a penalty taker may miss the goal as a direct consequence of weighing the possibility of

shooting close to the keeper (cf. Trommershäuser, Maloney, & Landy, 2003). As such, overcompensation may occur only for that matter to avoid ironic effects and would be caused by the same negative instruction as ironic effects.

Although, we are too late now to advise William Tell to avoid negatively worded (self-)instructions it is of both theoretical and practical relevance to gain more insight into the conditions under which ironic effects and overcompensation, or more general, *unwanted effects* occur in the perceptual-motor domain. Theoretically, research into unwanted effects in this domain is important for at least two reasons. First, one of the hypotheses in this thesis is that there is one theoretical explanation for both ironic and overcompensation effects. For tasks in the cognitive domain, in which most research was done, overcompensation is not possible. The instruction not to think of a white bear could lead to thinking of that bear, which is somewhat ironic, but there is no logical opposite of the white bear of which one could think (which would be necessary to overcompensate). In perceptual-motor tasks, in particular in aiming tasks, both phenomena could occur making these tasks suitable for investigating the abovementioned hypothesis. Second, in the explanation for ironic (unwanted) effects attention processes play an important role. Research on tasks in the perceptual-motor domain offers possibilities to obtain direct information about these attention processes, at least when it concerns visual attention. Practically, insights into unwanted effects, such as in missing a penalty and undershooting a golf putt, could provide starting points for giving advice on how to prevent such errors to trainers and performers in sports and other high-achievement settings such as fire fighting, armed forces, and police work.

In the remainder of this introduction the theoretical background of ironic effects and overcompensation is described followed by a brief description of the role of attention in aiming tasks, the core research questions and the scope of the present thesis.

Ironic effects in the perceptual-motor domain

Evidence for ironic effects is mainly found in the cognitive domain, especially in research concerning the mental control of thoughts (e.g., Clark, Ball, & Pape, 1991; Kulik & Perry, 2000; Purdon & Clark, 2000; Rassin, Meckelbach, & Murris, 2000; Wenzlaff & Bates, 2000; Wenzlaff & Wegner, 2000; Wegner, 1989, 1994, 2009; Wegner, Schneider, Carter, & White, 1987). For example, Wegner and colleagues (1987) asked participants to indicate (i.e., ring a bell)

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when they thought about a white bear. While one group was instructed to avoid, and therefore, suppress thinking about white bears, the other group was recommended to let those thoughts happen. Results showed that the suppression group indicated thinking about white bears more often compared to the non-suppression group implying that suppressing a thought produces a subsequent preoccupation with the thought. Overall, findings concerning ironic effects in the cognitive domain of thought control indicate that negative (avoidance) instructions may lead to a sort of rebound effect of that which one wants to avoid (cf. Wegner, 1989), making it ironically more resistant to getting banished out of the mind.

Instructions, either given by someone else or by a person him- or herself, will normally lead to intentions directly in line with these instructions. This implies that negatively formulated instructions normally will lead to negative intentions. Particularly in the perceptual-motor domain such negative intentions will easily occur, as in this domain it is often of crucial importance not to miss, not to shoot in the wrong direction (think of Wilhelm Tell or a footballer having to take a decisive penalty). Despite the obvious relevance, there is relatively little research into the effects of negative instructions (and hence, intentions) in the perceptual-motor domain. One of the few studies providing evidence for the occurrence of ironic effects in the perceptual-motor domain is the study by Wegner and colleagues (1998) who demonstrated ironic effects in a golf putting task. Participants were instructed to putt as accurately as possible without specification or with the additional instruction to make sure not to hit the ball past the hole (the target). Results indicated that under the negatively worded instruction, participants were more likely to hit the ball past the hole than following the “accurate” instruction.

The theory of ironic mental processes

Research concerning the occurrence of ironic thoughts or actions is mostly based on the theory of ironic mental processes (Wegner, 1989, 1994, 1997). According to this theory mental control of thoughts and actions is achieved through the sensitive interaction of two complementary cognitive processes: (A) an intentional and conscious *operating process* and (B) an unconscious *ironic monitoring process*. Whereas the operating process is controlled and geared toward obtaining a desired goal state, the ironic monitoring process is automatic and directed toward insuring that interference with achievement of the goal state

is identified by the operating process. Although unconscious, the monitoring process proceeds uninterrupted as long as effort is being directed toward achieving a desired goal state. The role of the controlled operating process is to replace any unwanted thought or feeling with a more appropriate task-related thought or feeling. The operating process is initiated when an unwanted thought or feeling is perceived by the automatic search process which monitors the contents of consciousness for any trace of unwanted thoughts or feelings. Thus, when an unwanted thought is detected, the controlled operating process “kicks in” and replaces this item. For example, if trying to relax during a preshot routine (e.g., in golf putting or football penalty shooting), the monitoring process would initiate the operating process by directing awareness to muscles that remain tensioned, followed by actions to readjust and reinitiate a more comfortable scenario (see also Janelle, 1999).

However, when attentional resources are taxed, the controlled replacing process, which requires attention for successful initiation, can be compromised – resulting in the contents of the monitoring process (unchecked by ‘the operator’) now being prioritized (through ‘the monitor’) leading to the manifestation of the exact thoughts and performances that are to-be-avoided, thus, leading to ironic effects.

Overcompensation

As already mentioned, ironic effects are not the only unwanted effect that may occur, negative instructions and intentions may also lead to overcompensation. Studies that were initially intended to shed light on ironic effects in the perceptual-motor domain indeed also found opposite effects (Beilock et al., 2001; De la Peña, et al., 2008). Beilock and colleagues tested Wegner's theory in a golf putting task with suppressive imagery. In this study participants were asked in one condition to imagine the ball rolling to the intended target, but to be particularly careful not to imagine leaving the ball short of the target. Results showed that participants in such imagery suppression conditions tended to putt the ball significantly past the hole. De la Peña and colleagues also tested participants' putt performance following the instruction to make the putt, but it was emphasized that the putt should not be left short of the target. In addition, such instructions were coupled with different cognitive load conditions to induce ironic effects, that is, four groups of participants were exposed to each of one cognitive, visual, auditory, and self-presentation/incentive load conditions,

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respectively. In the absence of finding average ironic effects, they found that participants who followed the negatively worded instruction significantly overshot the target compared to participants who followed a neutral instruction, irrespective of load, indicating that in such settings it is more likely to overcompensate than to show ironic effects. De la Peña, et al. (2008) concluded that the instruction "not to undershoot" creates an implicit message that it is better to 'go wrong' on the side opposite of that particular instruction (i.e., to overshoot the target). This would lead to an overcompensation of movement tendencies rather than to ironic effects. It is suggested here that these findings are still in line with Wegner's (1989, 1994) theory. Specifically, it is suggested that overcompensation, although unwanted, may be intention driven (see Beilock et al., 2001). In line with Wegner's theory the desired goal state would then be to do the opposite of the to-be-avoided. The monitoring process does not find thoughts or actions that are inconsistent with this desired state making it unnecessary for the operating process to come into action to replace such actions.

Attention and unwanted effects

In the explanation by Wegner (1989, 1994, 1997, 1998, 2009) attention plays an important role. The person strives for a certain goal or state. Information that helps to achieve that goal, the desired state, gets attention by virtue of activity of the controlled process. Information that would prevent achievement of the goal is detected by the automatic monitoring process, and subsequently replaced by information that is relevant for achieving ones goal.

Negative instructions (do not think of a white bear, do not shoot close to the keeper) bring information into the system that is detected by the automatic search process to be further processed by the controlled process. This information draws attention, and attention is also needed to get rid of the information. Therefore, according to Wegner's theory the chances on ironic effects will specifically increase when attentional resources are already taxed. For the perceptual-motor domain this means that negative instructions will lead to unwanted effects in situations in which the performer has to execute multiple tasks simultaneously, or in which task execution itself needs much attention (cognitive load), or in which there is much pressure (decisive penalty, Wilhelm Tell, high emotional load).

As mentioned, there is little research into ironic effects in the perceptual-motor domain, which is surprising given that in that domain attention can be easily manipulated as well as properly measured, at least when it concerns visual attention. Especially, measuring of attention is more difficult in the cognitive domain.

In perceptual-motor tasks, as in aiming actions, what is visually attended to (i.e., fixations on a target) normally dictates where one aims as there appears to be a strong link between gaze behavior and performance (e.g., Vickers, 1992; Vickers & Adolphe, 1997; Vickers & Williams, 2008; cf. Williams, Davis, & Williams, 1999; Williams, Singer, & Frehlich, 2002). Therefore, from a theoretical standpoint, it is worthwhile to explore where the (visual) attention (i.e., gaze fixation) is directed before an ironic aiming action is performed, in other words, whether gaze behavior is also directed to locations (sources of information) which are not appropriate for optimal task execution.

Normally, in aiming at far targets, the sequence from intention to attention to aiming action is followed. When ironic effects occur this chain seems to be interrupted between the intention and (visual) attention or between (visual) attention and the aiming action. For example, when football players are urged not to shoot within reach of the keeper, gaze behavior may possibly be directed to the keeper followed by shots closer to the keeper, implying that the chain is interrupted between intention and gaze behavior. As for the second possibility, it may be that gaze behavior is initially in the intended direction (e.g., the open goal space, thus, not ironic) while the aiming action is ironically in the ‘wrong’ direction (i.e., the penalty taker looked at the open goal space but ironically shot in the hands of the keeper). This would imply that the chain is interrupted between gaze behavior and aiming action.

Another question that arises following Wegner’s theory is whether, in the perceptual-motor domain, only negatively formulated instructions lead to ironic effects. For example, following instructions not to shoot close to the keeper, the keeper is detected by the monitoring system, that is, the keeper draws attention and must be replaced by the controlled process by items that relate to the desired goal, namely, the ball and the goal. It is not unlikely that just mentioning the keeper in a positively formulated instruction, for instance, pass the keeper, already draws attention to the keeper with all its ironic consequences. In short, it is worth investigating whether only negative instructions lead to ironic effects.

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Furthermore, it is well known that longer fixation durations on the appropriate target lead to better performance in aiming on this target (cf. Williams et al. 1999). More specifically, it is shown that a relatively long final gaze fixation on a target (sometimes called quiet eye) is a characteristic of higher levels of (sport) performance (cf. Vickers, 2007). For example, when elite basketball players prepare for an accurate shot, either a free throw or a jump shot, their gaze is fixated on a single location on the hoop and the (final) fixation is maintained on that location for an optimal duration (e.g., Harle & Vickers, 2001; Oudejans, Koedijker, Hutter, & Bakker, 2005; Vickers, 1996). Such research revealed that an optimal result in aiming requires sufficiently long gaze fixations on one specific target. In line with the previous example, when football players shoot penalties under negative instructions, do they still direct their gaze long enough on the open goal space (i.e., the appropriate target) for accurate aiming or do they look too long (i.e., longer fixation durations) at the keeper?

Finally, in the literature concerning ironic effects it is suggested that cognitive and physical load, emotional processing, internal and external distractions, and physiological arousal are all likely to increase the probability of ironic effects as those conditions would occupy attentional resources (Janelle, 1999; Wegner, 1989, 1994, 1997, 2009; Woodman & Davis, 2008). Specifically the assumption that emotional load increase the chances on ironic effects is relevant for the perceptual-motor domain. Aiming tasks are often executed in high pressure circumstances (penalties, golf putts, basketball free throws, etc.) in which one may expect performers to also give themselves negative self-instructions (“Please don’t miss that ball”). If pressure and anxiety indeed increase the chances on ironic effects this could mean that performance break down under pressure may partly be explained by ironic processes.

Scope of the thesis

Overall, the present thesis aims to provide more insight into the role of (visual) attention and different constraints in unwanted effects in several perceptual-motor tasks. In *Chapter 2* ironic effects in gaze behavior and shooting performance on an indoor penalty-kicking task were investigated. Specifically, football players were invited to kick penalties within 1 s to a back-projected video screen and under different instruction conditions. Initial gaze fixations directed on the free goal space, on the keeper, or on the areas next to the goal were monitored and shooting performance was categorized as a hit or a miss,

that is, shots further away from or closer to the keeper, respectively. This study examined the question whether the wish not to miss may play a role in wasting a penalty and whether shots closer to the keeper would be accompanied by gaze directed at the keeper.

In *Chapter 3* we examined unwanted effects in a golf putting task. In this study participants putted golf balls under mental load (on a carpeted indoor green) to a target (i.e., sprayed mark in the size of a regular golf hole) under three experimental instructions, that is, one baseline instruction and two instructions with the core to avoid putting too short or too long. Putting performance was used to distinguish groups showing good performance, overcompensation or ironic effects in both experimental instructions. Gaze fixation durations on the hole, the areas in front of the hole and behind the hole were analyzed for these groups to explore whether the relationship between gaze behavior and performance still remains strong when unwanted effects occur in a task in which neither time constraints nor potentially distracting elements in the field of view (e.g., a keeper) play a role.

Next, in *Chapter 4* we examined the effects of differently worded instructions in evoking unwanted effects to find out whether the negative formulation in the instructions (“do not”) is essential or whether positively worded instructions can also evoke ironic effects in the perceptual-motor domain. In brief, in a similar setting as in the experiment described in Chapter 2, football players shot penalties under a baseline instruction, a negatively worded (“not-keeper”) instruction and a positively worded instruction mentioning the keeper (“pass-keeper”). In addition, we tested whether gaze fixation duration on the keeper mediates the relationship between the instructions and ironic shooting performance.

In *Chapter 5*, football players took penalties with and without instructions to avoid shooting within reach of the keeper. In addition, we extended the time for task execution from 1 s to 1.5 s in the simulated penalty setting to examine whether the penalty takers used sufficiently long fixation durations on the target, the open goal space in this case, in order to prevent the occurrence of ironic effects.

Finally, in *Chapter 6* participants threw darts under both positively and negatively worded instructions and under conditions with and without anxiety. Anxiety was manipulated by using an indoor climbing wall on which participants took positions by holding themselves high and low on the wall. As

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anxiety is known to place a large burden on attentional resources and to play a crucial role in performance decrements in sports we investigated whether the combined effects of anxiety and negatively worded instructions would lead to increased level of ironic effects.

Chapter 7 – the Epilogue – provides a brief summary and a discussion concerning theoretical and practical implications of the main results in this thesis.

In order to put you out of your misery concerning Tell's vehement challenge we assume that he was used to performing under pressure, that he may have used a positively worded (self-)instruction dominated by the word apple, preceded by a long gaze fixation duration along the front sight on the sole target followed by the most wanted performance: he hit the apple with one shot.

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Chapter 2

Penalty shooting and gaze behavior: Unwanted effects of the wish not to miss

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Abstract

The intention to avoid a thought or action may ironically increase the tendency to engage in this thought or action. We show that in penalty shooting in soccer unwanted effects are mediated by changes in gaze behavior. Generally, in far aiming, people look at where they aim and they aim at where they look. With an indoor soccer-penalty task we first confirm this relationship. Next, we show that negatively formulated instructions not to shoot within reach of the keeper or outside the goal often direct the player's gaze to the area to-be-avoided, resulting in more unsuccessful shots. When visual attention is drawn to the to-be-avoided area there is probably not sufficient time to redirect attention to the proper location necessary for accurate aiming. These findings indicate that unwanted effects following the persistent wish not to miss may increase the probability of missing a decisive penalty.

Introduction

It is a common phenomenon that the intention to avoid a thought or action may paradoxically increase the tendency to have this thought or engage in this action. (e.g., Bargh, Chen, & Burrows, 1996; Janelle, 1999; Wegner, 1994; Wegner, Ansfield, & Pilloff, 1998). A well-known example from the realm of thought suppression is that the instruction or intention ‘not to think of a white bear’ immediately leads to thoughts of precisely that which one wishes to avoid: a white bear (Wegner, Schneider, Carter, & White, 1987). Evidence for such unwanted ironic effects not only comes from the domain of thought control (Wegner & Erber, 1992), but has also been found in the perceptual motor domain. For instance, novice golf putters overshoot relatively more putts when instructed not to overshoot (Wegner et al., 1998; see also Beilock, Afremow, Rabe, & Carr, 2001).¹

We suggest that unwanted effects may also manifest themselves in the penalty kick in soccer. Even though the penalty taker is generally assumed to have the advantage, a surprisingly large percentage of penalty kicks are missed, also among top players (about 25%, Kropp & Trapp, 1999). Clearly, missing a penalty may have far-reaching consequences, especially when it is part of a decisive shootout at a big tournament, such as the European or World Championships. In contrast to Germany, for example, who won four out of five shootouts, the national squads of England and the Netherlands have a particularly poor reputation in penalty kicking (only one win out of six and five shootouts, respectively). Infamously, during the European Cup semifinal in 2000 against Italy, the Dutch took six penalty kicks and missed five of them. It is possible that unwanted effects following the persistent wish not to miss also played a role in missing these decisive penalty kicks.

One explanation for unwanted effects in perceptual-motor actions, which forms the core of Wegner’s (1994) theory of ironic processes, is based on the notion that successful thought management relies on two cognitive processes: One controlled and the other automatic. The controlled process is initiated when an unwanted thought comes to mind. The role of the controlled process is to replace

¹ It should be noted that Beilock et al. (2001) also found that individuals may overcompensate in performance in an attempt to avoid a particular outcome. For example, in a golf putting task instructions not to hit the ball past the target resulted in putts being left significantly short of the target.

any unwanted thought with a more appropriate task-related thought. In contrast, the automatic search process scans the contents of consciousness for any trace of unwanted thoughts. When an unwanted thought is detected, the controlled system then “kicks in” and replaces this item. When attentional resources are taxed (e.g., high pressure situations), the controlled replacing process, which requires attention for successful initiation, can be compromised, resulting in the manifestation of unwanted thoughts and/or less-than-optimal performances.

Bargh et al. (1996) provide an alternative explanation, which is based on Williams James’ principle of ideomotor action that the mere act of thinking about a behavior may increase the tendency to engage in that behavior. Bargh et al. (1996) propose that thinking about a behavioral response may have a priming effect on the likelihood of engaging in that response, even when the person is trying to avoid that behavior.

There are also suggestions in the literature that unwanted effects in perceptual-motor actions may be mediated by unwanted effects on attention (e.g., Dugdale & Eklund, 2002; Janelle, 1999). In aiming actions, such as the penalty kick, this would imply that negatively phrased intentions not to hit a specific target ironically draw attention to the target that the player is trying to avoid. This conjecture can be tested directly by measuring gaze behavior during action, as there appears to be a strong link between attention and gaze behavior (e.g., Deubel & Schneider, 1996; Henderson, 2003; Itti & Koch, 2001; Kowler, Anderson, Doshier, & Blaser, 1995). Negatively phrased intentions to avoid an undesired target may draw visual attention to that target, resulting in the detection of information that is less appropriate for the accurate execution of the action. If there is no opportunity to redirect attention (i.e., gaze) to more appropriate sources of information, task execution is predominantly based on less useful information, causing an inaccurate action. Specific circumstances preventing the redirection of attention may include high cognitive or physical load leading to a depletion of attentional resources, as is suggested in the theory of ironic processes (Wegner et al., 1998). But if in the perceptual-motor domain unwanted effects are mediated through visual attention, then time constraints may also play a role, as even a brief excursion of attention to information that is less useful for accurate aiming may leave the player insufficient time to exploit the more appropriate information sources. This idea is supported by findings of, for instance, Beilock, Bertenthal, McCoy and Carr (2004) who demonstrated

that limited performance time may indeed affect one's ability to regulate attention in the most effective manner.

So far, it has never been investigated directly whether unwanted changes in gaze, and hence, attentional focus (e.g., Henderson, 2003; Kowler et al., 1995), occur and to what extent they can account for the unwanted effects in perceptual-motor actions. We therefore investigated gaze behavior and shooting accuracy of indoor penalty kicks to a video projected goal and keeper (see Figure 2.1) that was executed under a moderate time constraint. In the task of accurately aiming a penalty kick in soccer less appropriate (e.g., the goalkeeper, or outside the goal) and more appropriate (i.e., the open goal space) gaze locations can be distinguished (see also Van der Kamp, 2006). It is now generally accepted that when aiming at a far target, a gaze fixation on the target location precedes the aiming action. Generally people look at where they aim, and vice versa, they aim at where they look (e.g., Land & Furneaux, 1997; Vickers, 1996; Williams, Singer, & Frehlich, 2002). In the first experiment we set out to confirm these observations for the task under investigation by instructing participants to either attend to the goalkeeper or to the open goal space (called 'space' in the remainder of this paper), and comparing subsequent shooting performance. We hypothesized that performance would be better when shooters look at the space rather than the goalkeeper. More specifically, given the time constraint we expect that a first glance at the keeper would not leave enough time to redirect visual attention to the space long enough for accurate aiming. Establishing the relations among instruction, gaze behavior and performance provides an important prerequisite for sensible interpretation of the results of the second experiment in which we investigated whether the instruction to avoid the goalkeeper ironically draws visual attention to the goalkeeper resulting in poor kicking performance.

Experiment 1

Method

Participants and Design. Seven male amateur football players (mean age = 20.9 years, SD = 1.77) with an average of 11.6 years of football experience (SD = 2.64) participated in this experiment. All participants were actively engaged in football competition at the time of the study and practiced, on average, twice a

week (totaling three hours). Informed consent was obtained, and rights of participants were protected in this and the second experiment. Participants took 30 penalties without run-up in each of three conditions aimed at directing attention to different areas of the display: (1) just shoot as well as possible: no-instruction condition; (2) shoot as well as possible and make sure to attend to the goalkeeper: keeper condition; (3) shoot as well as possible and make sure to hit the open (goal) space: space condition. As we wished to determine a baseline measure (both with respect to gaze behavior and performance) unaffected by additional instructions, Condition 1 was always the first condition. The other two conditions were counterbalanced.²

Apparatus and Procedure. Video clips of a stationary goalkeeper anticipating a penalty kick were shown on a large screen (2.29 by 2.27 m) with a projection size of 1.95 x 1.01 m (projected goal size = 1.65 x 0.55 m; see Figure 2.1). The clips were made with a digital video camera (Sony XJ 2000) from the perspective of a penalty taker. The projected goalkeeper stood either in the middle, or 0.5 or 1.0 m to the left or right from the middle of the goal (yielding five different positions) to force the shooters to vary their shooting direction (rather than to always shoot to the same side). This goal was reached as there was a clear relation between position of the goalkeeper and shooting direction, that is, when the keeper stood to the left most shots were taken to the right (252 of the 270), and vice versa (220 of the 229). This pattern of results was similar for the different instructions and participants.

Each of the five clips was repeated six times leading to 30 fully randomized trials. Before these experimental trials were executed the player was given time to get used to the set-up and the foam football ($\varnothing = 19$ cm, 131 gram; see Figure 2.1) that was used to take the penalties. A foam ball was used to keep the screen in-tact. At each presentation the player shot the foam football from a distance of 2.48 m at the video projection that was visible for one second. At that distance the visual angle subtended by the projected goal (height) was about 9°, hereby closely simulating the real image size of the goal and goalkeeper for a real

² We checked for order effects as well as practice effects (by comparing the first 10 trials per condition with the last 10 trials). Although the analyses yielded some significant results, there were no systematic order or learning effects in this study (Experiments 1 and 2) that would favor our hypotheses.



Figure 2.1. Picture of the set-up.

penalty from 11 m. The player was instructed to make sure that the ball hit the screen within the 1 second that the projection lasted. Pilot testing had revealed that with 1 second participants just had about enough time to execute the task on time. With a projection lasting less than 1 second the number of trials for which the ball hit the screen too late increased considerably.

Gaze behavior was recorded using an Applied Science Laboratories (ASL) 501 eye-tracker system. The system works by collecting three pieces of information: displacement between the left pupil and corneal reflex (reflection of the light source from the surface of the cornea), position of eye in head, and position and orientation of head in space. The relative position of these features is used to compute visual point-of-gaze with respect to a pre-calibrated 9-point grid projected onto the scene plane. A simple eye calibration was performed to verify

point-of-gaze before each participant was tested. After calibration gaze location was superimposed onto the scene in the form of a positional cursor to highlight point-of-gaze. The video image of the scene including the point-of-gaze cursor was then stored using a video recorder for further analysis. The accuracy of the system was ± 1 degree visual angle. The calibration of the system was checked before each trial and if necessary the system was recalibrated (this rarely happened).

Data reduction. The ASL recordings were analyzed frame-by-frame at 50 Hz using a JVC BR-DV3000U digital video recorder from the moment the film clip appeared to the moment the ball entered the view of the scene camera after ball contact. As we wished to find out whether the instructions would draw visual attention to specific locations (particularly the keeper or the space), hereby limiting attention to other locations, trials were primarily coded as to whether the initial gaze fixation (≤ 120 ms) was to the keeper or the space. As mentioned, given the time constraint we hypothesize that an initial glance at the keeper would not leave enough time to redirect visual attention to the space long enough for accurate aiming. By determining the location of the initial fixation we could investigate this hypothesis. Sometimes the first fixation was outside the goal and sometimes there were no fixations on either of these locations, which resulted in two additional categories. To be precise, we noted the initial gaze fixation location: 1) the keeper, initial fixation on the keeper followed by further fixations on the keeper or on the space,³ 2) the space, initial fixation on the space followed by further fixations on the keeper or on the space,⁴ 3) extrinsic, first fixation outside the goal, 4) unclassified, neither of the above: gaze shifted rapidly (no fixations) among multiple locations within the goal area including the keeper. This analysis yielded frequency counts of trials per

³ It was possible to differentiate between initial fixations on the keeper followed by further fixations on the keeper ("keeper-keeper") and those followed by further fixations on the space ("keeper-space"). Analyses including this differentiation yielded similar patterns of results as the analyses without this differentiation. However, for a few of the individual analyses insufficiently high frequency counts remained after the differentiation, especially for the category "keeper-keeper" (in Experiment 2). Therefore, we only report the analyses without the differentiation. Nevertheless, it is important to know that in Experiment 1, 46% of the initial keeper fixations were followed by further fixations on the keeper (45%, 56% and 13% for the no, keeper, and, space instructions, respectively), while 54% were followed by further fixations on the space. In Experiment 2, 28% of the initial keeper fixations were followed by fixations on the keeper (32%, 28%, 17%, and 27% for the no, not-keeper, space, not-next instructions, respectively).

⁴ Note that initial fixations on the space were never followed by fixations to other locations. Thus, after an initial fixation to the open space gaze remained within the open space area throughout the trial.

individual per condition for which the primary gaze location was 1, 2, 3, or 4. An advantage of this frequency analysis is that individual patterns do not average out per condition. We were primarily interested in the occurrence of unwanted effects among individuals, rather than in the group as a whole. Per individual the frequencies per condition were analyzed using chi-square (χ^2) tests. As individual frequencies to locations 3 (extrinsic) and 4 (unclassified) were often not high enough to enter into the analyses, individual analyses were executed for locations 1 (keeper) and 2 (space) only. There was a high inter-observer agreement with regard to gaze behaviors for 90 trials of one participant when scored by a second independent observer, inter-observer agreement = 97%.

Shooting performance was obtained from ASL video-recordings by determining the location of the ball when it hit the projection screen. A penalty was considered 'successful' when it hit the goal within 1 s and out of reach of the keeper, operationalised as outside the real-size area of 2.96 x 2.48 m surrounding the keeper. A penalty was 'unsuccessful' when it hit the goal within 1 s inside the reachable area of 2.96 x 2.48 m surrounding the keeper, or next to or over the goal. Shots that hit the screen too late were excluded from the statistical analyses on shooting performance (5.5% of all shots; this will be discussed in the Discussion). For primary gaze location it was tested using χ^2 tests whether they were associated with different success rates. Scoring of shooting performance yielded an inter-observer agreement of 94% when a second independent observer scored 90 trials of one participant.

Results

As shown in Table 2.1 the instructions led to different initial gaze locations for the group, $\chi^2(6) = 151.9$, $p < 0.0001$, also when extrinsic and unclassified gaze behavior (negligible frequencies) were excluded from the analyses, $\chi^2(2) = 140.5$, $p < 0.0001$. Most important, for all individuals except participant 2 (see Table 2.1), it was confirmed that different instructions led to different gaze locations, $\chi^2(2) > 10.0$, $ps < 0.01$, implying that the overall results were not caused by only one or two extreme individuals.

Penalty shooting and gaze behavior

Table 2.1. Number of penalties with the gaze directed mainly at one of the four locations per participant and instruction condition in Experiment 1.

Particip.	instruction	Gaze location			
		keeper	space	extrinsic	unclass.
1	no-instr.	13	16	0	1
	keeper	25	5	0	0
	space*	12	11	0	0
2	no-instr.*	16	9	0	1
	keeper	16	14	0	0
	space	12	16	2	0
3	no-instr.	11	19	0	0
	keeper	21	9	0	0
	space	4	26	0	0
4	no-instr.	4	23	0	3
	keeper	23	5	0	2
	space	2	27	0	1
5	no-instr.	16	12	0	2
	keeper	28	2	0	0
	space	6	24	0	0
6	no-instr.*	6	23	0	0
	keeper	23	7	0	0
	space	2	28	0	0
7	no-instr.	12	18	0	0
	keeper	25	5	0	0
	space	2	28	0	0
Total	no-instr.	78	120	0	7
	keeper	161	47	0	2
	space	40	160	2	1

*One or more trials are missing because on those trials the gaze cursor was not visible on the video recordings. After such a trial the ASL system was immediately recalibrated.

To find out whether the differences that were found were in the expected direction (e.g., more initial looking at the keeper in the ‘keeper’ condition, and more to the space in the ‘space’ condition) separate analyses were done comparing the ‘no-instruction’ condition to the ‘keeper’ and the ‘space’

condition, respectively. It appeared that compared to the ‘no-instruction’ condition, in the ‘keeper’ condition more penalties had the keeper as primary gaze location and less penalties had the space as primary location, $\chi^2(1) = 60.5$, $p < 0.0001$. This was true for 6 of the 7 individuals, $\chi^2(1) > 9.5$, $ps < 0.01$.

In the ‘space’ condition the pattern of results was reversed. That is, for more penalties the primary focus was on the space and for less penalties it was on the keeper, $\chi^2(1) = 17.9$, $p < 0.0001$ (Table 2.1). This was confirmed for 5 of the 7 individuals, three $\chi^2(1) > 4.4$, $ps < 0.05$, two $\chi^2(1) > 2.4$, $ps = 0.06$ (see Table 2.1).

Table 2.2. Number of successful and unsuccessful penalties as a function of gaze location (keeper or space) per participant in Experiment 1.

Particip.	gaze loc.	successful	unsuccessful
1	keeper	20	26
	space	22	8
2	keeper	13	27
	space	30	9
3	keeper	5	27
	space	33	21
4	keeper	12	14
	space	42	13
5	keeper	18	26
	space	34	4
6	keeper	5	24
	space	40	18
7	keeper	17	18
	space	43	8
Total	keeper	90	162
	space	244	81

Furthermore, gaze location appeared to be closely related to the success of the shots (Table 2.2). Overall, penalties taken when looking at the space were significantly more often classified as ‘successful’, whereas penalties taken when initially looking at the goalkeeper were more often ‘unsuccessful’, $\chi^2(1) = 90.2$,

$p < 0.0001$. Again, most important, this was also true for all individuals, $\chi^2(1) > 6.5$, $ps < 0.05$.

These findings are only indicative of a strong relation between gaze and aiming location if most of the unsuccessful shots following a primary gaze at the keeper were within reach of the keeper rather than next to or over the goal. This appeared to be the case for 82% of the unsuccessful shots (i.e., 87%, 81%, and 76% in the no-instruction, keeper, and space conditions, respectively). When only these unsuccessful shots within reach of the keeper were included in the analysis of successful and unsuccessful shots, the pattern of results was the same: looking at the keeper led to more shots within reach of the keeper, while looking at the space led to more shots at the space, overall, $\chi^2(1) = 78.4$, $p < 0.0001$, and, again, for all individuals, $\chi^2(1) > 4.0$, $ps < 0.05$.

Experiment 2

Having established the close relation between gaze behavior and aiming accuracy in the indoor penalty task, we next set out to investigate how negatively formulated instructions affect gaze and aiming behavior in this task. Recall that the instructions in Experiment 1 were positively formulated. It is expected that negatively formulated instructions would induce unwanted effects in task execution, leading, for example, to more aiming and shooting within reach of the keeper when one is instructed not to shoot within reach of the keeper. Thus, if the conjecture that unwanted effects are mediated by gaze behavior is correct, then negatively phrased instructions to avoid shooting at the keeper or next to the goal would lead to more looking and shooting at these locations. Again, more specifically we hypothesized that given the time constraint initial fixations to locations other than the open space would leave insufficient time for a long enough fixation on the space to allow for accurate aiming. These hypotheses were tested in Experiment 2.

Method

Participants and Design. In the same setting as Experiment 1 ten male amateur football players (M age = 21.2 years, SD = 2.10) with 11.8 years of competition football experience (SD = 2.66) participated. All participants were actively engaged in football competition at the time of the study and practiced, on

average, twice a week (totaling three hours). Participants were instructed (1) to just shoot as well as possible: no-instruction condition; (2) to shoot as well as possible and make sure that the goalkeeper could not reach the ball: not-keeper condition; (3) to shoot as well as possible and make sure that they hit the open space: space condition; and (4) to shoot as well as possible and make sure not to shoot next to the goal: not-next condition. Note that the meaning of instructions 2 and 3 is identical, as both urge participants to shoot at the space. As in Experiment 1, Condition 1 was always the first condition. The other conditions were counterbalanced (see also Footnote 1). None of the participants had participated in Experiment 1.

Apparatus and Procedure. The apparatus, procedure and analyses were the same as in Experiment 1. Again, there was a high inter-observer agreement (obtained over 90 trials of one participant) with regards to determining gaze behaviors (96%) and shooting performance (98%).

Results

Just as in Experiment 1, the instructions led to significant differences in gaze location on group level, $\chi^2(9) = 121.6$; $p < 0.0001$ (Table 2.3). Given the small frequencies of trials with extrinsic and unclassified gaze behaviors it is important to note that this is also the case when only the gaze locations ‘keeper’ and ‘space’ were compared, $\chi^2(3) = 101.0$, $p < 0.0001$. Most important, different instructions led to significant differences in looking at the keeper or the space for all individuals, $\chi^2(3) > 7.5$, $ps < 0.05$ (Table 2.3).

To shed light on the direction of the differences that were found (which instructions led to which primary gaze locations), several pair wise comparisons were made between the conditions. First, it appeared that even though the negatively formulated keeper instruction urged participants to hit the space, it led to significantly less penalties during which the space was the primary gaze location and more penalties with the keeper as primary focus in comparison to the no-instruction condition, $\chi^2(1) = 9.0$, $p < 0.005$. This was true for 6 of the 10 individuals, $\chi^2(1) > 3.0$, $ps < 0.05$, one $p = 0.07$. Second, as before, overall the space condition led to more penalties with a primary focus on the space and less penalties with a primary focus on the keeper than the no-instruction

Penalty shooting and gaze behavior

Table 2.3. Number of penalties with the gaze directed mainly at one of the four locations per participant and instruction condition in Experiment 2.

Particip.	instruction	gaze location			
		keeper	space	extrinsic	unclass.
1	no-instr.	9	15	1	5
	not-keeper*	18	8	2	1
	space	8	17	3	2
	not-next	9	16	1	4
2	no-instr.	3	22	2	3
	not-keeper	8	21	0	1
	space	2	27	1	0
	not-next	8	14	0	8
3	no-instr.	10	16	3	1
	not-keeper	14	16	0	0
	space	7	23	0	0
	not-next	17	12	1	0
4	no-instr.	8	19	2	1
	not-keeper	15	11	4	0
	space	4	24	2	0
	not-next	13	13	3	1
5	no-instr.	28	1	0	1
	not-keeper	11	14	4	1
	space*	3	19	1	6
	not-next	14	9	3	4
6	no-instr.	6	23	1	0
	not-keeper	12	16	1	1
	space	5	23	0	2
	not-next	13	14	3	0
7	no-instr.	10	16	2	2
	not-keeper	17	8	4	1
	space	1	24	0	5
	not-next	10	12	6	2
8	no-instr.	14	13	1	2
	not-keeper	14	14	1	1
	space	3	27	0	0
	not-next	10	15	2	3
9	no-instr.*	8	21	0	0
	not-keeper	12	13	2	3
	space	1	28	1	0
	not-next	12	11	7	0
10	no-instr.	10	20	0	0
	not-keeper	17	7	1	5
	space	1	25	4	0
	not-next	5	18	5	2
Total	no-instr.	106	166	12	15
	not-keeper	138	128	19	14
	space	35	237	12	15
	not-next	111	134	31	24

*One or more trials are missing because on those trials the gaze cursor was not visible on the video recordings. After such a trial the ASL system was immediately recalibrated.

condition, $\chi^2(1) = 48.3, p < 0.0001$ (Table 2.3), which was confirmed for 5 of the 10 individuals, $\chi^2(1) > 6.0, ps < 0.05$. Most important, the direct comparison between the 'not-keeper' and the 'space' conditions (identical meaning, but differently phrased) revealed that the not-keeper instruction led to significantly less penalties during which the space was the primary gaze location and more penalties with the keeper as primary focus in comparison to the space instruction, $\chi^2(1) = 93.8, p < 0.001$ (Table 2.3). This was also true for all 10 individuals, $\chi^2(1) > 3.0, ps < 0.05$ (one $p = 0.058$). Regarding the second 'negative' instruction, the 'not-next' instruction, it should be noted that this instruction might have ironically drawn visual attention to areas outside the goal. Therefore, it is important to also include the 'extrinsic' gaze location in the analysis, even though the frequencies were not high (see Table 2.3). With all gaze behaviors included in the analysis it appeared that the not-next instruction also led to significant changes in gaze behavior compared to the no- instruction condition, $\chi^2(3) = 14.0, p < 0.005$. As can be seen in Table 2.3 it seems that the not-next instruction led to relatively more penalties with initial fixations outside the goal or with unclassified gaze behavior than the no-instruction condition (individual frequencies were not sufficient to allow separate analyses).

When looking at the open space, shots were again more often categorized as 'successful', whereas looking at the goalkeeper, outside the goal, or showing unclassified gaze behavior were associated relatively more often with 'unsuccessful' shots, $\chi^2(3) = 88.2; p < 0.0001$ (Table 2.4, bottom four rows). Most important, for the majority of the individuals, 7 out of 10, this was confirmed for looking at the space and the keeper, $\chi^2(1) > 3.5, ps < 0.05$ (see Table 2.4; individual frequencies of extrinsic and unclassified gaze behavior were too low to be included in the individual analyses). Additional analyses of the unsuccessful shots within reach of the keeper confirmed that looking at the goalkeeper was associated relatively more often with shots within reach of the keeper, while looking at the space led to more shots at the space. Again this was true for 7 of 10 individuals, $\chi^2(1) > 3.9, ps < 0.05$ (overall $\chi^2(1) = 43.8; p < 0.0001$).

In addition to the above observations there were relevant findings concerning extrinsic and unclassified gaze behavior and shots that hit the screen too late (see Table 2.4, bottom rows). First, of the 74 shots that were characterized by

Penalty shooting and gaze behavior

Table 2.4. Number of successful and unsuccessful penalties as a function of gaze location per participant in Experiment 2. 'Too lates' are included for the totals.

Partic.	gaze loc.	successful	unsuccessful	too late
1	keeper	21	21	
	space	43	13	
2	keeper	12	4	
	space	75	5	
3	keeper	15	30	
	space	40	25	
4	keeper	15	14	
	space	48	18	
5	keeper	29	25	
	space	29	14	
6	keeper	22	13	
	space	61	15	
7	keeper	19	13	
	space	33	27	
8	keeper	11	22	
	space	43	23	
9	keeper	10	20	
	space	55	17	
10	keeper	19	13	
	space	42	27	
Total	keeper	173	175	42
	space	469	184	12
	extrinsic	5	17	52
	unclass.	12	34	22

gazes outside the goal (extrinsic) 52 (70.3%) were too late (Table 2.4). Even if the large numbers of shots with the primary focus on the keeper and the space are excluded this frequency of too late shots was significantly larger than the number of 'too lates' following unclassified gaze behavior, $\chi^2(2) = 20.5$, $ps < 0.0001$. Second, of all the shots that were too late only 9% occurred while looking at the open space. 32.8%, 40.6% and 17.2% of the shots that were too late occurred while initially looking at the keeper, outside the goal, and when

gaze behavior was unclassified, respectively (Table 2.4), $\chi^2(3) = 31.3$, $p < 0.0001$. Thus, there were significant differences in the number of ‘too lates’ depending on initial gaze location.

Discussion

In the present study we show that in taking penalties to a projected goal and keeper unwanted effects are mediated by unhelpful changes in gaze behavior. We first established a strong relation between the shooter’s primary gaze direction and subsequent ball destination. Next, we showed that negative intentions (e.g., to avoid shooting at the keeper or next to the goal) ironically invited participants to look and aim at the to-be-avoided area more often. These results manifested themselves most clearly with respect to avoiding the keeper, but also the instruction not to shoot next to the goal ironically led to relatively more extrinsic and unclassified gaze behavior that apparently was associated with more misses than hits compared to the no-instruction condition (Table 2.4). These findings demonstrate that with negatively phrased instructions unwanted effects in penalty kicks may be triggered and that these effects are related to changes in gaze behavior.

Note that especially in the second experiment not all effects were evident for each and every individual. It is possible that for some individuals, initial unwanted effects washed out after several repetitions. Bear in mind that, in contrast to Wegner et al. (1998) who investigated one golf putt per participant, we investigated no less than 30 repetitions per condition and still found unwanted effects for the majority of the participants. Of course, it is also likely that not everyone is equally susceptible to unwanted effects. It would be interesting to find out what underlies these differences (i.e., psychological traits, attentional strategies or something else). Furthermore, our findings should, of course, not be taken to imply that on the field penalties are also always characterized by similar patterns in (gaze) behavior. For one, on the field time-constraints are different from those employed here; a penalty taker usually has much more time than one second. Furthermore, in “real-life” penalty taking there is often interplay between the penalty taker and the goalkeeper during which both try to conceal their true movement intentions. In this context it is important to note that the findings so far suggest that the goalkeeper does not

use the kicker's gaze fixations as an anticipatory cue (Franks & Hanvey, 1997; Savelsbergh et al., 2002, 2005), so that there is no need for the kicker to try to fool the keeper with his gaze behavior. Finally, our experiment did not even begin to approach the pressurized situations with which penalty takers are confronted when taking a decisive penalty in a nerve-racking shootout (see Jordet et al., 2006). In short, the generalizability of the reported findings to on-field penalty taking should be viewed with caution.

Nevertheless, our results fit well with recent findings by Van der Kamp (2006) concerning the different strategies a penalty taker can adopt. In penalty shooting there are generally two ways to approach a shot: The penalty taker can choose the target location in advance (e.g., shoot to the lower right corner) and disregard any action of the goalkeeper (keeper-independent strategy), or the penalty taker can choose the target location depending on the goalkeeper's actions during the run-up (keeper-dependent strategy; Kuhn, 1988; Van der Kamp, 2006). By examining on-field penalty shots in an experimental setting, Van der Kamp (2006) recently revealed that the keeper-independent strategy is linked to more accurate shot placement since the only information needed to control the aiming action is the information about the far target. In the keeper-dependent strategy, information about the keeper is needed first to choose the shooting side; only then the shooter can start searching for information necessary for accurate aiming. Dividing attention over information that is less (keeper) and more (target location) useful for the control of the aiming actions appears to compromise the quality of shot placement (Van der Kamp, 2006). This is in agreement with the current findings showing that 'keeper-independent' shots (looking at the space only) led to better performance than 'keeper-dependent' shots (also involving initial fixations at the keeper). Of course, it should be realized in this context that although each time the keeper was positioned in one of five different positions he remained stationary during a trial. As such, a 'keeper-dependent' strategy can only be narrowly defined with respect to the current experiments, not referring to a strategy depending on any movements of the keeper.

As for the underlying mechanisms of unwanted effects in the penalty kick, our findings do not unequivocally support either of the two explanations for unwanted effects presented in the introduction, ironic processes (Wegner, 1994) or priming (Bargh et al., 1996). Both the not-keeper and the not-next condition

involved a negative instruction concerning the to-be-avoided area, which may have elicited ironic processes as suggested in Wegner's (1994) theory. However, in both cases, the to-be-avoided area was also primed (Bargh et al., 1996) as 'goalkeeper' and 'next to the goal' figured prominently in the respective instructions. The mere fact of being (more) occupied with either the goalkeeper or the area next to the goal through the instructions may have directed gaze as well as aiming behavior towards these areas. To be able to tease apart these possible mechanisms in future penalty experiments it seems appropriate to use positive and negative instructions that prime the same areas (as was done for golf putting by Wegner et al., 1998: aim at the hole vs. do not aim past the hole; in both cases the hole is primed).

Whether the unwanted effects were the result of priming, inaccessible ironic processes, or other psychological processes, we now at least have an explanation at the behavioral level. Recall that participants executed the task with a specific time constraint: the ball had to hit the projection screen before the projection of the scene ended (within 1 second). This probably left insufficient time to redirect visual attention to the relevant location (space) after it was (ironically) diverted to an irrelevant location (keeper or next to the goal). This is supported by the finding that not just initial fixations to the keeper followed by further fixations to the keeper ("keeper-keeper"), but also initial fixations to the keeper followed by further fixations to the space ("keeper-space") led to less successful shots than fixations to the space only (see Footnote 4). Note that in Experiment 2, of the trials with initial fixations to the keeper 72% were accompanied by further fixations at the space (Footnote 4). Furthermore, although not discussed so far, it is striking that of the 33 shots that were too late in Experiment 1, 27 occurred when the initial gaze location was the keeper. Moreover, in Experiment 2 almost all shots (91%) that were too late occurred after looking at the keeper, next to the goal, or after having unclassified gaze behavior (Table 2.4). Together these findings demonstrate that not immediately looking at the space (the target area) left insufficient time for accurate aiming and shooting.

Our results also seem to confirm that unwanted effects do not necessarily have to occur under increased mental load, but rather depend upon the specific circumstances (e.g., time constraints) under which the task at hand is executed (Jordet et al., 2006; Beilock et al., 2001; Wegner et al., 1998). Most important, the current study shows that unwanted effects in the perceptual-motor domain,

particularly the penalty kick, are mediated by undesired changes in gaze behavior, and hence, attention. The intention to avoid a target may lead to (more) looking and aiming at precisely that which one wishes to avoid. The nerve-wrecking penalty shootout in football is often surrounded by negative thoughts or (self-)instructions directed at avoiding specific patterns of behavior (don't miss). It is important to learn to replace these negative thoughts about undesired targets by positive ones that direct attention to the desired target (e.g., hit the top corner of the goal) (Beilock et al., 2001). Trying to suppress negative thoughts is not a good strategy as it is as prone to the ironic effects as the negative thoughts themselves (Beilock et al., 2001; Janelle, 1999; Wegner & Erber, 1992). In sum, if soccer players are unable to approach a decisive penalty kick in a positive way with positive intentions, the persistent wish not to miss may ironically increase the probability that shooters do precisely what they intend to avoid, miss.

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Chapter 3

Unwanted effects in aiming actions: The relationship between gaze behavior and performance in a golf putting task

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Abstract

Objectives: Instructions to avoid an action may increase the tendency to engage in the action (ironic effects) or cause an undesirable increase in the opposing action (overcompensation). The aim of the study was to examine the relationship between gaze behavior and performance in a golf putting task when these kinds of unwanted effects occur.

Methods: Twenty seven participants performed an indoor golf-putting task with instructions to land the ball on the hole (neutral instructions), land the ball on the hole but avoid putting too short and land the ball on the hole but avoid putting too long. Order of instruction was randomized and both gaze behavior and putting performance were assessed.

Results: When participants gazed for longer at a specific area (in front, behind or at the hole) the ball was more likely to land in that area. Subsequent analyses confirmed a tight relationship between gaze behavior and putting performance when overcompensation occurred. For ironic effects such a tight relationship was only found when participants were instructed to avoid putting too short, but not when participants were instructed to avoid putting too long.

Conclusions: Overall the results make clear that changes in (visual) attention play a key role in unwanted effects. Consequences of the results for Wegner's (1994) theory of ironic processes are discussed.

Introduction

An instruction to avoid a thought or action may ironically increase the tendency to engage in the thought or action. That is, someone may do precisely that which s/he was instructed not to do (Beilock, Afremow, Rabe, & Carr, 2001; Wegner, Ansfield, & Pilloff, 1998). For example, instructions to avoid thinking about white bears tend to result in thoughts of white bears (Wegner, Schneider, Carter, & White, 1987) and an internal dialogue to avoid hitting the golf ball into the pond often ends with a splash (Wegner et al., 1998). Unwanted effects are not restricted to ironic effects. One may also overcompensate and do the opposite of what should be avoided. For instance, Beilock et al. (2001) demonstrated that instructions that urged participants to putt a golf ball accurately but not too far, led to a tendency to hit the ball short (i.e., to overcompensate).

An explanation for unwanted, ironic, effects is provided by the theory of ironic mental processes (Wegner, 1994). This theory is based on the notion that successful thought management relies on two cognitive processes, one automatic and the other controlled. The automatic process scans the contents of consciousness for any trace of unwanted thoughts. When an unwanted thought is detected, the controlled process is initiated to replace the unwanted thought with a more appropriate task-related thought. When attention resources are taxed, the controlled process may be compromised because insufficient attention capacity prevents the unwanted thought to be appropriately replaced. This may result in manifestation of unwanted thoughts or behavior.

The basis of Wegner's explanation of unwanted effects is changes in attention (cf. Janelle, 1999) so the aim of the current study was to increase understanding of attention changes that accompany unwanted effects in the perceptual-motor domain. Gaze behavior generally reflects direction of attention (e.g., Deubel & Schneider, 1996; Henderson, 2003; Itti & Koch, 2001; Kowler, Anderson, Doshier, & Blaser, 1995; Land & Furneaux, 1997) so we examined the relationship between gaze behavior and performance of a golf putting task when unwanted effects occur.

To formulate our expectations we assumed that instructions largely determine intentions. In aiming behavior the intention then determines what is visually

attended to in the environment and how (Bekkering & Neggers, 2002; Michaels & Carello, 1981). Visual attention subsequently determines where one aims, given that there is a strong link between gaze and aiming behavior (e.g., Bakker, Oudejans, Binsch, & Van der Kamp, 2006; Land & Furneaux, 1997; Vickers, 1992; Williams, Singer, & Frehlich, 2002). For instance, an instruction to land the ball in the hole should result in an intention to do exactly that, leading to gaze and consequently putting directed at the hole. Dual instructions to land the ball in the hole but certainly not past the hole may cause conscious or unconscious weighting of intentions, potentially leading to the intention to putt short (i.e., to overcompensate). Empirical evidence suggests that instructions indeed can cause participants to do the opposite of what they are urged to avoid (Körding & Wolpert, 2006; Trommershäuser, Maloney, & Landy, 2003). Consequently, overcompensation, although unwanted, may be intention driven (Beilock et al., 2001) so we expect a tight relationship between gaze direction and putting performance. For example, if the intention is to overcompensate when instructed not to overshoot the hole, then both gaze and the putting performance should be directed more to the area in front of the hole. In accordance with the theory of ironic processes there is, therefore, no mismatch between intended and actual behavior, making correction processes unnecessary and leaving the chain from intention to attention to aiming action unaffected.

Ironic effects, on the other hand, are by definition not intention driven. That is, they represent a mismatch between the behavior that was intended and the behavior that occurred. For ironic effects it is, therefore, not obvious whether a tight relationship should be expected between gaze direction and putting performance given that the chain between intention, attention, and aiming action is interrupted. It is unclear whether the chain is interrupted between intention and gaze behavior, or between gaze behavior and aiming action. That is, is the ironic aiming action preceded by ironic gaze behavior or is gaze behavior initially in the intended direction (thus, not ironic) but followed by an ironic aiming action? In line with suggestions in the literature (Dukdale & Eklund, 2002; Janelle, 1999), Bakker et al. (2006) found a tight relationship between gaze and ironic aiming behavior for experienced soccer players shooting indoor penalties. When the soccer players were asked not to shoot within reach of the keeper ("not-keeper" instruction) or outside the goal ("not-next-to" instruction), it seemed that the players' gaze as well as their shots were more often directed

to the areas to be avoided. However, in the penalty kick the keeper plays a complex role in terms of visual attention of the penalty taker. It is possible that the ironic effects found by Bakker et al (2006). were due to the fact that a keeper was present and that there was not enough time (players had to shoot within one second) to redirect attention to the free goal space after the keeper had attracted their attention. Hence, it might be that the findings are specific for the experimental task and set-up used rather than an indication of a more general relationship between gaze behavior and aiming actions when ironic effects occur.

Thus, the aim of the current study was to gain more insight into the attention changes associated with unwanted effects in the perceptual-motor domain by examining the relationship between specific instructions, gaze behavior and performance of a golf putting task. We chose golf putting because unwanted effects (both ironic & overcompensation), have previously been demonstrated in golf putting (Beilock et al., 2001; De la Peña, Murray, & Janelle, 2008; Wegner et al., 1998). Moreover, there are neither time constraints nor potentially distracting elements (e.g., a goal keeper) present in the field of view during golf putting. Similarly to Beilock et al. (2001), De la Peña et al. (2008), and Wegner et al. (1998) we also tested novices. We expected that overcompensation effects would be accompanied by more gaze behavior to the end location of the ball, that is, in front of the hole when instructed not to putt too long, and behind the hole when instructed not to putt too short.

With respect to ironic effects, it is possible that there is not a tight relationship between gaze direction and putting performance, as the initial intention is accompanied by gaze directed to the correct location ironically followed by a putt to the to-be-avoided area. However, on the basis of the evidence that there is a tight relationship between gaze and putting performance (Bakker et al., 2006), we expected to find both gaze and putting performance directed more to the to-be-avoided area when ironic effects occurred.

Methods

Participants

Twenty-seven undergraduate students (14 women, 13 men) with no golf experience served as participants. Their mean age was 21.9 years ($SD = 0.43$). Informed consent was obtained and the rights of participants were protected in the study. The protocol of the experiment was approved by the Ethics Committee of the research institute.

Experimental set-up

Participants performed putts with a standard golf ball and putter on a carpeted indoor putting green (Greenfield, Al Kampen/ The Netherlands) that was 1.20 m wide and 3.50 m long. For each putt the initial distance between the ball and the target was 1.80 m. The target on which the ball was supposed to stop was marked by a white-sprayed circle with the diameter of a real golf hole ($d = 10$ cm), which allowed a continuous measure of performance. Participants first watched an interactive instruction video for beginners, which lasted for 2 minutes. The movie was back-projected using a projector (EIK CC-7000) on a reflective screen (2.29 m x 2.27 m) positioned next to the putting green.

Gaze behavior was recorded using an eye tracking system (Applied Science Laboratories 501, Bedford, MA) that consisted of a head-mounted scene camera and a monocular corneal reflection system. An infrared eye-camera detected the displacement between the left pupil and cornea reflex and visual point-of-gaze was determined after calibration relative to a 9-point grid. A video image of the scene including the point-of-gaze cursor was captured with the miniature scene camera and stored using a video recorder for further analysis. The accuracy of the system was ± 1 -degree visual angle. The calibration of the system was checked before each trial and, if necessary, the system was recalibrated (once or twice per participant). The eye-tracker was connected to the main computer with a 6-m long cable, which was attached to the waist of the participant but permitted normal putting mobility.

For all putts the end position of the golf ball was recorded at 25 Hz with an external digital video (DV) camera (Canon XM1). The camera was connected to a JVC BR-DV3000U DV recorder and was suspended 4 m above the target (the 'hole'). Recordings were calibrated using a 60 by 60 cm white cross

that was placed on the center of the hole. Camera calibration was repeated for every participant.

Design

All participants performed golf putts under three instruction conditions: (1) make sure that the ball ends on the hole: “hole” condition; (2) make sure that the ball ends on the hole, but be careful that the ball does not end in front of the hole: “not-in-front” condition; (3) make sure that the ball ends on the hole, but be careful that the ball does not end past the hole: “not-past” condition. Participants made three putts per condition, nine in total (in random order). Only three putts were used in each condition for several reasons. First, in principle, unwanted effects refer to a discrete phenomenon occurring for a particular action possibly washing out over more repetitions as individuals adapt to the instructions (De la Peña et al., 2008). Given the nature of golf, using fewer putts is probably also more ecologically valid than using many putts. Furthermore, the most important study showing ironic effects in the perceptual-motor domain (Wegner et al., 1998) used only one trial per condition (see also Woodman & Davis, 2008).

As the chances of unwanted effects increase when attention capacity is taxed (Wegner et al., 1998), participants performed the putts under mental load - they simultaneously counted backwards in steps of three starting from a given three-digit number between 200 and 1000. Although performance on this secondary task was not recorded, an experimenter monitored that counting continued throughout the condition. Generally, counting backwards (in threes or sevens, or even twos) is an attention-consuming task, which has already been demonstrated to be suitable for examining working memory involvement and automatization of task execution in perceptual-motor tasks (Koedijker, Oudejans, & Beek, 2007; Lewis & Linder, 1997; MacMahon & Masters, 2002). MacMahon and Masters (2002) actually tested the effects of several secondary tasks on golf putting performance (unattended speech, articulatory suppression, random letter generation, counting backwards in sevens). Counting backwards had the most detrimental effect on performance, making clear that it provides a suitable manipulation of load.

Procedure

Participants were tested individually. After providing written informed consent, the participant was told that he or she would complete a series of golf putts on the putting green with the objective to land the ball on the hole under different instructions. The participant was then fitted with the eye-tracker, which was then calibrated. After calibration, participants watched the interactive teaching movie and learned how to handle the golf putter and how to execute the putt movement adequately. Five to ten warm-up putts were allowed, followed by a further series of familiarization putts under mental load (i.e., counting backwards). Before each putt, one of the experimenters called out a number between 200 and 1000 from which the participant started to count backwards in steps of three. After the warm-up putts the nine experimental putts were performed. Prior to each putt one of the three instructions was provided verbally to the participant who was standing with his or her back to the hole. To have a clear indication of trial onset, which was necessary for the analysis of gaze behavior (see Data Reduction), the participant was then instructed to turn around and briefly fixate a marker located 40 cm away from the ball. The participant started counting backwards and made a putt. After each putt the participant stopped counting and was asked to recall the instruction, as a check of whether the participant had followed the instruction.

Data reduction

All trials were analyzed for each participant, resulting in a total data set of 243 putts (27 participants x 3 conditions x 3 trials). For each putt the end position of the ball (in cm) relative to the center of the hole was obtained by capturing single bitmap images with Adobe Premiere 6.5 from the DV recordings made by the external camera. Next, the images were analyzed by using Image Digitizing Software "DIDGE" (version 2.2.0, see Van Wassenbergh, Aerts, & Herrel, 2006). DIDGE produces X- and Y-coordinates (in cm) with respect to an arbitrary origin, in this case the hole. As we were primarily interested in over- and undershooting following specific instructions, and because lateral deviations were small, only the Y-coordinates of end positions were further analyzed.

Before analyzing the gaze recordings we enhanced the video frame rate from 25 to 50 Hz by capturing the video recordings of each putt with Adobe Premiere 6.5, a video editing software package installed on a personal computer (Toshiba, PA3362U-1MPC). Each video frame of 40 ms duration was separated into two

frames of 20 ms duration thereby enhancing the image rate to 50 Hz (see Adobe Premiere 6.5 online Manual, 2007, topic: "Field Rendering in Adobe"). For each putt, gaze data was subsequently analyzed frame-by-frame from the first moment that the gaze left the marker and was directed at either the ball, feet, club or hole area (the first fixation was always on one of these locations) until the ball was hit with the club.

To establish whether there is a relationship between where people look and where they putt when unwanted effects occur, we distinguished three relevant fixation locations, an area of approximately 25 cm in front of the hole, the hole (10 cm), and an area of approximately 25 cm behind the hole. The 25 cm cut-off points in front of and behind the hole were estimated using the white calibration cross that was also used for camera calibration. Inspection of the video recordings made clear that of all fixations around the hole, participants only showed fixations within the dimensions of the cross, with most fixations more to the middle than close to the edges of the calibration cross (i.e., from about 15 cm in front of the hole to 15 cm behind the hole). Fixations were coded according to these three locations. Whenever there was a saccade or a fixation to another location (e.g., ball, feet or club) gaze was coded as "other". A coding reliability check was carried out in which 21 randomly selected trials were coded independently by two different observers. The 21 trials involved 311 code changes and a total of 15603 video frames. The inter-observer agreement at the level of frames was 96.3%.

The minimum gaze duration of fixations employed in the literature varies, ranging from 80 to 150 ms (for an overview see Williams, Davids, & Williams, 1999). In the current study we analyzed the data using minimal fixation durations of 80 and 100 ms, which yielded similar results. We only report the data using 80 ms as minimal fixation duration. Thus, a fixation was coded when the participant's gaze was directed at a location (i.e., in-front of the hole, hole, and behind the hole) for minimally 80 ms (four or more frames). We then computed how long (in ms) gaze was fixated on each of the three locations for each putt. We also computed relative fixation durations by computing the fixation durations on each location as a percentage of the total fixation duration of looking at the three locations (cf. Behan & Wilson, 2008; Williams et al., 2002). In addition, as putt duration (from the first moment that the gaze left the marker until the ball was hit) varied from about 4 to 11 seconds we also determined absolute fixation durations (in ms) during the final 4 seconds prior to

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the ball being hit. After 4 seconds several participants had already completed their putts, making a longer duration unsuitable for analysis. Both the relative fixation durations (percentages) and the absolute fixation durations during the final four seconds were analyzed statistically. Because both dependent variables yielded similar results only the results concerning the final four seconds are reported in the *Results* section.

Statistical analysis

To gain insight into the relationship between gaze behavior and putting performance we first computed Pearson correlation coefficients between the fixation durations to the three fixations locations (in front of the hole, the hole, and past the hole) and the end positions of the balls.¹ We expected negative correlations between looking in front of the hole and putt distance, and positive correlations between looking behind the hole and putt distance. That is, we expected that the longer the fixation duration in front of the hole the shorter the putt, and the longer the fixation duration behind the hole the further the putt. Next, we classified participants in both experimental instruction conditions (not-in-front and not-past) into groups depending on whether they showed ‘good’ putt performance, ‘overcompensation’ or ‘ironic’ effects relative to performance following the neutral ‘hole’ instruction. Putt performance of an individual participant in the not-in-front and not-past conditions was classified as “good” when the average end location of the ball was within 10 cm in front of or behind the participant’s average putt performance in the hole condition. An unwanted effect was classified as more than 10 cm in the direction in question (overcompensation, ironic).² Thus, when participants overshot their average putt performance in the hole condition (over three trials) by more than 10.0 cm

¹ Of the 243 trials (27 participants times 9 trials) there were 9 trials in which the participant had not looked at all at one of the three target areas. As we were interested in the relationship between looking around the hole and aiming action we excluded these 9 trials from the correlation analyses. Furthermore, as the remaining 234 trials contained different participants as well as repeated measures per participant, we first computed the correlations over all participants for each trial per condition separately (nine trials in total). Subsequently, Fisher z transformations were computed. We averaged these z-values, transformed the average back to a correlation coefficient, and determined the significance on the basis of the degrees of freedom (in this case 232).

² The standard deviation of putting performance was 22.7 in the hole condition. We decided to consider putts more than about half a SD (10 cm) away from the mean performance in the hole condition as unwanted (ironic or overcompensation), and checked whether this cut-off point would yield sufficiently large groups for further analyses. Because it would not be justified to call performance within 10 cm unwanted, a closer cut-off point was not an option. We tried a cut-off point larger than 10 cm, namely, 15 cm radius around the center of the hole, but this left insufficient participants showing ironic effects (4 and 3 in the not-in-front and not-past conditions, respectively).

during the not-in-front condition, or when they left the ball more than 10.0 cm short (relative to this average) during the not-past condition, performance was classified as “overcompensation”. In contrast, performance was classified as “ironic” when, relative to their average putt performance in the hole condition, participants left the ball too short (< -10.0 cm) during the not-in-front condition, or when they overshot (> 10.0 cm) during the not-past condition.

In the not-in-front condition 9 of the 27 participants showed good performance, 9 showed overcompensation and 9 showed ironic effects. In the not-past condition 6 participants showed good performance, 14 showed overcompensation, and 7 showed ironic effects. These classifications were analyzed separately, resulting in six comparisons for changes in fixation durations. Therefore, for each of these comparisons we performed a 2 (condition: hole versus not-in-front *or* not-past, depending on the comparison in question) $\times$ 3 (fixation location: in-front of hole, hole, behind hole) repeated measures ANOVA on the total fixation duration (in ms) per putt for the final 4 s of the putt.³ In all cases fixation durations of the selected participants in the condition in question (not-in-front or not-past) were compared with their fixation durations in the hole condition. With good performance we expected no changes in fixation duration from the hole to the other conditions. For both overcompensation and ironic effects we expected shorter durations of looking at the hole and longer durations of looking at the area where the ball eventually landed (i.e., for overcompensation - behind the hole for the not-in-front condition and in front of the hole for the not-past condition; for ironic effects - in front of the hole for the not-in-front condition and behind the hole for the not-past condition).

³ For each of the two comparisons involving ironic effects box plot analyses revealed extreme outliers in gaze behavior for two participants. They showed extremely long fixations but nonetheless changes from condition to condition in the same direction as the other participants. Due to their extremely high values, they had to be excluded from further analysis, leaving seven and five participants, respectively.

Results

Correlations between fixation duration and end position

In line with our expectations, the correlation coefficient between the duration of fixations in front of the hole and the distance of the ball to the hole was negative, $r = -.13$, $p < .05$, while the correlation coefficient of the duration of fixations behind the hole and the distance of the ball to the hole was positive, $r = .34$, $p < .01$. To provide visual support for these correlations we computed the average duration with which participants fixated any of the three locations (in front of hole, hole, behind the hole). These results revealed that participants looked on average for 247 ms at the area in-front of the hole, for 459 ms at the hole and for 152 ms at the area behind the hole. Subsequently we determined for each putt, which of these areas the participant had looked at for proportionally longer than the average duration. Figure 3.1 shows the end positions of all putts as a function of this area.

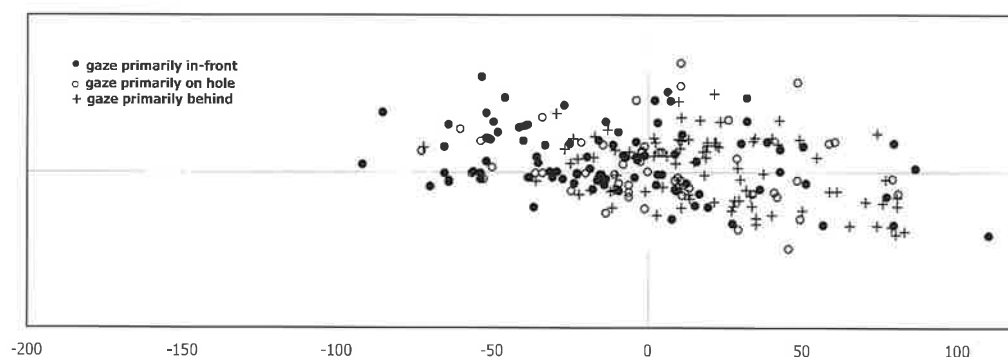


Figure 3.1. Top-view of the golf green with end positions of the balls and main area of gaze location.

The black dots in Figure 3.1 represent end positions of golf balls for which participants looked longer than average at the area in front of the hole. The white dots represent those putts for which participants looked more at the hole while the crosses represent balls where participants primarily looked at the area behind the hole. As can be seen, when participants looked relatively longer at the area in front of the hole, more balls actually landed in front of the hole

(black dots). When participants looked relatively longer behind the hole more balls ended behind the hole (crosses). This provides support for the idea that overall there was a relationship between where participants looked and to where they putted when unwanted effects occurred.

Fixation durations with (un)wanted effects

Following classification of putts as good performance, overcompensation or ironic effects we performed six ANOVAs to investigate whether there were specific shifts in visual attention relative to the neutral 'hole' instruction.

Not-in-front condition - Good performance. As mentioned above, we expected no differences in fixation duration when performance was classified as good in the not-in-front condition ($n = 9$). A 2 (condition: hole, not-in-front) x 3 (fixation location: in front of hole, hole, behind hole) repeated measures ANOVA on the total fixation duration during the last 4 s of each putt was performed. As expected, the ANOVA yielded no significant effects, $F_s < 1.75$, $p_s > .10$ (Figure 3.2a).

Not-in-front condition - Overcompensation. When performance was classified as overcompensation in the not-in-front condition ($n = 9$) we expected gaze to be fixated longer (during the final 4 s of the putt) on the area behind the hole relative to the neutral hole condition. A 2 (condition: hole, not-in-front) x 3 (fixation location: in front of hole, hole, behind hole) repeated measures ANOVA on the total fixation duration only revealed a significant interaction between condition and fixation location, $F(2, 16) = 4.0$, $p < .05$, $\eta_p^2 = .33$; other $F_s < 1.15$, $p_s > .10$ (see Figure 3.2b). Post hoc pair-wise comparisons confirmed that participants directed their gaze for a longer period (180 ms longer) to the area behind the hole in the not-in-front condition compared to the hole condition, $p < .05$. Furthermore, on average they looked for less time at the hole in the not-in-front condition than in the hole condition (122 ms shorter) but this difference was not significant, $p = .20$.

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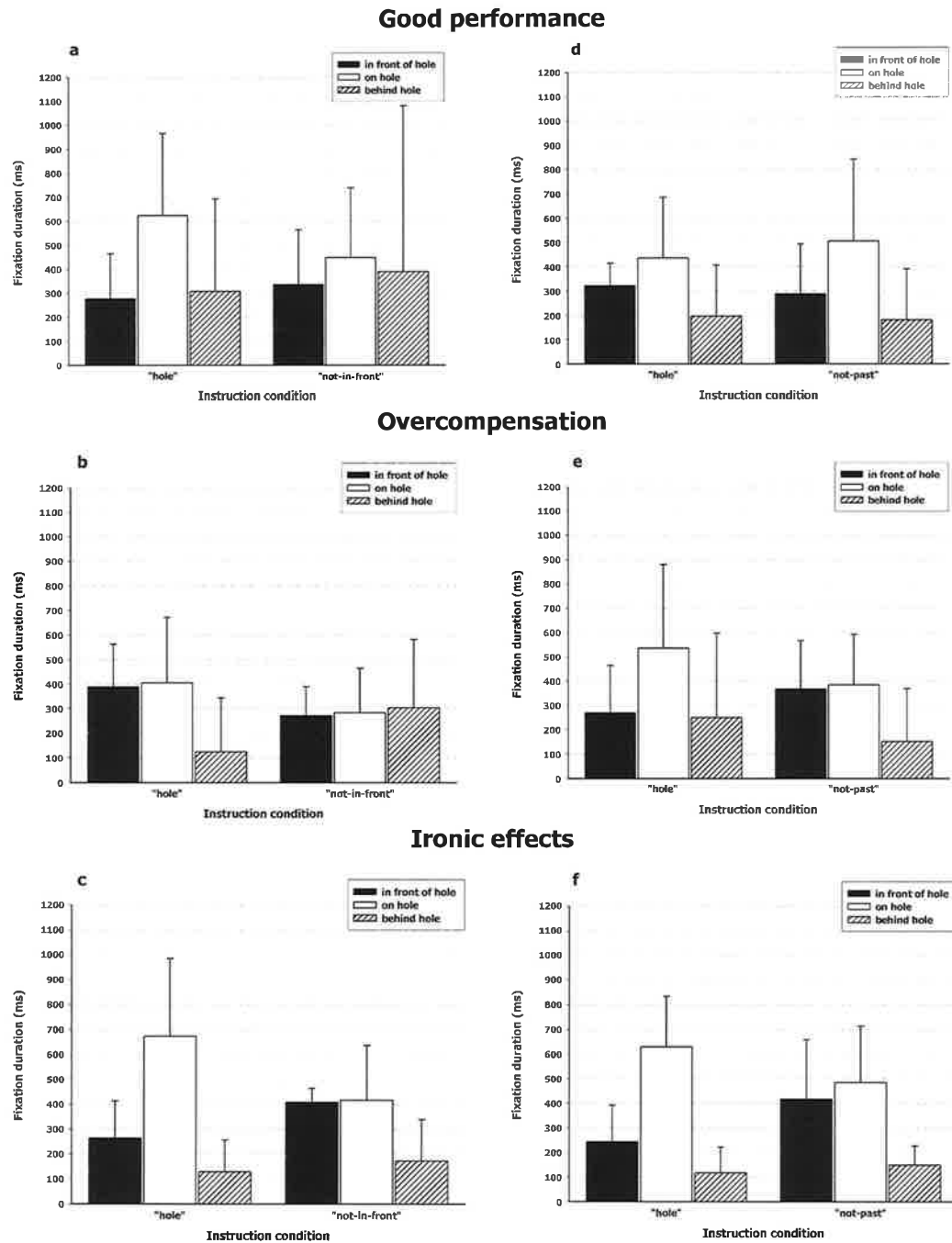


Figure 3.2. Total fixation durations on the three locations (with standard deviations) for the hole and the not-in-front condition (a, b, c) and for the hole and the not-past condition (d, e, f).

Not-in-front condition - Ironic. When performance was classified as ironic in the not-in-front condition (i.e., participants putted in too short; $n = 7$) we examined whether a tight relationship existed between gaze behavior and putting performance, leading to longer fixations to the area in front of the hole. A 2 (condition: hole, not-in-front) $\times$ 3 (fixation location: in front of hole, hole, behind hole) repeated measures ANOVA on the total fixation duration was carried out. This analysis yielded a main effect of fixation location, $F(2, 12) = 6.8$, $p < .05$, $\eta_p^2 = .53$, and a significant interaction between condition and fixation location, $F(2, 12) = 16.0$, $p < .001$, $\eta_p^2 = .73$ (see Figure 3.2c). The effect of condition was not significant, $F < 1$, $p > .10$. Post hoc pair-wise comparisons showed that participants who did the opposite of what was instructed (i.e., they left the putt too short) fixated significantly longer on the area in front of the hole (146 ms longer) during the not-in-front condition in comparison to the hole condition, $p < .05$. Furthermore, they fixated for a shorter time on the hole in the not-in-front condition (256 ms shorter) than in the hole condition, $p < .01$.

Not-past condition - Good performance. We expected no differences in gaze behavior when performance was classified as good in the not-past condition ($n = 6$). A 2 (condition: hole, not-past) $\times$ 3 (fixation location: in front of hole, hole, behind hole) repeated measures ANOVA on the total fixation duration of each putt was performed. This ANOVA only yielded a significant main effect for fixation location, $F(2, 10) = 11.0$, $p < .01$, $\eta_p^2 = .69$, suggesting that participants looked at the hole for longer when compared to the other two locations (see Figure 3.2d). As expected, the effect of condition as well as the interaction was not significant, $F_s < 1$, $p_s > .10$ (Figure 3.2d).

Not-past condition - Overcompensation. When performance was classified as overcompensation in the not-past condition ($n = 14$) we expected gaze to be fixated longer on the area in front of the hole. A 2 (condition: hole, not-past) $\times$ 3 (fixation location: in front of hole, hole, behind hole) repeated measures ANOVA on the total fixation duration yielded a significant main effect of condition, $F(1, 13) = 6.5$, $p < .05$, $\eta_p^2 = .33$, a significant main effect of fixation location, $F(2, 26) = 4.0$, $p < .05$, $\eta_p^2 = .24$, and a significant interaction between condition and fixation location, $F(2, 26) = 5.1$, $p < .05$, $\eta_p^2 = .28$ (see Figure

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3.2e). Post hoc pair-wise comparisons showed that in line with our expectations the participants fixated their gaze longer on the area in front of the hole (98 ms longer) in the not-past condition in comparison to the hole condition, $p < .05$. In addition, they also fixated for less time on the area behind the hole in the not-past conditions (99 ms) compared to the hole condition, $p < .05$. Moreover, participants directed their gaze for less time to the hole itself in the not-past condition (152 ms shorter) compared to the hole condition, $p < .05$.

Not-past condition - Ironic. When performance was classified as ironic in the not-past condition (i.e., the ball landed further behind the hole relative to the hole condition; $n = 5$) we examined whether a tight relationship existed between gaze behavior and putting performance, leading to longer fixations to the area behind the hole. A 2 (condition: hole, not-past) $\times$ 3 (fixation location: in front of hole, hole, behind hole) repeated measures ANOVA on the total fixation duration yielded a significant main effect of fixation location, $F(2, 8) = 7.1$, $p < .05$, $\eta_p^2 = .64$, and a significant interaction between condition and fixation location, $F(2, 8) = 10.9$, $p < .01$, $\eta_p^2 = .73$ (see Figure 3.2f). There was no significant main effect of condition, $F < 1$, $p > .10$. Post hoc pair-wise comparisons showed that in the not-past condition the participants did not look significantly longer at the area behind the hole (where the ball eventually landed), $p = .19$, compared to the hole condition. If anything, they tended to look longer at the area in front of the hole (174 ms longer), $p = .077$. Furthermore, participants looked for less time at the hole in the not-past condition (144 ms shorter) compared to the hole condition, $p < .05$.

Discussion

The main purpose of this study was to gain more insight into the relationship between gaze behavior and putting performance when unwanted effects, either overcompensation or ironic effects, occur. By having participants execute a golf putting task with negative instructions and mental load, both overcompensation and ironic effects were induced. Not all participants were equally susceptible to unwanted effects, with a number of participants per condition showing good performance, several showing overcompensation, and some showing ironic effects. Differences in susceptibility to ironic effects were also recently found

by De la Peña et al. (2008) and Woodman and Davis (2008; cf. Plessner, Unkelbach, Memmert, Baltes, & Kolb, 2009). For example, De la Peña et al., found that only about 20% of their participants, who also performed a golf putting task, showed ironic effects, while most of the others showed overcompensation in that they putted short when instructed not to putt too long, or vice versa. Our results confirm that unwanted effects in the perceptual-motor domain are not restricted to ironic effects but can manifest themselves repeatedly in the form of overcompensation.

A question that remains is why some participants showed ironic effects while others showed overcompensation or good performance? Apart from situational constraints, as people may react differently at different times in different settings, there may be specific dispositions associated with susceptibility to ironic effects, such as regulatory focus (Plessner et al., 2009), action-control (Jostmann & Koole, 2007) or repression (Woodman & Davis, 2008). Regulatory focus refers to modes of self-regulation in which people approach a task (e.g., a penalty kick) with a prevention focus (don't miss) or a promotion focus (make the goal). Similarly, action control refers to mental processes involved in pursuing intentions where action-oriented people perform better under pressure than state-oriented people. Repression refers to the disposition to report low anxiety even when anxiety is actually high, as evidenced from behavioral and physiological responses. Woodman and Davis examined performance on a golf putting task and demonstrated that only participants who were classified as repressive (16%) showed ironic effects. Future studies are needed to investigate the relationship between these dispositions and susceptibility to ironic effects.

Overall there appeared to be a systematic relationship between gaze duration to specific locations and putting performance. Moreover, specific comparisons confirmed that in most cases there was such a relationship between gaze behavior and putting performance. The only exception was for ironic effects in the not-past condition (Figure 3.2f), which might explain why the correlation between gaze behavior and putting performance in front of the hole was not high ($r = -.13$). Apparently these participants looked more in front of the hole yet they putted further away (i.e., past the hole). In the remainder of the discussion we further address this pattern of findings and present possible explanations and implications.

Unwanted effects in aiming actions

In the introduction we argued that, normally, intentions determine direction of (visual) attention, which in turn determines where one aims. Furthermore, we argued that not just good performance but also overcompensation is intention driven (cf. Beilock et al., 2001). Consequently, in these cases there is not a mismatch between desired and actual behavior that needs to be corrected. Thus, we expected that the usual sequence from intention to putting action would unfold for good performance as well as overcompensation. In line with this expectation we indeed found a relationship between gaze behavior and putting performance for these two kinds of effects. Fixation durations were similar to those in the neutral ‘hole’ condition in case of good performance while they changed in the expected directions when overcompensation occurred. Finding this tight relation supports the idea that, though unwanted, overcompensation is in fact intention driven, probably due to a weighing process of intentions following dual instructions (e.g., to land the ball on the target, and to make sure not to putt too short [or too long]). With dual instructions participants tend to do the opposite of what should be avoided (Körding & Wolpert, 2006; Trommershäuser et al., 2003).

For ironic effects we were unexpectedly confronted with both of the depicted scenarios. First, in the not-in-front condition gaze behavior was ironically drawn more to the same area, in front of the hole, as where the ball eventually landed (Figure 3.2c). This finding suggests that ironic putting performance may indeed be preceded by ironic gaze behavior when there is no time constraint or ‘distracting’ element (e.g., goal keeper) in the visual field, as was the case in the study by Bakker et al. (2006). Second, in the not-past condition gaze behavior was drawn more to the area in-front of the hole, where the ball did not land, perhaps due to the intention to putt in front. Despite this alleged intention and accompanying gaze behavior, eventual putting performance was ironic and, thus, past the hole (Figure 3.2f). Thus, it seems that the chain between intention, looking and performance may be interrupted between looking and performance as well as between intention and looking. That the findings related to these ironic processes are based on small groups of participants urges us to be cautious in drawing conclusions. Future studies involving larger groups of participants showing ironic effects and perhaps involving other tasks are necessary to confirm our findings. For now, if we wish to elaborate on the current findings several issues remain.

First, are all findings in line with the theory of ironic processes (Wegner, 1994)? According to the theory, when a mismatch between the actual and desired state is detected, a controlled process is initiated to redirect (correct) behavior in the desired direction. When attention load is high, the controlled process can be compromised, resulting in the manifestation of unwanted behavior. These ideas leave room for good performance, overcompensation and both of the scenarios related to ironic effects. Due to their intentional character, good performance and overcompensation are not inconsistent with Wegner's theory (1994). The theory only predicts ironic processes when there is a mismatch between original intention and eventual action, which is not the case for good performance or overcompensation. Concerning ironic effects, in principle, there can be a mismatch between desired and actual gaze behavior or between desired and actual motor behavior. Thus, all findings of the present study including the complex pattern of results found for ironic effects can be explained by a combination of the logical sequence from intention to action, and Wegner's theory of ironic processes.

Second, what is yet unexplained is where in ironic effects the abovementioned mismatch between desired and actual state comes from. For example, if one has the intention to putt accurately, or to overcompensate, then why would a mismatch between this intention and what one actually does occur? We propose that the negative instruction, for instance, not to putt past, still has an influence on the mental processes during the putt. Bargh, Chen, and Burrows (1996) proposed that thinking about a behavioral response may increase the likelihood of engaging in that response, even when the person is trying to avoid that behavior. Therefore, the priming of "past" may cause a mismatch between intended and actual state of affairs, as a result of which one may eventually putt past, despite the intention to putt in front. Thus, priming may play a role in the initiation of ironic effects. Still, the self-regulatory processes proposed in Wegner's theory are needed to explain the complex pattern of relationships between gaze and putting performance found in the current study.

Third, we can only speculate about why a tight relationship between the location of where participants looked and putting performance seemed to have occurred in the not-in-front condition but not in the not-past condition. This difference does not seem to be the result of individual differences as four of the five participants who show ironic effects in the not-in-front-condition also

showed them in the not-past condition. Other possibilities that come to mind are the temporal evolution of the processes in question, differences in priming of gaze and performance, and specific task constraints. As for the last idea it can be noted that in golf putting looking past the hole may be less common, as gaze behavior normally extends from the ball to the hole and back (Vickers, 1992, 2007). This fits with our finding that, on average, the area behind the hole was looked at for a much shorter duration than the hole and the area in front of the hole.

Practically, it is important to emphasize that the mismatch between desired and actual states originates in the negative instruction that primes the behavior one wishes to avoid. Therefore, in learning and performance settings involving perceptual-motor tasks it may be best to avoid negative instructions that may prime undesired behavior. This would fit well with findings and practical guidelines in sport psychology concerning, for instance, the use of imagery and self-talk. Research suggests that positive imagery (i.e., imagining a successful outcome) or positive self-talk (involving positive and rational thoughts and statements) are associated with successful performance (Wann, 1997), while negative imagery (i.e., imagining an unsuccessful outcome) and negative self-talk (involving negative and self-defeating thoughts and statements) are associated with performance decrements (e.g., Beilock et al, 2001; Van Raalte, Brewer, Rivera, & Petitpas, 1994; Woolfolk, Parrish, & Murphy, 1985). The results of the current study make clear that, at least for aiming actions, negative instructions may affect gaze behavior, the aiming action or both, leading to either overcompensation or ironic effects. Therefore, coaches, trainers and athletes are advised to avoid the use of negative instructions in order to diminish the chance of unwanted effects on performance.

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Chapter 4

Ironic effects in a simulated penalty shooting task: Is the negative wording in the instruction essential?

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Abstract

Bakker et al. (2006) showed that following a negative instruction not to shoot near the keeper in a penalty shooting task, gaze and shots were ironically more often directed to the keeper. Here we examined whether the negative formulation in the instruction ("not") or mentioning the to-be-avoided area ("keeper") was responsible for ironic effects. Thirty-two male football players performed an indoor penalty-kick task following negatively (not-keeper) and positively (pass-keeper) worded instructions. There was no significant difference between instructions concerning the number of participants who showed ironic effects. Furthermore, regression analyses showed that both instructions affected shooting distance from the keeper to a similar degree and that duration of fixations on the keeper mediated the ironic relationships between both the negative and the positive instructions and performance ($ps < .01$). It is concluded that in the perceptual-motor domain mentioning what should be avoided and not necessarily the negative wording is responsible for ironic effects and that these effects are mediated by gaze behavior.

Introduction

Research in the field of sport psychology reveals that performance decrements may be expected if athletes use negative self-talk involving negative and self-defeating thoughts and statements (e.g., Murphy, 1994; Van Raalte et al., 1995; Woolfolk, Parrish, & Murphy, 1985). Negatively worded instructions or negative images may even lead to so-called ironic effects: someone does precisely that which s/he was instructed not to do. For example, one tends to think of a white bear when specifically instructed not to do so (Wegner, 1994; Wegner, Schneider, Carter, & White, 1987). In the perceptual-motor domain a golf player may putt the golf ball too long following the explicit instruction not to let that happen (Binsch, Oudejans, Bakker, & Savelsbergh, 2009; Wegner, Ansfield, & Pilloff, 1998; Woodman & Davis, 2008; cf. Beilock, Afremow, Rabe, & Carr, 2001; Janelle, 1999). Recently, Bakker, Oudejans, Binsch, and Van der Kamp (2006) investigated ironic effects in experienced association football players who shot penalties under differently worded instructions towards a screen on which video clips of a goal and keeper were presented for one second. When the football players were asked not to shoot within reach of the keeper, it appeared that gaze and shots were more often actually directed (closer) to the keeper compared to the neutral instruction condition.

A possible explanation for ironic effects is provided by the theory of ironic mental processes (Wegner, 1994), which holds that successful behavior relies on two cognitive processes: one controlled and the other automatic. In brief (for more elaborate descriptions we refer to Wegner; cf. Janelle, 1999), the automatic search process continuously scans the contents of consciousness for any trace of unwanted thoughts. When an unwanted thought is detected, the controlled system “kicks in” and replaces this item with a more appropriate task-related thought. Under certain circumstances, for instance, with a high mental load or with time pressure, the controlled replacing process, which requires attention for successful initiation, can be compromised – resulting in the manifestation of unwanted thoughts and less-than-optimal performance. For example, a football player about to take a penalty may instruct himself not to aim at the keeper. As a result, “keeper” may linger on in the system hereby undesirably drawing attention. The pressure to perform may prevent the controlled system to replace the unwanted thought with a more positive instruction (“aim at the open space”),

eventually leading to a bad shot and a save by the keeper. Note that although specific instructions increase the chances on ironic behavior they do not always and automatically lead to such behavior (Binsch et al., 2009; De la Peña et al., 2008; Woodman & Davis, 2008). As an example, De la Peña et al. (2008) found that only about 20% of their participants, who performed a golf putting task, showed ironic effects, while most of the others showed overcompensation in that they putted extra short when instructed not to putt too long, or vice versa.

In the domain of thought control a negative formulation is necessary to evoke ironic effects, as it is impossible to urge someone, for example, not to think of a white bear using a positively phrased instruction. In contrast, in some perceptual-motor tasks it may be possible to induce ironic-like effects without a negatively formulated instruction. For example, in the study of Bakker et al. (2006) the ironic effects in penalty shooting could have been the result of the negative instruction to avoid the keeper (“not-keeper”) or of mentioning of the word “keeper” as the word keeper also figured prominently in the negative instruction. The mere fact of being (more) occupied with the goalkeeper through the instruction may have directed gaze as well as aiming behavior towards this (to-be-avoided) area. Thus, the main question of the current study was whether the negative formulation in the instructions (“not”) or mentioning of the to-be-avoided area (“keeper”) is essential in inducing ironic effects in the perceptual-motor domain.

To answer that question we investigated football players performing a penalty kick task following a negatively and positively worded instruction containing the word keeper. More specifically, players were instructed to “shoot as accurately as possible, and be particularly careful not to shoot within reach of the keeper” (not-keeper instruction), and to “shoot as accurately as possible, and be particularly careful to pass the keeper” (pass-keeper instruction). If mentioning of the word ‘keeper’ is decisive in inducing ironic effects one would expect similar ironic effects following both instructions, that is, football players’ shooting performance would then be equally close to the keeper. If it is the negative instruction that is decisive we expect the occurrence of ironic effects only during the not-keeper condition. As this is the first time that this was investigated we had no a priori expectations regarding these two possibilities.

Furthermore, we also wished to gain more insight into the relationships between instruction, gaze behavior, and ironic performance. As it has been shown that performance in far aiming tasks is preceded by fitting gaze behavior (e.g., Deubel & Schneider, 1996; Henderson, 2003; Itti & Koch, 2001; Land & Fumaux, 1997) also when unwanted effects occur (Bakker et al., 2006; Behan & Wilson, 2008; Binsch et al., 2009), it was suggested that gaze behavior (i.e., fixations on the to-be-avoided area) is a mediator in the relationship between instructions and ironic effects (Bakker et al., 2006; Binsch et al., 2009). Specifically, it was suggested that specific instructions lead to longer fixations on the keeper which in turn lead to ironic performance. To investigate these relationships, we also measured gaze behavior preceding the penalty kicks and performed regression analyses between instruction (both negatively and positively worded instructions), duration of fixations on the keeper, and ironic performance following the procedure by Baron and Kenny (1986; Judd & Kenny, 1981) to test mediator effects. Most important, these analyses also provide additional information regarding our main question as to whether both negative and positive instructions lead to similar levels of ironic performance.

Methods

Participants

Thirty-two male intermediate football players from a district amateur league participated (mean age = 24.2 years, $SD = 7.4$). On average, they had 14.6 years ($SD = 10.2$) of experience in football competition. All participants were actively engaged in football competition at the time of the study and practiced, on average, two times (totalling three hours) a week. The experiment was approved by the ethics committee of the research institute. Each participant gave his written informed consent before the start of actual testing.

Task and Design

Video clips of a stationary goalkeeper anticipating a penalty kick were shown on a large screen. The clips were made from the perspective of a penalty taker. The task of the participant was to take a penalty, that is, to shoot a ball lying in front of him towards the projected goal. The player was instructed to hit the screen within the 1 second that the projection lasted, hereby creating a reasonable time

pressure which is suggested and found in the literature as a possible constraint to induce ironic effects (Bakker et al., 2006; Janelle, 1999; Wegner, 1994).¹ The goalkeeper shown in the video clips stood either in the center of the goal or 0.15 or 0.30 m to the left or to the right from the center of the goal, resulting in five clips, one for each position. The off-center positions of the keeper were included to induce variability of players' shot direction and, thus, to prevent that players would choose one particular corner, to which they would then shoot all balls in the exact same manner. Each of the five position clips was presented twice in one of three instruction conditions, leading to 10 trials per condition. Within each condition the 10 trials were randomized. The instructions in each of the three conditions were as follows: (1) just shoot as accurately as possible: "accurate instruction"; (2) shoot as accurately as possible, and be particularly careful not to shoot within reach of the keeper: "not-keeper instruction"; (3) shoot as accurately as possible and be particularly careful to pass the keeper: "pass-keeper instruction". What it meant to 'shoot as accurately as possible' was explained to the participants prior to testing by showing each video clip while holding the football in the larger goal space next to the keeper and close to the ground. When the keeper stood in the center of the goal the football was held successively left and right close to the goalposts and close to the ground.

As we wished to determine a baseline measure (both with respect to performance and gaze behavior) unaffected by additional instructions, the "accurate" instruction condition was always the first condition. The other two instruction conditions were counterbalanced. Note that the off-center trials only served as catch trials. Given that on one side there was a relatively large open space next to the keeper, making the choice for shooting side as well as shooting itself easy, ironic effects were not expected for these trials. Moreover, only trials with the keeper in the center position allowed for sound comparisons of performance (distance to the keeper, see *Data Reduction*) among the instruction conditions.² Therefore, only these trials were further analyzed. Thus, only two trials were used in each condition. Relevant studies showing ironic effects in the

¹ Pilot testing with durations of 0.8, 1 and 1.2 s (50 kicks per time condition) showed that half of the balls were too late during the 0.8 s condition apparently providing a too stringent time constraint. During the 1 s condition already almost all balls were on time, demonstrating that 1 s provided just enough time to execute the current penalty kick task.

² The landing positions of the ball relative to the keeper are not comparable from keeper position to keeper position as the open space at one side of the keeper is much larger in the off-center trials than in the center trials. To still adhere to the task instructions a participant need not shoot as close to the post in the off-center trials as in the center trials making unambiguous interpretations in terms of ironic effects difficult.

perceptual-motor domain used only 1 trial per condition (Wegner et al., 1998; Woodman & Davis, 2008); using many trials would harm comparability. Furthermore, in search for ironic effects using less trials is probably more ecologically valid than using many trials (De la Peña et al., 2008).

Experimental set-up

The video clips (made with a digital video camera, Sony XJ 2000) were back-projected, using a mirror and projector, on a large projection screen (2.29×2.27 m). The projection size of the clips was 2.20×1.05 m with a projected goal size of 2.00×0.81 m. At each presentation, lasting 1 s, the player shot a foam ball ($\emptyset = 21$ cm, 296 gram, thus, proportions comparable to those of an official futsal [i.e., indoor football] size 4 football) to the projected goal from a penalty spot located at a distance of 2.83 m from the screen. At that distance the visual angle subtended by the projected goal (height) was about 15° , hereby closely simulating the real image size of the goal and goalkeeper for a real penalty from 11 m. A Canon-XM1 video camera, connected to a JVC digital video (DV) recorder and directed at the screen, was used to record shooting performance (at 50 Hz). The video camera was attached to the ceiling at a height of 2.80 m directly above the penalty spot and aimed at the screen.

Gaze behavior was registered using an eye tracking system (Applied Science Laboratories 501, Bedford, MA) that consisted of a head-mounted scene and (infrared) eye camera. With the eye-camera, detecting the displacement between the left pupil and cornea reflex relative to a pre-calibrated 9-point grid, the visual point-of-gaze was determined and integrated into the image of the scene camera that was recorded for further analysis. The accuracy of the system was ± 1 -degree visual angle. The calibration of the system was checked before each trial and if necessary the system was recalibrated (on average once per 10 trials). The eye-tracker was connected to the main computer with a 6-m long cable. The 6-meter long cable was attached to the waist of the participant with a waistband and permitted normal shooting mobility.

We used an optical switch located just behind the penalty spot to determine when the ball was hit. The optical switch consisted of an infrared light beam that was interrupted by the ball when it was kicked. This interruption was converted to a signal that was sent to a Light Emitting Diode (LED) mounted in front of

the ASL scene camera. Thus, as soon as the ball was hit, the LED turned on which was visible in the scene camera recordings.

Procedure

Participants were tested individually. After a brief general explanation of the experiment each participant provided written informed consent. The participant then completed 20 warm-up shots to a white circle ($\varnothing = 30$ cm) that was each time projected for two seconds on the screen at different locations at ground level. After the warm-up, the participant was equipped with the eye-tracker, the eye-calibration was executed, and it was explained what it meant to 'shoot as accurately as possible'. Next the participant made 10 practice shots towards the screen, without further instruction. Subsequently the trials of the three experimental conditions (3 times 10 shots) were performed. Prior to each trial the instruction in question was repeated verbally. Then, a video clip was presented and the participant kicked the ball to the screen. After the ball hit the screen, the ball was collected by the experimenter and repositioned on the penalty spot. Hereafter, participants were instructed to look at certain marks left and right on the screen to verify the eye-calibration. Then the next instruction was given.

Data reduction

As mentioned, per participant only the two center trials per instruction condition were analyzed, resulting in a total data set of 192 trials (2 trials $\times$ 3 conditions $\times$ 32 participants). For each of these trials we determined shooting performance, that is, the horizontal distance of the ball (in cm) from the center of the screen (keeper) when the ball hit the projection screen. Single bitmap images were captured with Adobe Premiere 6.5 from the video recordings made by the scene camera. With these images X- and Y-coordinates of the landing position of the ball were digitized using Image Digitizing Software "DIDGE" (see Binsch et al., 2009). The known dimensions of the goal, that is, the height of the goalposts and the distance between the goalposts, were used for calibration.

To ensure that our analyses accounted for earlier findings (Binsch et al., 2009; De la Peña et al., 2008; Woodman & Davis, 2008) that not everyone demonstrates ironic behavior we distinguished participants who did show ironic effects from those who did not according to the following criterion: when, in the not-keeper or pass-keeper condition, the two shots in that condition landed on

average at least 10 cm closer to the keeper than in the accurate condition, this was interpreted as an ironic effect.³ This criterion, albeit arbitrary, seemed reasonable, the difference of 10 cm being just over half the standard deviation of shooting performance in the accurate condition (18.4 cm), and thus substantial. Furthermore, a shot landing 10 cm closer to the projected keeper would be tantamount to a shot more than 30 cm closer to a real keeper in a real penalty setting, thus, more than one football diameter (22 cm) closer. Thus, when participants shot on average more than 10 cm closer to the keeper in the not-keeper or pass-keeper condition (relative to the accurate condition) their performance was classified as ironic.

For each of the ironic participants gaze data was analyzed (frame-by-frame; 20 ms per frame) from the first moment after appearance of the video clip that the gaze was directed at the screen until the moment at which the football was kicked. Following Vickers (1992, 1996) and Williams, Davids, and Williams (1999), considering a minimal fixation duration of 100 ms (five or more video frames), the number of fixations and the fixation durations on the keeper were determined. With these numbers we computed per trial how long gaze was fixated on the keeper (in ms). A coding reliability check was carried out in which 20 randomly selected trials were coded by two different observers. The 20 trials involved 72 code changes and a total of 1224 video frames. The inter-observer agreement at the level of frames was 97.5 %.

Statistical analysis

A chi-square test was performed comparing the number of participants who did and did not show ironic effects in the two experimental instruction conditions (not-keeper and pass-keeper) as a first test of the question whether the negative formulation in the instruction (“not”) or mentioning of the to-be-avoided area (“keeper”) was responsible for the occurrence of ironic effects.

³ The argument for using the average of the two trials here is that they provide a more reliable measure of performance, and thus of ironic performance, than individual trials. Note that averages were not the result of a combination of one shot closer and one shot further away from the keeper, which would have been possible. In fact, all individual shots in the ironic selection were closer to the keeper, and 88% actually met the criterion of 10 cm closer to the keeper. Furthermore, we considered taking a closer cut-off point as undesirable because we felt it would not be justified to call performance within 10 cm of the ‘accurate’ performance as ironic. Analyses with a cut-off point of 15 cm only led to minor changes.

Furthermore, to further explore the ironic effects and whether they were *mediated* by fixation duration on the keeper a mediation analysis consisting of three regression analyses (cf. Baron & Kenny, 1986; Judd & Kenny, 1981) was done over the individual trials of the 13 participants who showed ironic effects, as this was our population of interest. Three individual trials were excluded from the analyses because their combination of gaze behavior and performance (fixation duration $\times$ distance from the keeper) was more than 2 standard deviations away from the overall mean leading to analyses with 75 trials (13 participants $\times$ 2 trials $\times$ 3 instructions minus 3). Because the data included repeated measurements, the effects of fixation duration and instruction on the horizontal distance that the ball landed from the keeper (in short, distance from the keeper) were quantified using generalized estimating equations (GEE) (Liang & Zeger 1993). These regression analyses consider the measurements within participants as repeated measurement and account for this dependency. Following the approach of Baron and Kenny (1986) we used three GEE regression analyses to examine the role of fixation duration on the keeper as mediator of the relationship between the instructions and ironic performance. As a first step, the regression analyses must show that the initial variable (instruction) is significantly related to the outcome (distance from the keeper). In the current study this first regression merely confirms the classification of ironic performance, yet it is needed as a first step in the mediation analysis to be compared with the third regression. Moreover, it does provide additional insight into the degree to which both instructions induced ironic effects. The second regression analysis must show that initial variable (instruction) is also significantly related to the expected mediator (fixation duration on the keeper). The final regression analysis must show that the mediator (fixation duration) significantly affects the outcome variable (distance from the keeper) while controlling for the effects of the initial variable (instruction). Gaze behavior can be considered a mediator when the effects of instruction on shooting performance (distance from the keeper) are zero (or at least decreased) in the final regression analysis compared to the first regression analysis.

Specifically, in the first regression analysis it was tested whether instruction (i.e., the not-keeper and the pass-keeper instructions) was correlated with

distance from the keeper according to:

$$DK = \text{constant} + B_1 \cdot NK + B_2 \cdot PK$$

in which DK is the distance from the keeper (cm), NK is the not-keeper instruction (= 1; accurate and pass-keeper instructions were set at 0), PK is the pass-keeper instruction (= 1; accurate and not-keeper instructions were set at 0), and B_1 and B_2 are regression coefficients. The constant comprises the estimated average value of the shooting performance in response to the accurate instruction.

In the second regression analysis the instruction conditions were related to fixation duration on the keeper according to:

$$FD = \text{constant} + B_1 \cdot NK + B_2 \cdot PK$$

in which FD is the fixation duration (ms), NK is the not-keeper instruction and PK is the pass-keeper instruction. The constant comprises the estimated average value of the fixation duration on the keeper in response to the accurate instruction.

In the third regression analysis instruction as well as fixation duration on the keeper were related to shooting performance according to:

$$DK = \text{constant} + B_1 \cdot NK + B_2 \cdot PK + B_3 \cdot FD$$

in which DK is the distance from the keeper (cm), NK is the not-keeper instruction, PK is the pass-keeper instruction, FD is the fixation duration (ms), and $B_1 - B_3$ are regression coefficients, whereas the constant comprises the estimated average value of the shooting performance in response to the accurate instruction.⁴

⁴ For the sake of completeness, we also explored whether the relationship between the instructions and distance from the keeper was *moderated* by fixation duration on the keeper, that is, whether the effect of instruction on distance from the keeper is different for short fixation durations compared to long fixation durations. In a final regression analysis the interactions between both instructions and fixation duration were included in the model, yet this regression revealed no effects of the interactions, and is therefore not further reported here.

For each regression model we also computed the explained variance (R^2), that is, we computed the correlation coefficient between the real outcome and the predicted outcome.

Results

Number of participants showing ironic shooting performance

Of the 32 participants, 13 participants shot the ball on average more than 10 cm closer to the keeper after the not-keeper instruction or the pass-keeper instruction or both, relative to the performance after the accurate instruction. In particular, 7 participants showed ironic shooting performance after both instructions, 2 and 4 additional participants showed ironic shooting performance after only the not-keeper or pass-keeper instruction, respectively. Thus, there were 9 participants who showed ironic performance after the not-keeper instruction (23 who did not) and there were 11 participants who showed ironic shooting performance after the pass-keeper instruction (21 who did not). In short, after both experimental instructions similar numbers of participants showed ironic effects, which was confirmed by a chi-square test that did not reveal significant differences between those ratios, $\chi^2(1) = 0.29, p = .59$.

The relationships between instruction, fixation duration, and ironic shooting performance

The first regression confirmed the classification procedure: both instruction conditions significantly affected the distance that the ball landed from the keeper (Table 4.1, Mediation 1). The regression equation was:

$$DK = 79.65 - 19.08 \cdot NK - 17.91 \cdot PK$$

implying that in response to the accurate instruction on average balls landed almost 80 cm from the keeper. Furthermore, following both the not-keeper and pass-keeper instruction balls landed almost 20 cm closer to the keeper. Thus, both instructions affected shooting distance from the keeper to a similar degree (see regression coefficients). Together the instructions explain 50% of the variance.

Table 4.1. Results from the regression analyses concerning the relationships between instruction, fixation duration and distance from the keeper.

		Constant	1 Not-keeper (1) accurate and pass-keeper (0) B_1	2 Pass-keeper (1) accurate and not-keeper (0) B_2	3 Fixation duration on the keeper B_3	R^2
MEDIATION 1 Distance from keeper	Coefficient	79.67	- 19.08	- 17.91		0.50
	SE	4.19	3.05	2.96		
	<i>p</i> -value	0.00	0.00	0.00		
MEDIATION 2 Fixation duration on keeper	Coefficient	266.92	138.46	162.12		0.43
	SE	28.15	44.76	47.42		
	<i>p</i> -value	0.00	0.00	0.00		
MEDIATION 3 Distance from keeper	Coefficient	86.28	- 15.64	- 13.79	-0.03	0.57
	SE	4.78	2.83	3.08	0.01	
	<i>p</i> -value	0.00	0.00	0.00	0.01	

Note. The actual values, standard errors (SE), and corresponding *p*-values are presented of the constant and the regression coefficients B_1 - B_3 . The constant represents the predicted average for distance from the keeper (cm) or fixation duration on the keeper (ms) in response to the accurate instruction. The proportion of the explained variance (R^2) to compare the values predicted by the GEE model and the actual values at group level is also presented.

Ironic effects in penalty shooting

The second regression analysis showed that both instruction conditions also significantly affected fixation duration on the keeper (see Table 4.1, Mediation 2). The regression equation was:

$$FD = 267 + 139 \cdot NK + 162 \cdot PK$$

In the accurate instruction participants fixated their gaze on average for 267 ms on the keeper. Furthermore, under the not-keeper and pass-keeper instruction they fixated the keeper 139 ms and 162 ms longer, respectively, together explaining 43% of the variance.

The third regression analysis showed that fixation duration on the keeper corrected by instruction condition affected distance from the keeper (see Table 4.1, Mediation 3). The regression equation was:

$$DK = 86.28 - 15.64 \cdot NK - 13.79 \cdot PK - 0.03 \cdot FD$$

The equation makes clear that irrespective of instruction distance from the keeper decreased significantly with an increase in fixation duration on the keeper, that is, with 3 cm for every 100 ms, which indicates that fixation duration on the keeper indeed played a mediating role in inducing ironic effects. Within the range of observed durations of fixation (100-600 ms) this would result in an additional decrease of 3 to 15 cm of shooting performance. Furthermore, the not-keeper and pass-keeper instructions caused a similar significant decrease in shooting performance of almost 16 cm and 14 cm, respectively. As both instructions still continued to affect shooting distance from the keeper in the final regression analysis independent of fixation duration (see Table 4.1, Mediation 3), the effect of mediation is considered to be partial. Together both instructions and fixation duration explained 57% of the variance. Overall, these analyses reveal a partial mediating role of fixation duration on the keeper when ironic shooting performance occurs. Moreover, they show that negatively as well as positively formulated instructions affect performance to a similar degree, that is, both instruction types lead to similar levels of ironic performance.

Discussion

The main aim of the present study was to find out whether the negative formulation in the instruction (“not”) or mentioning of a to-be-avoided area (“keeper”) is responsible for the ironic effects in the perceptual-motor domain. To this aim we examined ironic effects in an indoor penalty-kick task using negatively worded (not-keeper) and positively worded (pass-keeper) instructions to induce ironic effects. Most important, ironic effects occurred not only following negatively worded instructions but also after positively worded instructions containing the word keeper. This demonstrates that mentioning the to-be-avoided area (‘keeper’) rather than the negative formulation (‘not’) is crucial in inducing ironic effects in this penalty kick task. This was corroborated by the subsequent regression analyses that further explored the relationships between instruction, duration of fixations on the keeper, and (ironic) shooting performance. The analyses revealed that both instructions led to ironic effects to a similar degree. Furthermore, they revealed that ironic effects were (partially) mediated by fixation duration on the keeper indicating that ironic effects (shots closer to the keeper) were preceded by significantly longer fixations on the keeper. This is consistent with earlier findings (Bakker et al., 2006; Binsch et al., 2009) and shows that ironic effects in the perceptual-motor domain can be affected by longer fixations on the to-be-avoided area. This provides insight into the underlying mechanisms involved in ironic effects and supports the idea that in far aiming specific instructions disrupt the attentional control in the aiming action leading to ironic gaze as well as aiming behavior (Binsch et al., 2009).

Still, it should be noted that the accurate condition was always the first condition because we needed a measure of baseline performance unaffected by the other instructions. As a consequence, during the not-keeper and pass-keeper conditions participants may have adopted another intention than just to shoot accurately. Such a change in intention would not undermine the current findings, as changes in intention are at the core of ironic effects in perceptual-motor performance. Ironic effects exist by virtue of subtle and unconscious manipulations of intentions (using verbal instructions; Wegner, 1994). For instance, when instructed to shoot accurately but to also make sure not to shoot within reach of the keeper or to pass the keeper, the intention to avoid the keeper may lead to an ironic effect. It is also known that with such dual instructions participants may choose to overcompensate (cf. Körding & Wolpert, 2006;

Trommershäuser, Maloney, & Landy, 2003), that is, to shoot further away from the keeper even at the risk of shooting next to the goal. In several studies concerning golf-putting such overcompensation was also found (Beilock et al., 2001; De la Peña et al., 2008). Future studies are needed to investigate the occurrence of ironic effects as well as overcompensation in the current setting and other perceptual-motor tasks.

A question that remains is why in the current experimental circumstances some participants showed ironic effects while others did not. Apart from situational constraints, as people may react differently at different times in different settings, it is suggested that there may also be specific dispositions that are related to the vulnerability to ironic effects, such as regulatory focus (Higgins, 1997, 1998; Plessner, Unkelbach, Memmert, Baltes, & Kolb, 2009), action-control (Jostmann & Koole, 2007; Kuhl, 1994) or repression (Woodman & Davis, 2008). Regulatory focus refers to different modes of self-regulation, where people may differ in whether they approach a certain task, for instance, a penalty kick with a prevention focus (don't miss) or a promotion focus (make the goal; Plessner et al., 2009). It may be that in the current study the added instruction to 'be particularly careful' already appealed to the preferred focus of participants. In a similar fashion action control refers to mental processes involved in pursuing intentions where action-oriented people appear to perform better under pressure than state-oriented people (Jostmann & Koole, 2007). Repression refers to different coping styles in situations in which people encounter unpleasant emotions, such as anxiety. People who repress such emotions were found to show ironic effects, while others did not (Woodman & Davis, 2008). Still, that one person is more susceptible to ironic effects does not mean that this person will always show ironic effects. Similarly, that another person is less susceptible to ironic effects does not mean that this person will never show ironic effects. Future studies should examine to what degree situational constraints or personality dispositions are decisive in the occurrence of ironic effects (and overcompensation).

Furthermore, our findings should, of course, not be taken to imply that in actual penalty kicking the same results would have been found. For one, on an actual football pitch time-constraints are different from those employed here; a penalty taker has more time than one second. Furthermore, in 'real' penalty kicks there is often an interplay between the penalty taker and the goalkeeper during which

both try to conceal their true movement intentions. Finally, our experiment did not even begin to approach the pressurized situations with which penalty takers are confronted when taking a decisive penalty in a nerve-racking shootout (see Jordet, Elfering-Gemser, Lemmink, & Visser, 2006). In short, the generalizability of our findings to on-field penalty taking should be viewed with caution. Still, though perhaps not representative for on-field competitive penalty taking per se, the current design, including life-like video projection and actual kicks as response, is representative for complex perceptual-motor behavior, making it appropriate to reveal more general principles underlying the (ironic) effects of instructions on gaze and aiming behavior in tasks with a target and possible distracters (for discussion on representative design see Brunswik, 1956 and Dhimi, Hertwig, & Hoffrage, 2004).

Theoretically, the current study makes clear that in the perceptual-motor domain a negative formulation is not required to initiate ironic mental processes. Ironic effects may be triggered by negative as well as positive instructions in which the to-be-avoided area is mentioned. Apparently mentioning the keeper suffices to trigger the processes described by Wegner (1994) that may eventually lead to ironic effects. Note that no specific load was used to overload the attentional system which is claimed to be a condition for ironic effects to occur (Wegner, 1994). However, in the current study participants were urged to shoot within one second, which introduced a moderate amount of time pressure. Due to this time pressure, the mental controlling process may have failed to replace the unwanted thought or action (keeper) leading to more shots in the direction of the keeper. This would suggest that time pressure may in fact lead to ironic effects (Wegner, 1994). Specifically, it may have been the case that after visual attention was ironically drawn to the keeper as a result of the specific instructions, there was insufficient time to redirect visual attention and fixate the target, the open goal space, long enough for more accurate aiming (Bakker et al. 2006). It is well-documented that such a relatively long final fixation on the target (called 'quiet eye') is essential for good performance in far aiming tasks (e.g., de Oliveira, Oudejans, & Beek, 2006; Oudejans, van de Langenberg, & Hutter, 2002; Wilson, Vine, & Wood, 2009; for an overview see Vickers, 2007). Future studies are needed to investigate the role of quiet eye as well as time pressure in ironic effects in the perceptual-motor domain.

Practically, if an ironic effect occurs it provides a hindering phenomenon for the performer, be it in sports or another task environment, which may have

far reaching consequences such as losing a championship. As such, it is desirable to prevent ironic effects as much as possible. Insight into the underlying mechanisms of ironic effects may provide starting points to do that. For now it seems that, at least for aiming actions, not only negatively worded instructions but also positive ones may affect gaze behavior, or aiming behavior or both, leading to ironic effects. Generally, sport psychology research suggests that positive imagery (i.e., imagining a successful outcome) or positive self-talk (involving positive and rational thoughts and statements) are associated with successful performance (Wann, 1997), while negative imagery (i.e., imagining an unsuccessful outcome) and negative self-talk (involving negative and self-defeating thoughts and statements) are associated with performance decrements (e.g., Beilock et al, 2001; Van Raalte et al., 1995; Woolfolk et al., 1985). It now appears that even positive wording (make sure that you pass the keeper) can prime ironic behavior. Until recently it has been suggested that it is better to avoid negatively worded instructions and, thus, to focus on what to do rather than what not to do (Bakker et al., 2006; De la Peña et al., 2008). It now seems that this important principle is not necessarily sufficient to prevent unwanted effects. The focus on what to do (e.g., pass the keeper) should be combined with the right wording involving the target (e.g., shoot in the open space), which was found by Bakker et al. to lead to the most accurate performance, as mentioning the target will draw attention, and hence, performance more in the direction of the target. Positive instructions that involve objects that should be avoided and are present in the visual field of athletes may still prime unwanted behavior, as visual attention is then ironically drawn to these to-be-avoided objects.

In short, words referring to the to-be-avoided area or behavior should be avoided in instructions altogether; just avoiding negative instructions is not sufficient. Therefore, in aiming actions coaches, trainers and athletes are advised to only use positive instructions that involve the target, such as, the open goal space in penalties, the hoop in basketball, the triple 20 or bull's eye in darts, the hole in golf putting, or the apple on the head of Wilhelm Tell's son (cf. Trommershäuser et al., 2003), so that the target rather than the to-be-avoided area will draw attention, leading to successful performance. Only such positive instructions may best guarantee that ironic effects are prevented.

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Chapter 5

Ironic effects and final target fixation in a penalty shooting task

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Abstract

The aim of the present study was to find out whether ironic effects in a far aiming task were accompanied by shorter final fixations on the target. Generally, it is well known that a sufficiently long final fixation on the target is of crucial importance for accurate performance in far aiming. Recently, it has been shown that ironic effects in golf putts and penalty kicks (in which one does the opposite of what was intended, e.g., shoot close to the keeper while attempting to avoid this) were preceded by longer fixations on the to-be-avoided area, which may have resulted in shorter final fixations on the target area. Therefore, in the current study we examined football players taking penalties in a simulated penalty environment with and without instructions to avoid the goalkeeper. The findings revealed that ironic effects were indeed accompanied by significantly shorter final fixations on the target area, i.e., the open goal space. It is concluded that in far aiming tasks, ironic effects are accompanied by insufficiently long final fixations on the target.

Introduction

In taking penalties in football the persistent wish not to miss may, ironically, increase the likelihood that this is precisely what will happen (cf. Bakker, Oudejans, Binsch, & Van der Kamp, 2006). In general, the intention to avoid an action may paradoxically increase the tendency to engage in this action (Beilock, Afremow, Rabe, & Carr, 2001; De la Peña, Murray, & Janelle, 2008; Janelle, 1999; Wegner, 1994; Woodman & Davis, 2008). Recent studies in the perceptual-motor domain have shown that there is a strong relationship between visual attention and performance when ironic effects occur (Bakker et al. 2006; Binsch, Oudejans, Bakker, & Savelsbergh, 2009; Wegner, Ansfield, & Pilloff, 1998). Binsch et al. (2009) showed, for instance, that ironic effects in golf putting were related to changes in gaze behavior. More specifically, they found overall longer average durations of the fixation on the to-be-avoided areas (in front of or behind the hole) and shorter average durations of the fixation durations on the hole when ironic effects occurred.

Bakker et al. (2006) tested experienced football players shooting penalties with a time constraint of 1 second in a simulated penalty environment during differently worded instructions. The task was to shoot footballs towards a screen on which video clips of a goal and goalkeeper were presented for one second. The players were asked to shoot as accurately as possible (“*accurate condition*”), not to shoot within reach of the keeper (“*not-keeper condition*”), or to shoot to the target area, the open goal space (“*open-space condition*”). Results showed that in the *not-keeper* condition gaze and shots were more often directed to the to-be-avoided area (the keeper) compared to the *accurate* and *open-space* conditions. Bakker et al. suggested that initial fixations on the keeper may have prevented participants from redirecting their attention to the more appropriate area for aiming (open goal space), resulting in more shots at the keeper.

Still, neither Binsch et al. (2009) nor Bakker et al. (2006) directly examined the role of the *final* fixation on the target when ironic effects occurred. It is a well-established fact that the final fixation on the target prior to and during the final movement (often referred to as “quiet eye”) is essential in far aiming tasks in general (e.g., Vickers, 1992, 1996; Williams, Singer, & Frehlich, 2002; Wilson, Vine, & Wood, 2009; for an overview see Vickers, 2007). In a broad variety of tasks, it has been shown that for accurate aiming a longer final fixation on the target prior to and during the aiming action is a characteristic of high levels of skill and accuracy (cf. Vickers, 2007). Furthermore, it appears that

emotional factors such as anxiety may lead to shorter final fixations on the target, followed by a decrease in performance (Behan & Wilson, 2008; Vickers & Williams, 2007; Wilson, Vine, & Wood, 2009). The findings by Bakker et al. (2006) that penalty shooters showing ironic effects spend more time looking at the keeper may imply that, as a consequence, the final fixation on the open-goal space is shorter, which in turn might lead to worse performance.

In the present study we examined whether ironic effects in aiming are indeed accompanied by a shorter final fixation on the target. To this aim we investigated football players taking penalty kicks in a similar setting as the one used by Bakker et al. (2006) following negatively and positively worded instructions. More specifically, experienced football players shot penalties, with a constraint on the response time of 1.5 s, while instructed to shoot as accurately as possible (“*accurate* condition”), to shoot as accurately as possible while being careful not to shoot within reach of the keeper (“*not-keeper* condition”), and to shoot as accurately as possible while being careful to shoot into the open goal space (“*open-space* condition”). We measured shooting performance, gaze behavior, and response time (time elapsing between presentation of the imperative stimulus, i.e., the presentation of the projected goal and goalkeeper on a screen and the moment of foot-ball contact).

Because not all persons tend to show ironic behavior (Beilock et al., 2001; Binsch et al., 2009; De la Peña et al., 2008; Wegner, 1994; Woodman & Davis, 2008), we first distinguished participants who did and did not show ironic effects in the *not-keeper* condition. Then we compared shooting performance, duration of the initial fixation on the keeper, onset and duration of the final fixation on the open goal space, and response time across the three instruction conditions (i.e., *accurate*, *not-keeper*, *open-space*) for those participants who did and who did not show ironic effects. Most importantly, we subsequently assessed whether responses indicative of ironic effects were accompanied by longer fixations on the keeper (as was found by Bakker et al., 2006) and shorter final fixations on the open goal space than responses not showing ironic effects. Given the relevance of final target fixations for far aiming and the aforementioned results by Bakker et al. (2006) and Binsch et al. (2009) we expected ironic effects to co-occur with longer keeper fixations and shorter final fixations on the open goal space.

Methods

Participants

Thirty-two male intermediate football players from a district amateur league (mean age = 21.8 years, $SD = 2.1$) participated in the experiment. On average, they had 12.6 years ($SD = 4.7$) of experience in football competition. At the time of the study all participants were actively engaged in football competition and they practiced, on average, two times (totaling three hours) a week. The experiment was approved by the ethics committee of the Faculty of Human Movement Sciences, VU University, Amsterdam. Each participant gave his written informed consent before starting with the experiment.

Task and design

Video clips of a stationary goalkeeper anticipating a penalty kick were shown on a large screen (see Figure 5.1). The clips were made from the perspective of a penalty taker. The task of the participant was to take a penalty without run up towards the projected goal. The player was instructed to hit the screen before the projection disappeared, i.e., within 1.5 s after its appearance. Pilot testing had revealed that 1.5 s provided players with more than enough time to execute the penalty kicks (Bakker et al. [2006] used a time constraint of only 1.0 s).

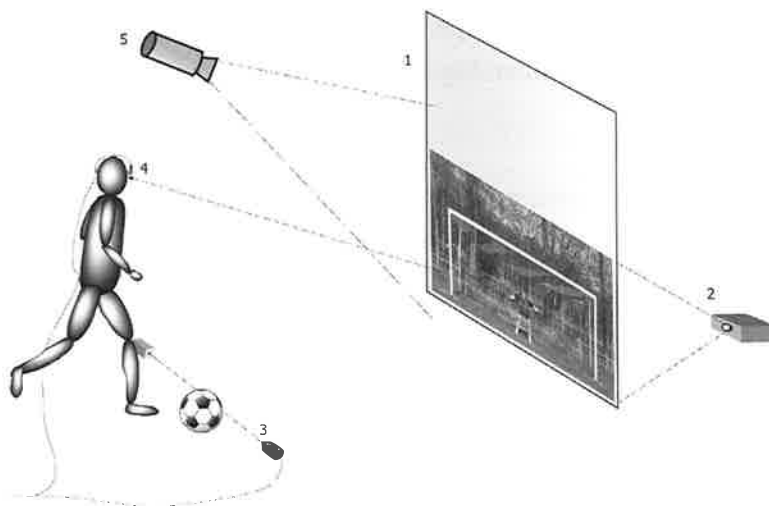


Figure 5.1. Experimental setup: The screen (1) on which the video clips were back-projected with a projector (2), the optical switch (3) that was used to determine when the ball was kicked, the eye-tracker (4) worn by the participant and the screen camera (5) to determine the shooting performance.

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The goalkeeper presented in the video clips stood either in the center of the goal, or 0.15 or 0.30 m to the left or to the right from the center, resulting in five clips, one for each position. The off-center positions of the keeper were included to induce variation into the shot directions of the players. Each of the five clips was presented once in each of the three instruction conditions, resulting in five trials per condition. Within each condition the five trials were randomized. The instructions in each of the three conditions were as follows: (1) just shoot as accurately as possible: *accurate* condition; (2) shoot as accurately as possible, and be careful not to shoot within reach of the keeper: *not-keeper* condition; (3) shoot as accurately as possible and be careful to shoot into the open space: *open-space* condition. What it meant to “shoot as accurately as possible” was explained to the participants prior to testing by showing each video clip while holding the football (1) close to both the left and the right goal post when the goalkeeper stood in the center of the goal, and (2) close to the goal post that was furthest away from the goalkeeper when the latter stood off-center. In all cases the ball was held close to the ground.

As we wished to determine a baseline measure (both with respect to performance and gaze behavior) unaffected by specific additional instructions, the *accurate* condition was always presented first. The other two conditions were counterbalanced. Furthermore, following the methodology of Binsch et al. (in press) only trials with the keeper in the center position were analyzed as these provided the most unambiguous determination of (ironic) shooting performance.

As anticipated, not each participant showed ironic performance in the *not-keeper* condition: Relative to the *accurate* condition some participants shot closer to the keeper in the *not-keeper* condition while others did not. Therefore, we distinguished participants who did show ironic effects in the *not-keeper* condition from those who did not, according to a criterion specified below (see Data reduction). Therefore, the analytical design of the study also included a group factor (with an “ironic” and “not-ironic” group).

Experimental set-up

The video clips (made with a digital video camera, Sony XJ 2000) were back-projected, using a mirror and projector, on a large projection screen (2.29 x 2.27

m; see Figure 5.1). The projection size of the clips was 2.20 x 1.05 m with a projected goal size of 2.00 x 0.81 m. At each presentation, lasting 1.5 s, the player shot a foam ball ($\varnothing = 21$ cm, weight: 296 gram; thus, with about the same diameter and weight as an official futsal, i.e., indoor football, size 4) to the projected goal from a penalty spot located at a distance of 2.83 m from the screen. At that distance the visual angles subtended by the projected goal closely resembled the visual angles subtended by the goal for soccer players taking a real life penalty from 11 m. A Canon-XM1 video camera, connected to a JVC digital video (DV) recorder and directed at the screen, was used to record shooting performance (at 50 Hz). The video camera was suspended 2.80 m directly above the penalty spot and aimed at the screen.

Gaze behavior was registered using an eye-tracking system (Applied Science Laboratories 501, Bedford, MA) that consisted of a head-mounted scene and (infrared) eye camera. With the eye-camera, detecting the displacement between the left pupil and cornea reflex relative to a pre-calibrated nine-point grid, the point-of-gaze was determined and integrated into the image of the scene camera that was recorded for further analysis. The accuracy of the system was ± 1 -degree visual angle. The calibration of the system was checked before each trial; if necessary, the system was recalibrated (on average once per 10 trials). The eye-tracker was connected to the main computer with a six-m long cable, which was attached to the waist of the participant but permitted undisturbed shooting mobility.

We used an optical switch located just behind the penalty spot to determine the moment when the ball was hit. The optical switch was operated by an infrared light beam that was interrupted by the ball when it had been kicked (see Figure 5.1). This interruption was converted to a signal that was sent to a Light Emitting Diode (LED) mounted in front of the ASL scene camera (invisible for the participant). Thus, as soon as the ball was hit, the LED turned on and was visible in the scene camera recordings, making it possible to relate gaze behavior to the moment that the ball was kicked.

Procedure

Participants were tested individually. After a brief general explanation of the experiment participants provided written informed consent. The participant then

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completed 20 warm-up shots to a white circle ($\varnothing = 30$ cm) projected during two seconds on the black screen at different locations at ground level. After the warm-up, the participant was equipped with the eye-tracker, the system was calibrated and it was explained what it meant to 'shoot as accurately as possible'. Then the participant made 10 practice shots to randomly selected clips of goal and keeper, without further instruction. Subsequently the trials of the three experimental conditions (three times five shots) were performed. Prior to each trial the instruction in question was repeated verbally. Then, a video clip was presented and the participant kicked the ball towards the goal. After the ball hit the screen, the ball was collected and repositioned on the penalty spot by the experimenter. Hereafter, participants were instructed to look at certain marks on the screen to verify eye-tracker calibration. Then the next instruction was given, and so on.

Data reduction

As indicated before, only the trials with the keeper located at the center of the goal were analyzed, thus the resulting data set consisted of 32 (participants) $\times$ 3 (conditions) $\times$ 1 (shot) = 96 trials. For each of these trials we determined shooting performance, that is, the horizontal distance of the ball (in cm) from the center of the goal (keeper) when the ball hit the screen (in short: distance from the keeper). In connection with this it should be noted that ball trajectories were almost always close to the ground; only in 6 cases the ball landed high in the goal. Single bitmap images were captured with Adobe Premiere 6.5 from the video recordings made by the scene camera. With these images X- coordinates of the landing position of the ball were digitized using Image Digitizing Software "DIDGE" (cf. Binsch et al., 2009). The distance between the goalposts was used for calibration.

When, in the *not-keeper* condition, the ball landed at least 10 cm closer to the keeper than in the *accurate* condition, this was interpreted as an ironic effect. This criterion, albeit arbitrary, seemed reasonable, the difference of 10 cm being half the standard deviation of shooting performance in the *accurate* condition (20.2 cm), and thus substantial. (The results of the analyses with a criterion difference of 15 cm proved to be very similar to the results presented below). To further validate our criterion we also investigated the number of times that this criterion was met in the *open-space* condition, in which by definition ironic effects are out of the question.

Inspection of the video recordings made clear that almost all gaze behavior was within the goal space (enclosed by the goal posts and bar), although occasionally participants' gaze was directed at the floor in front of the goal or outside of the goal. For the purposes of the current study fixations were coded in terms of three relevant locations within the goal, viz. one keeper area that extended from 40 cm to the right to 40 cm to the left of the center of the goal (i.e., the middle 80 cm of the goal) and two open goal spaces, extending 60 cm inwards from each goal post. Together, the latter two areas are referred to as open goal space. We determined the onset and durations of the fixations on the keeper and the final fixation on the open goal space by analyzing the gaze recordings (frame-by-frame; 20 ms per frame) from the first moment during response time that the gaze was directed at the screen until the moment at which the football was kicked. In line with the literature the gaze at a specific location had to last at least 100 ms, that is, five or more video frames, to be defined as a fixation (cf. Vickers 1992, 1996, 2007; Williams, Davids, & Williams, 1999).

Finally, in order to check if the expected shorter final fixations on the open goal space in the *not-keeper* condition might have been due to shorter response times, it was checked whether the response times differed across conditions.

Results and discussion

Number of participants showing ironic performance

There were 14 participants who met the criterion for ironic effect in the *not-keeper* condition and 18 who did not. In the *open-space* condition there were only 2 participants who met the criterion used for ironic effect versus 30 who did not. The chi-square test confirmed that the number of times that the criterion was met in the *not-keeper* condition was significantly higher than in the *open-space* condition, $\chi^2(1) = 12.0, p < .01$. These figures indicate that shots that met the criterion for ironic effect in the *not-keeper* condition did indeed reflect ironic performance rather than accidental variations in performance.

Shooting performance

Firstly we conducted a 2 (group: "ironics" [$n = 14$], "not-ironics" [$n = 18$]) $\times$ 3 (condition: *accurate*, *not-keeper*, *open-space*) repeated measures ANOVA on shooting performance. This ANOVA revealed a significant main effect for condition, $F(2, 60) = 6.82, p < .01, \eta_p^2 = .19$, and no significant main effect for

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group, $F(1,30) < 2.5$, $p > .10$. Further, as should of course be the case because of the classification procedure used to distinguish “ironics” from “not-ironics”, a significant interaction between group and condition, $F(2, 60) = 13.06$, $p < .001$, $\eta_p^2 = .30$, was found (see Figure 5.2A and 5.2B). Post hoc pair-wise comparisons using Bonferroni correction confirmed that participants who showed ironic performance in the *not-keeper* condition shot 24.3 cm closer to the keeper in this condition compared to the *accurate* condition, $p < .01$ (Figure 5.2A). Moreover, these participants also shot 24.6 cm closer to the keeper in the *not-keeper* condition than in the *open-space* condition, $p < .01$, a difference that played no role in the classification procedure. By comparison, there were no significant differences in shooting distance from the keeper among the three conditions for participants who showed no ironic performance, $ps > .17$ (Figure 5.2B).

Gaze behavior

Figure 5.2C and 5.2D show average durations of fixations on the keeper and on the open goal space until the ball was kicked in each of the conditions for those participants who showed ironic effects (Figure 5.2C) and for those who did not (Figure 5.2D). As can be seen, there were two general patterns of gaze behavior. In all cases participants first fixated the keeper followed by a final fixation on the open goal space. In most cases this final fixation on the open goal space lasted until the ball was kicked (e.g., the *accurate* and *open-space* conditions in Figure 5.2C). In a number of cases participants returned their gaze to the keeper before the ball was kicked (e.g., *not-keeper* condition in Figure 5.2C). To test whether ironic effects in the *not-keeper* condition (see Figure 5.2A) were accompanied by either a longer first fixation duration on the keeper, an earlier onset or a shorter duration of the final fixation on the open goal space, or a combination of these, 2×3 mixed design ANOVA's were conducted with the factors group (“ironics”, “not-ironics”) and condition (*accurate*, *not-keeper*, *open-space*) and with repeated measures on the last factor.

Duration of the initial fixation on the keeper. The first 2×3 ANOVA on duration of the fixation on the keeper before the final fixation on the open goal space revealed neither a significant main effect for group or condition, nor a significant interaction between group and condition, $F_s < 2.5$, $ps > .10$, indicating that the ironic performance was not accompanied by a longer initial fixation duration on the keeper (see Figure 5.2C and 5.2D).

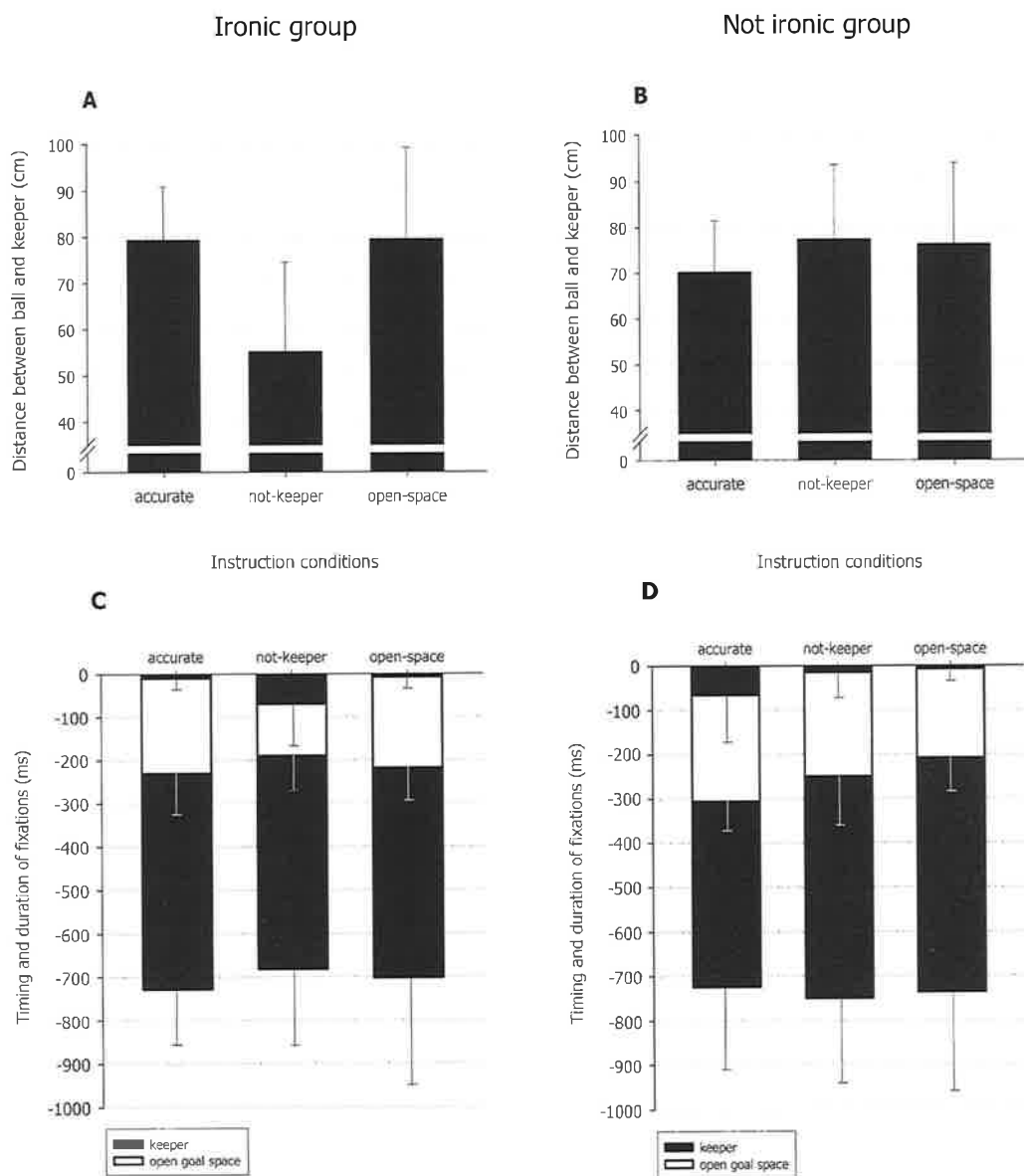


Figure 5.2. Mean shooting distance from the keeper in cm (with SD) for the “ironic” group (Panel A) and the “not-ironic” group (Panel B) in the three instruction conditions. Mean duration of the initial and second fixation on the keeper in ms (with SD; black areas) and mean duration of the final fixation on the open goal space in ms (with SD; white areas) from the “ironic” group (Panel C) and the “not-ironic” group (Panel D) in the three instruction conditions. The times along the y-axis are presented relative to zero indicating the moment that the ball was kicked. (Note that the mean durations of the second fixation on the keeper may be less than 100 ms because many participants did not fixate the keeper for a second time; see text for explanation).

Ironic effects and final target fixation

Onset of the final fixation on the open goal space. The group $\times$ condition ANOVA on the onset of the final fixation on the open goal space revealed a trend for group, $F(1, 30) = 3.52$, $p = .071$, $\eta_p^2 = .10$, and a main effect for condition, $F(2, 60) = 3.62$, $p < .05$, $\eta_p^2 = .11$, in the absence of a significant interaction between group and condition, $F(2, 60) < 1.5$, $p > .25$. Post hoc pair-wise comparisons with Bonferroni correction revealed that the onset of the final fixation on the open goal tended to be earlier in each condition for the participants who showed ironic effects ($M = 214$ ms before ball contact) compared to participants who did not show ironic effects ($M = 225$ ms before ball contact), $p = .071$. Furthermore, participants also showed an earlier onset of the final fixation on the open goal space in the *accurate* condition ($M = 273$ ms before ball contact) compared to the *open-space* condition ($M = 208$ ms before ball contact), $p < .05$.

Duration of the final fixation on the open goal space. The ANOVA on the final fixation on the open goal space revealed a trend for group, $F(2, 60) = 3.79$, $p = .061$, $\eta_p^2 = .11$, a significant main effect for condition, $F(2, 60) = 6.18$, $p < .01$, $\eta_p^2 = .17$, as well as a significant interaction between group and condition, $F(2, 60) = 6.41$, $p < .01$, $\eta_p^2 = .18$ (see Figure 5.2C and 5.2D). Post hoc pair-wise comparisons using Bonferroni correction showed that for participants who had shown an ironic effect in the *not-keeper* condition the average final fixation on the open goal space ($M = 129$ ms, $SD = 68$) in the *not-keeper* condition was significantly shorter than in the *accurate* ($M = 224$ ms, $SD = 79$) and the *open-space* ($M = 206$, $SD = 56$ ms) conditions, respectively ($ps < .01$, see Figure 5.2C). Thus, ironic performance was accompanied by shorter final fixations on the open goal space. Participants who did not show ironic performance did not have significantly shorter final fixations on the open goal space in the *not-keeper* condition compared to the other two conditions, $ps > .13$. The latter participants fixated the open goal space 39 ms longer in the *accurate* condition compared to the *open-space* condition, $p < .05$. Moreover, participants who did not show ironic shots fixated the open goal space 99 ms longer in the *not-keeper* condition than participants who did show ironic effects in this condition, $p < .01$ (see Figure 5.2C and 5.2D).

Response time

To check whether the shorter fixations on the open goal space that accompanied ironic effects were related to shorter response times, a group $\times$ condition ANOVA on response time was performed. There was a significant main effect for condition, $F(1, 30) = 15.99, p < .001, \eta_p^2 = .35$, but no significant main effect for group, $F(1, 30) < 0.50, p = .49$, and no significant interaction between condition and group, $F(2, 60) < .50, p = .66$. Post hoc pair-wise comparisons with Bonferroni correction revealed that the main effect for condition was due to the fact that the participants used more time for task execution in the *open-space* condition ($M = 1037$ ms, $SD = 206$) compared to the *accurate* ($M = 845$ ms, $SD = 158$) and *not-keeper* conditions ($M = 893$ ms, $SD = 208$), $ps < .01$. Importantly, the response times of the participants who showed ironic performance were not significantly shorter than those of the participants who did not show ironic performance. Thus, the shorter final fixation on the open goal space that accompanied ironic performance was not the result of reduced response times.

In sum, it seems probable that the final fixation on the open goal space in the *not-keeper* condition was not sufficiently long for participants who showed ironic performance in this condition. As a result of this short final fixation they seemed to have shot closer to the keeper. In principle, these shorter final fixations on the open goal space might have been due to a subsequent return of the gaze to the keeper before the ball was kicked (see Figure 5.2C, *not-keeper* condition), as well as to a long initial fixation on the keeper (even though on average the latter fixations in the *not-keeper* condition did not significantly differ between the participants who showed ironic performance and those who did not).

To shed light on this issue we split up the ironic group into those participants who showed an additional fixation on the keeper after the final fixation on the open goal space just before the ball was kicked ($n = 8$) and those who did not ($n = 6$). Figure 5.3 shows average shooting performance (top panels) as well as accompanying gaze behavior (bottom panels) for these two “ironic” subgroups. Duration of the initial fixation on the keeper, and the onset and the duration of the final fixation on the open goal space were further analyzed for these two subgroups. Shooting performance and response time were also further analyzed. However, these latter two analyses yielded no significant differences between the subgroups, indicating that both subgroups

showed ironic effects to the same degree and that these effects were not related to response time. Therefore, these analyses are not reported in detail (see Figure 5.3 top panels for shooting performance).

Comparison of the two “ironic” subgroups

Duration of the initial fixation on the keeper. A 2 (subgroup: “ironics” with extra fixation on the keeper [$n = 8$], “ironics” without extra fixation on the keeper [$n = 6$]) $\times$ 3 (condition: *accurate*, *not-keeper*, *open-space*) mixed design ANOVA on the average duration of the initial fixation on the keeper revealed no significant effect for group, no significant effect for condition nor a significant interaction between group and condition, $F_s < 0.75$, $p_s > .50$, indicating that initial fixations on the keeper were of comparable duration for both subgroups in all three conditions (see Figure 5.3C and 5.3D).

Onset of the final fixation on the open goal space. The group $\times$ condition ANOVA conducted on the onset of the final fixation on the open goal space revealed a trend for group, $F(1, 12) = 3.64$, $p = .081$, $\eta_p^2 = .23$, but no significant effect for condition, $F(1, 12) < 1.50$, $p = .33$. Furthermore, there appeared to be a significant interaction between group and condition, $F(2, 24) = 5.26$, $p < .05$, $\eta_p^2 = .31$. Post hoc pair-wise comparisons with Bonferroni correction revealed that the onset of the final fixation on the open goal space was significantly later in the *not-keeper* condition for participants who had no extra fixation on the keeper in this condition ($M = 87$ ms before foot-ball contact, see Figure 5.3D) compared to the participants who did have an extra fixation on the keeper ($M = 278$ ms before foot-ball contact, see Figure 5.3C), $p < .01$.

Duration of the final fixation on the open goal space. The group $\times$ condition ANOVA conducted on the duration of the final fixation on the open goal space revealed a significant main effect for condition, $F(2, 24) = 7.67$, $p < .01$, $\eta_p^2 = .39$, in the absence of a main effect for group and in the absence of a significant interaction between group and condition, $F_s < 0.75$, $p_s > .50$. Post hoc pair-wise comparisons only confirmed that for participants who showed ironic performance the final fixation on the open goal was shorter in the *not-keeper* condition compared to the *accurate* and *open-space* conditions, $p_s < .01$. Importantly, there was no significant difference in the duration of the final fixation on the open goal space between those who did and did not have an extra fixation on the keeper before the ball was kicked (see Figure 5.3C and 5.3D).

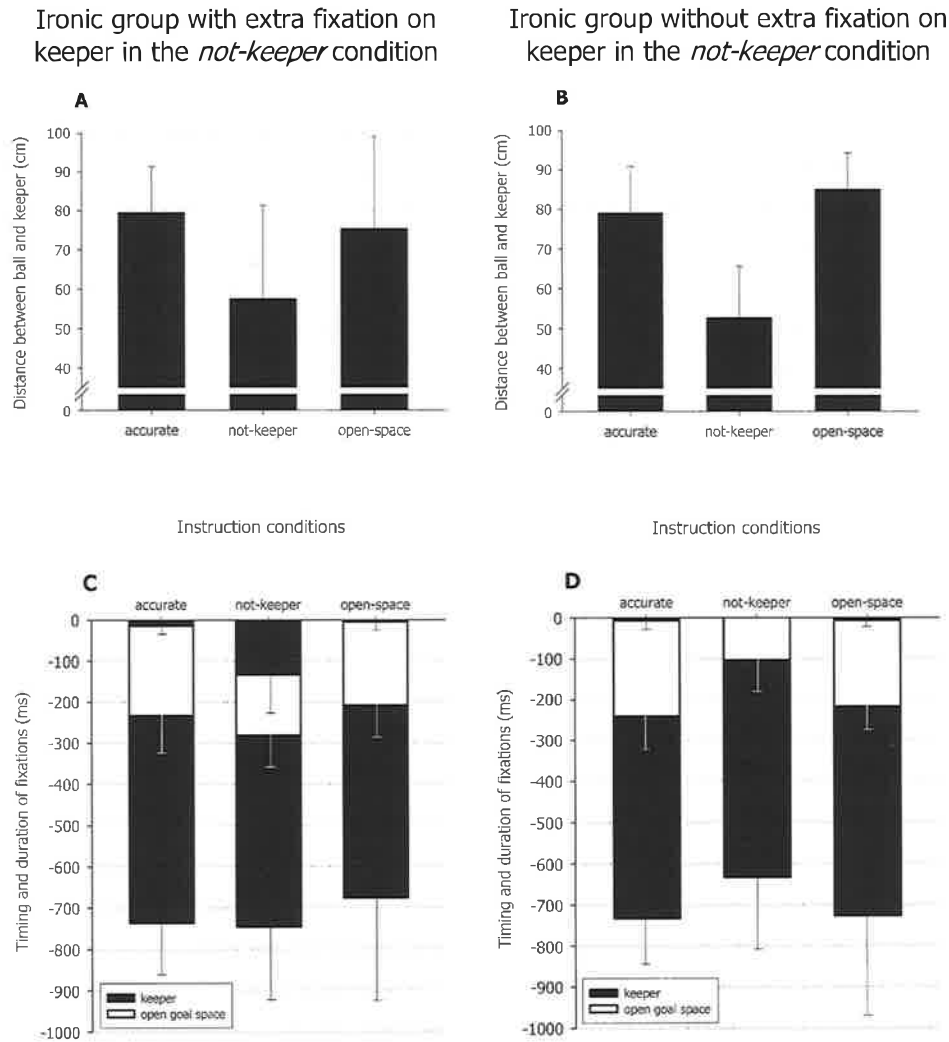


Figure 5.3. Mean shooting distance from the keeper in cm (with SD) for the “ironic” subgroup with (Panel A) and without (Panel B) a second fixation on the keeper in the not-keeper condition in the three instruction conditions. Mean duration of the initial and second fixation on the keeper in ms (with SD; black areas) and mean duration of the final fixation on the open goal space in ms (with SD; white areas) for the “ironic” subgroup with (Panel C) and without (Panel D) a second fixation on the keeper. (Note that the mean durations of the second fixation on the keeper may be less than 100 ms because many participants did not fixate the keeper for a second time; of course, the mean duration of this second fixation on the keeper equals 0 ms for the “ironic” subgroup in the not-keeper condition that did not fixate the keeper for a second time in this condition).

General discussion

The aim of the present study was to find out whether ironic effects in far aiming tasks are accompanied by shorter final fixations on the target, as would be expected on the basis of the literature (Bakker et al., 2006; Binsch et al., 2009). To this aim we tested experienced football players shooting penalties in an experimental penalty indoor setting under differently worded instructions. Fourteen of the 32 participants (44%) showed ironic performance in the *not-keeper* condition, which is more than reported in several other studies (De la Peña et al. 2008; Woodman & Davis, 2008; Binsch et al., 2009). Most importantly, the combined results confirm that ironic performance was closely related to an insufficiently long final fixation on the open goal space (the target) whether or not this fixation was followed by an additional fixation on the keeper. For the “ironic” group (and subsequently both “ironic” subgroups) the duration of the final fixation in the *not-keeper* condition was significantly shorter than in the other conditions. When performance was not ironic the minimal average duration of the final fixation on the open goal space was always about 200 ms. In short, ironic performance was accompanied by a (too) short final fixation on the open goal space, the most appropriate gaze location for successful aiming in this experimental setting, either because “ironic” participants disengaged their gaze from the keeper later, that is, closer to kicking the ball, or because they showed an extra fixation on the keeper prior to kicking the ball. Earlier findings that ironic effects occur when the gaze dwells longer on the to-be-avoided area (e.g., the goal keeper; Bakker et al., 2006; Binsch et al., 2009), already suggested that as a consequence fixations on the target area might be shorter. The present study is the first one in which this relationship between the duration of the final fixation on the target and the occurrence of ironic effects has been explicitly shown.

An explanation for the shorter final fixation on the target might be that, following a negative instruction, participants hasten their performance leaving insufficient time to fixate the target area after attention is first drawn to the keeper. However, as was shown here, response times were not shorter in the *not-keeper* condition (when ironic effects occurred) in comparison to the *accurate* condition. Of course, it should be noted that in the present study the participants had ample time to execute their shots; the response times varied from 845 through 1037 ms (ball flight not included), whereas 1.5 s were available. In practice, time constraints may play a role in ironic effects, especially as

performers tend to hasten their performance under pressure (cf. Jordet, 2009; Nieuwenhuys & Oudejans, 2009).

Two phenomena responsible for the shorter final fixations on the target area (open goal space) related to the ironic effect were demonstrated in the present study. The first one, occurring in 6 of the 14 participants showing ironic effects, implies that the initial fixation on the keeper lasted too long as to leave enough time for subsequent fixation of the open goal space. The second one, occurring in the remaining 8 participants showing ironic effects, implies that the final fixation of the open goal space did not last long enough because the gaze returned once more to the keeper. Both phenomena can be explained by Wegner's (1994) theory of ironic processes, which holds that successful behavior relies on two cognitive processes: one controlled and the other automatic. In brief (for more elaborate descriptions we refer to Wegner; cf. Janelle, 1999), the automatic search process continuously scans the contents of consciousness for any trace of unwanted thoughts. When an unwanted thought is detected, the controlled system "kicks in" and replaces this item with a more appropriate task-related thought. Under certain circumstances, for instance, in situations with a high mental load or with time pressure, the controlled replacing process, which requires attention for successful initiation, can be compromised – resulting in the manifestation of unwanted thoughts and less-than-optimal performance. In the present study, the negative instruction not to aim within reach of the keeper may have caused the "keeper" to linger on in the cognitive system. In one case this may have led to difficulty in disengaging from the keeper, leading to a too short final fixation on the target. In the second case, in which the "ironic" participants showed an extra fixation on the keeper, they apparently remained more easily distracted by the keeper even after their gaze had already moved to the open goal space. So even though attention was already directed to the open goal space, the keeper apparently lingered on in the cognitive system, once more drawing (visual) attention and thus leaving insufficient time for a proper final fixation on the target.

Interestingly, both the inability to disengage from the keeper, who is a potential distracter in the penalty kick task, and the enhanced distractibility (by the keeper), closely resemble the effects of anxiety on perceptual-motor performance. Comparable results, that is, shorter final fixations on the target and/or more or longer fixations on potential distracters (such as the keeper in penalty shooting), were found in archery, handgun shooting, rifle shooting in

biathlon, free throw shooting and penalty shooting under high anxiety conditions (Behan & Wilson, 2007; Binsch et al., in press; Nieuwenhuys & Oudejans, 2009; Vickers & Williams, 2007; Wilson, Vine, & Wood, 2009; Wilson, Wood, & Vine, 2009). Comparison of the effects of anxiety in the latter studies with the ironic effects found in the present study, as well as in the studies by Bakker et al. (2006) and Binsch et al. (in press), makes clear that anxiety and ironic instructions can have similar effects on gaze and aiming behavior. Recently, the effects of anxiety on cognitive as well as on perceptual-motor performance have been explained within the framework of attentional control theory (Eysenck, Derakshan, Santos, & Calvo, 2007; Nieuwenhuys & Oudejans, 2009). In brief, this theory holds that anxiety leads to changes in attention and attentional control involving a shift from the more controlled goal-directed attentional system (top down), influenced by action goals and intentions, to the more automatic stimulus-driven attentional system (bottom up) geared to all kinds of stimuli (e.g., threat-related stimuli) that might affect reaching those goals (Corbetta & Shulman, 2002; Eysenck et al., 2007). More in particular, these changes imply both a higher distractibility by task-irrelevant (threat-related) stimuli like the keeper in the present setting following a negative instruction, and a greater difficulty to disengage from such stimuli. In short, there are striking resemblances between ironic effects and effects of anxiety on perceptual-motor performance, as well as between the self-regulatory mechanisms proposed in Wegner's (1994) theory of ironic mental processes and in attentional control theory (Eysenck et al., 2007; cf. Wilson, Wood, & Vine, 2009). Both theories are dual-process theories in which automatic and controlled processes are supposed to interact, and in which the interaction may be affected by circumstances leading to suboptimal performance. It is a challenge for future research to gain more insight into the differences and similarities between the effects of ironic instructions and anxiety on performance in terms of both theories.

With regard to practice our findings should not be taken to imply that in actual penalty kicking the same results would have been found. On a football pitch several important constraints are different from those employed here (time constraints, pressure; e.g., Jordet, 2009; Jordet, Elfering-Gemser, Lemmink, & Visser, 2006). Thus, the generalizability of our findings to on-field penalty taking should be viewed with caution. Still, in far aiming tasks it seems important to avoid negative instructions involving the to-be-avoided area (e.g.,

the goal keeper), either by coaches or instructors or by athletes themselves. The present results also show that positive instructions involving the target area (*open-space* instruction) led to sufficiently long final fixations on the target, a somewhat extended task duration and good performance. Therefore, such positive instructions should be favored (cf. Binsch et al., in press). In agreement with earlier findings, the results of the present study once more emphasize the important role of the final fixation on the target in far aiming, this time in relation to ironic effects.

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Chapter 6

Anxiety and ironic effects in aiming at a far target

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Abstract

In far aiming the negative intention not to miss may ironically increase the tendency to do precisely that. Although cognitive constraints enhance the occurrence of ironic effects in the perceptual-motor domain the role of anxiety in inducing such effects has rarely been investigated while anxiety is known to play a crucial role in performance decrements in sports (e.g., choking under pressure) and to place a large burden on cognitive resources. Therefore, in the current study we investigated the combined effects of anxiety and negative instructions (to induce ironic effects) on perceptual-motor performance. Participants threw darts under one neutral instruction to hit bulls-eye and one negatively worded instruction not to throw worse than a pre-determined average while positioned either high or low on a climbing wall (i.e., with and without anxiety). Only the combination of high anxiety and the negative instruction led to ironic effects, which is in line with the theory of ironic processes as well as recent theories on choking under pressure.

Introduction

Research concerning adverse intentions has revealed that instructions to avoid specific behavior may lead to decrements in performance. Intentions to avoid specific behavior may even lead to so-called ironic effects, that is, someone may do precisely that which s/he intended not to do (Bakker, Oudejans, Binsch, & Van der Kamp, 2006; Binsch, Oudejans, Bakker, & Savelsbergh, 2009; Janelle, 1999; Wegner, 1994; Wegner, Ansfield, & Pilloff, 1998; Woodman & Davis, 2008). For example, in the perceptual-motor domain a soccer player in a penalty shoot-out may kick the ball within reach of the keeper following the explicit instruction not to let that happen (Bakker et al., 2006; Binsch et al., 2009).

An explanation for such ironic effects is provided by the theory of ironic mental processes (Wegner, 1989, 1994, 2009). This theory holds that unwanted behavior is caused by defective interplay of two hypothetical cognitive processes which are supposed to balance (operating process) and to check (monitor process) intentions or actions. Under normal circumstances the operating process fills the mind with items relevant to the desired state. In contrast, the monitor process scans the contents of consciousness for any trace of unwanted items. When an unwanted item is detected, the monitoring process reinitializes the operating process and the item will be appropriately replaced. However, when mental resources are depleted, the controlled replacing process, which requires attention for successful initiation, can be compromised – resulting in the manifestation of unwanted thoughts and/or actions.

According to this theory it is not the (negative) intention (e.g., “*not to miss*”) alone that causes ironic effects in the perceptual-motor domain, but also limitations in attentional capacity. Wegner (1994) suggested that cognitive or physical load (e.g., counting backwards in steps of seven or holding a heavy brick, respectively), internal and external distractions (e.g., inducing negatively or positively feelings and performing under loud noise, respectively) and emotional loading (e.g., fury or anxiety) can enhance the probability of ironic processes as these factors tax attentional resources. For example, Wegner et al. (1998) examined the combined effects of cognitive load and negative instructions on perceptual-motor performance by asking participants to memorize a six-digit number while they had to putt a golf ball to a fixed mark on a golf green under the instruction not to putt past the mark. Results indicated that under load participants putted the ball further past the mark than in

conditions without load. More recent studies were conducted to investigate the role of different loads and the significance of ironic effects in the perceptual-motor domain by using similar golf-putt settings and instructions (e.g., Beilock, Afremow, Rabe, & Carr, 2001; Binsch et al., 2009; De la Peña, Murray, & Janelle, 2008). However, the role of anxiety in inducing ironic effects in the perceptual-motor domain has rarely been investigated, while it is well known that especially anxiety often plays a crucial role in performance decrements in sports (choking under pressure) because it places a large burden on cognitive resources (e.g., Baumeister, 1984; Beilock & Carr, 2001; Jordet, 2009; Oudejans & Pijpers, 2009; Wilson, Vine, & Wood, 2009).

One recent exception is the study by Woodman and Davis (2008) into the combined effects of anxiety, negative intentions and specific dispositions (i.e., anxiety coping styles) in a golf putting task. The authors conclude that particularly participants who indicated to experience low levels of cognitive anxiety but actually had high heart rates during the high anxiety competition putt (so called repressors) showed ironic effects on this putt, as these repressors significantly over-shot the target by 35 cm when they were urged not to overshoot the target. The participants who were classified as high anxious (high cognitive anxiety and higher heart rates) under-shot the target by 11 cm while the participants of the low anxious group also over-shot the target by 24 cm, but these differences were not significant. The authors argue that particularly repressors are susceptible to ironic effects as they ironically self-generate more load by cognitively repressing anxiety compared to other anxious or not anxious participants. However, it is unclear why only repressors would be expected to show ironic effects while anxiety is also known to provide a cognitive load for the other participants, especially those who were high anxious. Yet these participants undershot the target while low anxious participants, who were supposedly not burdened at all, also largely overshoot the target just as the repressors. That in the latter case (low anxious participants) the difference was not significant may simply have been a power issue (the *p*-value of the non-significant difference was not provided). Furthermore, Woodman and Davis (2008) did not investigate all four combinations of low and high anxiety and neutral and negative instructions (low-neutral, high-neutral, low-negative, high-negative), but only low-neutral and high-negative. In short, more research into the relationship between anxiety and ironic effects is warranted.

Therefore, in the current study we investigated the combined effects of high levels of anxiety and negative instructions by investigating all four combinations of low and high anxiety and neutral and negative instructions (low-neutral, high-neutral, low-negative, high-negative). As we were mainly interested in the combined effects of state anxiety and instructions (and to circumvent the power issue) we did not distinguish participants on the basis of their anxiety coping style. Furthermore, we used an established method to manipulate anxiety, namely an indoor climbing wall of which there is ample evidence that it can consistently induce high levels of anxiety (see Nieuwenhuys, Pijpers, Oudejans & Bakker, 2008; Oudejans & Pijpers, 2009, 2010; Pijpers et al., 2003, 2005, 2006). Participants threw darts while positioned either high (with anxiety) or low (without anxiety) on the climbing wall under two instruction conditions: (1) “throw as accurate as possible, thus, try to hit bulls-eye” and (2) “throw as accurate as possible, thus, try to hit bulls-eye, but be careful not to hit less than X” where X was the average dart score as determined in a pre-test. We expected that participants would consistently indicate higher levels of anxiety high on the wall compared to low on the wall. Furthermore, we expected that with anxiety participants would show decrements in performance compared to when they threw darts without anxiety, irrespective of instruction as such effects were already established in the same setting in earlier studies (e.g., Oudejans & Pijpers, 2009, 2010). Most important, we expected that the combination of high anxiety and a negative instruction would lead to worst performance.

Methods

Prior to the experiment the protocol was approved by the ethics committee of the research institute.

Participants

Forty undergraduate students (20 males and 20 females, mean age = 21.3 years, $SD = 1.9$; each of them was right-handed by self-report) participated voluntarily. The participants had no climbing experience and gave written informed consent before testing.

The Dutch version of the A-Trait scale of the State-Trait Anxiety Inventory (STAI) was used as a standard check to measure trait anxiety (Spielberger, Gorsuch, & Lushene, 1970; Van der Ploeg, Defares, Spielberger, 1979). The mean trait anxiety scores for the male and female participants were 31.5 ($SD = 5.2$) and 32.9 ($SD = 4.8$), respectively. These values were significantly lower than the mean values for Dutch male ($M = 36.1$) and female ($M = 37.7$) students obtained by Van der Ploeg, Defares, Spielberger (1980) on a t test between a sample and a population mean for the men, $t(19) = 3.99$, $p < .01$, and women, $t(19) = 4.49$, $p < .001$, respectively. Although significant, the results clearly indicated that the participants had no extraordinary tendency to respond to situations perceived as threatening with an elevation in state anxiety.

Task and design

The task of the participants was to throw 96 darts, that is, 24 darts in each of four experimental conditions. These conditions were the combination of the two height conditions (i.e., high, and low on the climbing wall) and the two instruction conditions (i.e., “dart as accurate as possible, thus, try to hit bulls-eye”, “accurate” instruction; and “dart as accurate as possible, thus, try to hit bulls-eye, but be careful not to hit less than X”, “not-less” instruction), where X was the average dart score on a pre-test of 24 throws minus 1 ring. For example, when a participant achieved an average dart score of 7 in the pre-test, the participants’ not-less instruction was “dart as accurate as possible, thus, try to hit bulls-eye, but be careful not to hit less than the 6th ring”. Participants were unaware of the use of their individual pre-test score. The two height conditions and instruction conditions were counterbalanced between participants, with the exception that once the participants performed high or low on the wall they completed both instruction conditions before they changed to the other position on the wall.

Experimental set-up

For the purpose of the high-anxiety manipulation participants threw their darts (BRASS, Tilburg, NLD) while they were positioned on a vertical climbing wall (width: 3.5 m, height: 7.0 m; see Figure 6.1), which was set up in a gym-sized laboratory. On the wall, at two different heights several holds were bolted, four footholds and three handholds (see Figure 6.1B). The mean height of the footholds in the low condition was 0.32 m above the ground. The height of the

two handholds was 2.03 m in this condition. The height of foot- and handholds in the high condition (used to increase anxiety) was 3.63 m and 5.34 m, respectively. In order to take position high on the climbing wall a large stepladder was used.

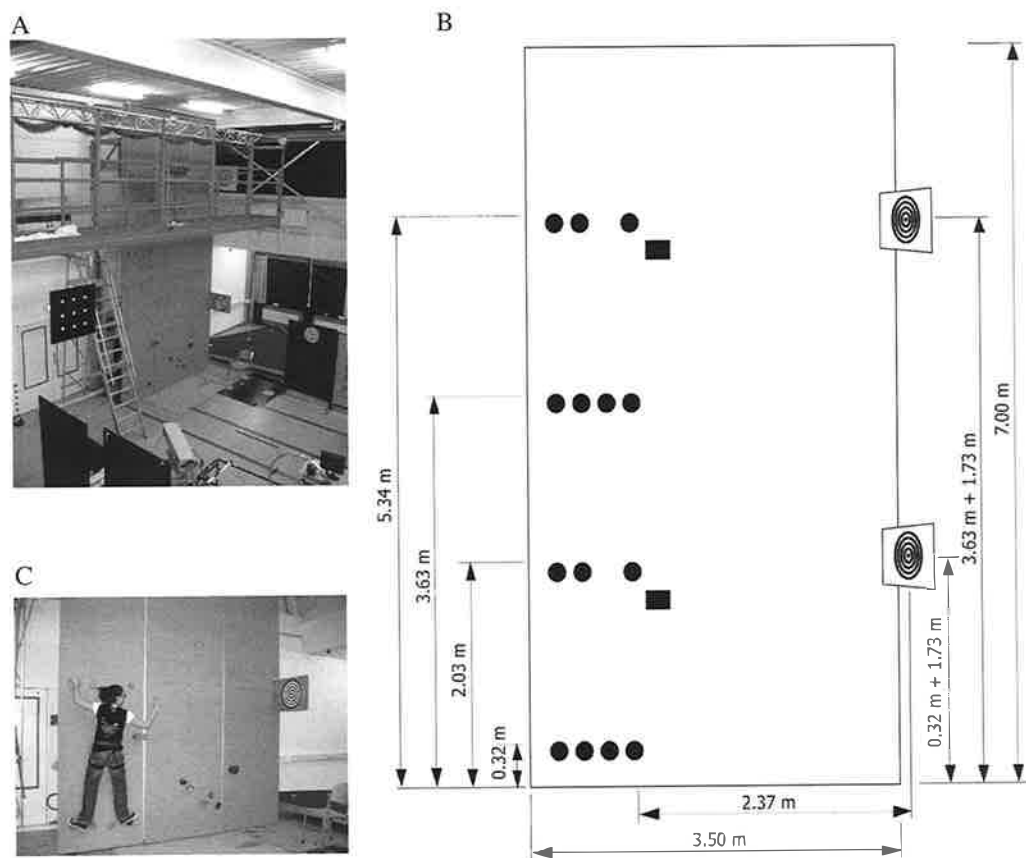


Figure 6.1. Overview of the experimental set-up of Experiment 2 (A); Front view of the climbing wall with its relevant measures (B); Example of a person throwing darts low on the wall (C).

The stepladder had a small platform that allowed participants to rest after having climbed it and to start testing in the high condition in a similar physical condition (i.e., non-fatigued, similar heart rate) as in the low condition. The stepladder was removed from the wall once participants were safely positioned on the wall.

For safety reasons participants had to be secured high on the climbing wall. Therefore, and to keep conditions as similar as possible, participants wore a climbing harness (Singing Rock, Zenith, Type C) and were secured high and low on the wall using the so-called 'top-roping' technique (Skinner & McMullen, 1993).

For both high and low positions on the wall a dart board ($\varnothing = 0.43$ cm; Win500, Winmau Diamond, USA) was placed near the right edge of and at right angles with the wall (see Figure 6.1). Each dart board was attached to the wall on a wooden board with the edge of the dart board at a distance of 15 cm from the wall and for both high and low positions at the regulation distance of 2.37 m from the right foothold. Bulls-eye was placed at a relative height of 1.73 m above the footholds (regulation height). The face of each board showed ten circles (i.e., one red [bulls-eye], five black, and four white circles). The diameter of the bulls-eye was 1.6 cm and the rim of each black or white circle was 2.3 cm wide. Each circle yielding a certain number of points per dart, starting with 10 when bulls-eye was hit to zero points when the dart board was not hit at all. Participants were standing on two footholds and holding one handhold while they threw their darts. After each set of six darts an experimenter collected the darts from the board and returned them to a box which was mounted on the wall beside the participant. In the high condition the darts were collected and returned using a mobile footbridge (see Figure 6.1A). Because parking the footbridge close at the participants would possibly impair the anxiety manipulation, the footbridge was taken to a position of 2.50 m away from the wall after the scores were counted and the darts were collected and returned to the box.

The anxiety scores were obtained using a visual-analogue anxiety scale, called the anxiety 'thermometer', which was validated for the Dutch population by Houtman and Bakker (1989) and successfully used in earlier experiments (Pijpers et al., 2003, 2005). The anxiety thermometer is a 10-cm continuous scale on which participants rated their anxiety feelings, ranging from 0 (*not anxious at all*, the left end) to 10 (*extremely anxious*, the right end). The anxiety thermometer provides a quick and reliable way to measure state anxiety (cf. Pijpers et al., 2005). Generally, validity and test-retest reliability of the anxiety

thermometer are fair, with correlation coefficients ranging between .60 and .87 for several comparisons (Bakker, Vanden Auweele, & Van Mele, 2003; Houtman & Bakker), including comparisons between anxiety scores taken before or after an event. This provides support for the validity of a measurement procedure in which feelings of anxiety are obtained after the event which was done in the current study. After each condition individuals placed a small vertical line on the scale to indicate how they had felt during that condition.

Participants were also equipped with a heart rate transmitter (T31; Polar, Finland) strapped around their chests. The heart rate monitor (wrist unit AXN 700; Polar, Finland) was worn by an experimenter to make sure that participants had no feedback about their somatic indices of anxiety, and to easily save participants' heart rates after each set of six throws.

Procedure

Participants were tested individually on one day and within one hour. Participants were informed about the procedure, that is, each of them was told that they would complete a series of dart throws on a climbing wall with the objective to throw as accurately as possible under different instructions. After that, participants signed a statement of informed consent. The participants then completed a pre-test, that is, they took position behind a taped mark on the floor in front of a dartboard (regulation height and distance, i.e., 1.73 and 2.37 m, respectively) and threw 24 darts (i.e., four sets of six darts) under no specific instruction. The participant's score on this pre-test was used in the negative "not-less" instructions in the experimental conditions of that same participant. After the pre-test, participants were equipped with the climbing harness and heart rate transmitter. Then, participants started high or low on the wall (counterbalanced) with the accurate or not-less instruction (counterbalanced).

On the wall, a stable position was obtained using the left handhold and the two footholds, leaving the right arm free for dart throwing. After the participants had reached the starting position, the instruction in question (i.e., "accurate" or "not-less") was given. In addition, the instruction in question was repeated after each third throw. After each set of six throws the participant could, whenever s/he felt the need, grasp the right handhold with the right hand, slightly change position and release the tension on the muscles to prevent fatigue. After the first instruction condition participants continued with the next instruction condition

in the same position high or low on the wall. After both instruction conditions were done, the participant came off the wall, rested briefly and prepared for the other height condition on the wall. Once the participant was in position on the wall and at the new height the two instruction conditions were performed. In each of the four conditions participants threw four sets of six darts, 24 in total. After each condition participants completed a new anxiety thermometer. After last condition participants stepped-off the wall and filled in the Dutch version of STAI A-Trait inventory. Finally, the participants were fully debriefed, questions were answered and participants were thanked for their participation.

Statistical analysis

For each participant dart performance was determined, operationalized as the average dart score (ranging from 0 to 10) per condition. Per condition and participant anxiety scores were registered and average heart rates were computed. Dart scores were analyzed using a 2 (position: high, low) $\times$ 2 (instruction: accurate, not-less) analyses of variance (ANOVAs). Furthermore, anxiety scores and average heart rates were analysed using similar ANOVAs to determine whether the anxiety manipulation was successful and whether the instruction conditions affected self-report and somatic indices of anxiety. Pair-wise comparisons using Bonferroni correction (Kinnear & Gray, 2000) were made to identify specific mean differences when appropriate. Partial eta squared (η_p^2) assessed the explained variance in the ANOVA models.

Results

Dart performance

The position $\times$ instruction ANOVA on dart performance (i.e., average dart score) with repeated measures on dart performance revealed a significant main effect of position, $F(1, 39) = 15.07$, $p < .001$; $\eta_p^2 = .28$, and no effect of instruction, $F(1, 39) = 2.44$, $p = .13$. However, the main effect of position was superseded by the significant interaction between position and instruction, $F(1, 39) = 10.99$, $p < .01$; $\eta_p^2 = .22$ (see Figure 6.2). Post hoc pair-wise comparisons revealed that low on the climbing wall the not-less instruction did not negatively affect performance, $p = .25$, while high on the wall it did, $p < .01$ (see Figure 6.2). Furthermore, with the accurate instruction there was no significant difference in performance high and low on the wall, $p = .24$ (see Figure 6.2).

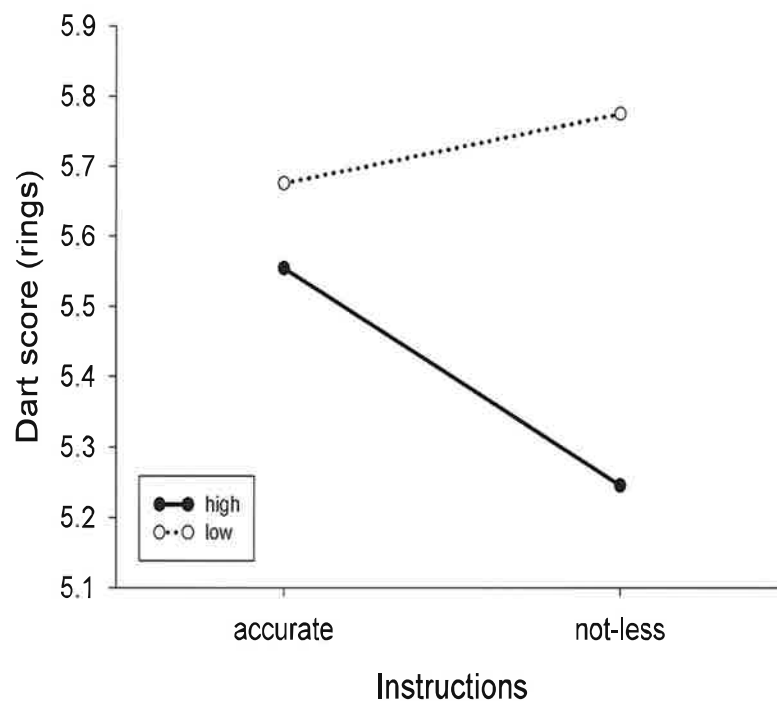


Figure 6.2. Average dart scores high and low on the wall and following the accurate and not-less instruction conditions (SD low – accurate = 1.2; SD low – not-less = 1.3; SD high – accurate = 1.3; SD high – not-less = 1.3).

Anxiety scores and heart rates

The position $\times$ instruction repeated measures ANOVA on the anxiety scores revealed a main effect for position, $F(1, 39) = 106.29$, $p < .001$; $\eta_p^2 = .62$, in the absence of a significant effect for instruction and a significant interaction between position and instruction, $F_s < 1.0$, $p_s > .15$. Post hoc pair-wise comparison of the main effect for position revealed that on average participants indicated higher levels of anxiety when they were positioned high on the climbing wall ($M = 3.84$; $SD = 1.75$) compared to when they were positioned low on the wall ($M = 1.90$; $SD = 1.26$), $p < .01$. The ANOVA on heart rate revealed a significant main effect of position, $F(1, 39) = 4.18$, $p < .05$; $\eta_p^2 = .10$, no effect for instruction, $F < 1.0$, $p > .50$, and no significant interaction between position and instruction, $F < 2.75$, $p > .10$. On average heart rates were significantly higher high on the climbing wall ($M = 111.98$, $SD = 18.52$) than

low on the wall ($M = 109.25$, $SD = 16.31$), $p < .05$. Overall these results show that our anxiety manipulation was successful, that is, anxiety scores and heart rates were significantly higher high compared to low on the wall. Furthermore, anxiety scores and heart rates were not affected by instruction.

Discussion

The main purpose of this study was to gain more insight into the combined effects of anxiety and negative instructions on perceptual-motor performance. It appeared that performance was affected by the not-less instruction, but only high on the climbing wall, thus, with anxiety. This is in line with Wegner's theory of ironic processes (1994) which predicts ironic effects under conditions of increased load, in this case induced with anxiety. Furthermore, anxiety alone did not affect performance which is somewhat in contrast with earlier findings by Oudejans and Pijpers (2009, 2010) who found hampered dart performance high on the climbing wall without a negative instruction (cf. Behan & Wilson, 2007; Wilson, Vine, & Wood, 2009). However, in these studies a learning paradigm was adopted and participants were only tested after one or more training sessions. Alternatively, and admittedly speculative, a possible explanation is that the accurate instruction condition, which provided a positive instruction to throw at bulls eye, might have helped in maintaining performance high on the wall. Bakker et al. (2006) have shown that positive instructions including the target (i.e., the open-goal space in a football penalty) effectively guarded performance against ironic effects. It might be that the positive accurate instruction including the target helped in maintaining performance high on the wall.

Although speculative, such an interpretation would fit Attentional Control Theory (ACT; Eysenck et al., 2007), which is recently emerging as more of an over-riding framework for the effects of anxiety on attention and performance (cf. Wilson, Wood, & Vine, 2009). In contrast to several other theories that describe the underlying mechanisms of the effects of anxiety on performance ACT also describes how negative effects of anxiety may be countered by investing extra mental effort in performance. Several recent studies have shown that additional mental effort may indeed help in maintaining performance with anxiety (Oudejans & Pijpers, 2009, 2010). Positive instructions may also have such a positive effect. Interestingly, there are striking resemblances between the self-regulatory mechanisms proposed in the ACT and Wegner's (1994) theory of

ironic mental processes (cf. Wilson, Wood, & Vine., 2009), as both theories are dual-process theories in which automatic and controlled processes in working memory are proposed to interact, and in which the interaction may be affected by emotional load leading to suboptimal performance. It is a challenge for future research to develop one theoretical framework to explain effects of anxiety as well as ironic instructions on performance.

In contrast to Woodman and Davis (2008) the present study found ironic effects averaged over all participants, thus, irrespective of individual differences in anxiety coping style. Apparently, when the anxiety level and hence the cognitive load is high enough general ironic effects are found following negative instructions. For the sake of comparison, we also analyzed the data after grouping participants in the same way as Woodman and Davis into repressors, and defensive, high anxious, and low anxious participants. The analyses only revealed that, next to the significant interaction between position and instruction (as reported in the results section), there appeared to be a significant interaction between instruction and group indicating that repressors performed worse following the negative instruction (for high anxious participants the effect was marginally significant). However, this was irrespective of anxiety condition meaning that participants previously selected because they repress anxiety high on the climbing wall (making them more susceptible to ironic effects in that condition) showed performance decrements also when no anxiety was present and higher susceptibility to ironic effects should not be apparent. Repressors should not be more susceptible to ironic instructions without anxiety. In short, these results do not unambiguously support the idea that anxiety coping style plays a crucial role in the occurrence of ironic effects.

Most important, the present findings make clear that particularly the combination of high anxiety and negative instructions (don't miss) provide the most dangerous combination for performance. Ironically this combination is often encountered in high-pressure situations as found in the sporting arena or in police work or fire fighting (e.g., Oudejans, 2008). Next to reducing anxiety, recent studies show that training with anxiety may help in preventing choking under pressure in such environments (Oudejans, 2008; Oudejans & Pijpers, 2009; 2010). Furthermore, it is clearly advisable not to use negative instructions and rather replace them with positive instructions to prevent ironic effects.

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Chapter 7

Epilogue



Epilogue

The present thesis set out to gain more insight into the conditions under which unwanted effects, that is, ironic effects and overcompensation occur in the perceptual-motor domain. As we focused mainly on the role of (visual) attention in unwanted performance we measured participants' gaze behavior (Chapters 2-5) and performance (Chapters 2-6) in several complex aiming tasks, that is, penalty shooting in football, golf putting and dart throwing. In those tasks unwanted effects were induced by using differently worded instructions and/or different load conditions that enhance the probability that one does the opposite of what is intended (i.e., ironic effect), or the opposite of what should be avoided (i.e., overcompensation). The aim of this epilogue is to provide an overview of the main findings accompanied by theoretical and practical implications.

Unwanted Effects, Visual Attention and Cognitive Load

The present thesis demonstrates that there is a strong relationship between visual attention and performance in the perceptual-motor domain also when ironic effects (Chapters 2-5) and overcompensation (Chapter 3) occur. In a penalty shooting task (Chapter 2) the negative instruction *not to shoot within reach of the keeper* induced ironic effects, that is, participants more often shot closer to the keeper. Furthermore, ironic shots were more often preceded by initially looking at the keeper than not-ironic shots.

In Chapter 3, in a golf putting task participants looked less long at the target (i.e., the hole) and longer at one of the inappropriate areas (e.g., in front of the hole) when ironic effects occurred both when participants were instructed not to *undershoot* and when instructed not to *overshoot*. Furthermore it was found that when ironic effects occurred the chain between intention, visual attention and performance was sometimes interrupted between intention and visual attention and sometimes between visual attention and performance. As a specific example, under the *do not overshoot* instruction participants who showed ironic performance looked more in-front of the target, as if they intended to overcompensate, eventually putting the ball ironically past the target. This confirms that ironic effects are not intention driven (Beilock et al., 2001; Wegner et al., 1994). As for overcompensation, the results of Chapter 3 confirm that overcompensation is intention driven as visual attention was always directed

to areas where the ball eventually landed when overcompensation occurred. Thus, a negative instruction, for example, *do not undershoot the target* may lead to the intention to do the opposite of what should be avoided, that is, to overshoot the target, in this case leading to gaze behavior and aiming action to such intended areas.

Chapter 4 more directly revealed that visual attention partially mediates the relationship between instructions and ironic effects on performance. That is, in the penalty shoot-out setting used in this experiment the duration of gaze behavior directed at the keeper was related to the type of instruction as well as to shooting performance. The instruction *not to shoot within reach of the keeper* as well as the instruction *to pass the keeper* led to longer gaze behavior on the keeper and shots closer to the keeper. These findings make clear that in the football penalty setting differently worded instructions probably induce ironic effects by interrupting the chain from intention to visual attention to performance between intention and visual attention (i.e., gaze behavior). Most important, in this Chapter it is shown that not only a negative instruction may lead to ironic effects but also positively formulated instructions in which the to-be-avoided object is mentioned. These findings imply that in every setting in which distracting objects or elements are present in the visual field (e.g., opposing player, supporters, etc.) instruction including this element may increase the probability that ironic effects occur.

Chapter 5 once more confirmed that visual attention plays a crucial role in ironic effects in the perceptual-motor domain. Whereas earlier studies (Chapters 2 and 4) showed that when ironic effects occurred participants looked longer and more often at the keeper, this study revealed that ironic effects were (consequently) accompanied by insufficiently long final fixations on the open goal space. The short final fixation on the target was not the result of shorter response times, but rather of either an enhanced difficulty to disengage from the keeper (i.e., late onset of the final fixation on the open goal space) or higher distractibility by the keeper (i.e., a second fixation on the keeper prior to kicking the ball after gaze was already on the open goal space).

In Chapter 6 it was shown that in a far aiming task (i.e., dart throwing) without a distracting element in the visual field particularly the combination between an ironic (negative) instruction and high emotional load (i.e., anxiety) led to ironic

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performance while separately neither the ironic instruction nor anxiety led to ironic effects.

In all experiments discussed above ironic effects were induced, yet not always to the same degree. On one occasion overcompensation effects were also induced next to ironic performance. In most cases it was clear that there was a strong relationship between type of instruction, gaze behavior and performance also when unwanted effects occurred. Furthermore, it is now clear that in the perceptual-motor domain positively worded instructions may also induce ironic effects, implying that the negative formulation (“not”) is not crucial. Finally, it was shown that especially in combination with anxiety certain instructions may lead to ironic effects.

Theoretical implications

Overall the results in the present thesis seem to be in line with predictions of Wegner’s theory of ironic mental processes (Wegner, 1989, 1994, 1997, 2009). In brief, this theory is based on the sensitive interaction of two cognitive processes, that is, an operating process and a monitoring process to replace unwanted thoughts or actions into thoughts or actions that matches desired states. The operating process is initiated when an unwanted thought is perceived by the monitoring process which searches the contents of consciousness for any trace of unwanted thoughts. When an unwanted thought is detected by the monitoring process, the operating process is initiated to replace this item. However, when attentional resources are depleted, the process to replace unwanted items may fail, resulting in manifestation of the contents of the monitoring process (i.e., an unwanted thought or action).

The present thesis makes clear that ironic instructions may also lead to overcompensation which is not necessarily in conflict with Wegner’s theory (cf. Beilock et al., 2001; De la Peña, 2008). For overcompensation the sensitive interaction of both the operating and monitoring processes may not be interrupted because the intention to do the opposite of the to-be-avoided is actually the desired state of affairs. As it is not possible to investigate overcompensation in the cognitive domain (see Introduction) it is suggested that further research concerning overcompensation should use perceptual-motor tasks (e.g., golf putting and penalty shooting) in combination with negatively worded instructions.

Furthermore, as argued in Chapters 5 and 6, there are striking resemblances between the theory of ironic mental processes (Wegner, 1994) and self-regulatory mechanisms proposed in the Attentional Control Theory (ACT; Eysenck et al, 2007) to explain the effects of anxiety on performance. The ACT predicts that anxiety impairs performance via its adverse effects on attentional control. Performers who are confronted with circumstances that increase anxiety find it difficult to exercise attentional control, to inhibit the effect of distracting stimuli, and to shift attentional resources to task demands efficiently, hereby suffering from impaired performance as attentional resources are needed for effective performance. Both Wegner's theory of ironic processes and ACT are dual-process theories in which automatic and controlled processes in working memory are proposed to interact, and in which the interaction may be affected by emotional load leading to suboptimal performance. It is a challenge for future research to develop one theoretical framework to explain effects of anxiety as well as ironic instructions on performance.

Finally, as for the 'alternative' explanation for ironic effects, namely, priming (cf. Bargh, Chen, & Burrows, 1996), the results of the present thesis show that priming and Wegner's ironic processes rather complement than exclude each other. Priming seems to play a crucial role in inducing ironic effects. Priming is based on James' (1890) principle of ideo-motor action, which holds that the mere act of thinking about a behavior or key word may increase the tendency to engage in that behavior or to think about a specific action (cf. Bargh et al., 1996). Although in earlier research concerning ironic effects and/or overcompensation (Beilock et al., 2001; Wegner et al., 1998) the priming approach was argued as an opposite and independent theory to explain the occurrence of unwanted performance, this thesis suggests that the combination of the ironic mental process theory and the priming theory may best explain the occurrence of ironic effects as ironic effects may be triggered by a negative or positive instruction that primes the unwanted thought or item (e.g., do not shoot within reach of the *keeper*; pass the *keeper*). Thus, priming may play an important role in the initiation of ironic effects by putting the unwanted items in the cognitive system while the failure to replace these items ultimately results from the hampered interaction between monitoring and operating processes as proposed by Wegner's theory of ironic processes.

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Practical implications

Overall, the findings described in the present thesis make clear that in learning and performance settings involving perceptual-motor tasks it may be best not only to avoid negative instructions but also to avoid any instructions that involve objects that should be avoided and are present in the visual field of performers. As people look at where they aim, and vice versa, they aim at where they look, the use of inappropriate instructions may prime the wrong target which may lead to unwanted effects. Therefore, the focus on what to do (e.g., pass the keeper) should be combined with the right wording involving the target (e.g., shoot in the open space), which was found to lead to the most accurate performance, as mentioning the target will draw attention, and hence performance, in the direction of the target. Furthermore, as particularly the combination of high anxiety and negative instructions provides the most dangerous combination for ironic performance, next to avoiding particular instructions, preventing, reducing and/or learning to cope with anxiety would provide additional ways to minimize the chances on ironic behavior.

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Samenvatting

(Summary in Dutch)

Onbedoelde effecten bij het uitvoeren van miktaken

Het in dit proefschrift beschreven onderzoek had als doel om meer inzicht te verschaffen in de condities waaronder onbedoelde effecten voorkomen bij het uitvoeren van perceptueel-motorische taken. Onbedoelde effecten kunnen worden onderscheiden in *ironische effecten* en *overcompensatie*. Bij ironische effecten doet iemand precies het tegenovergestelde van wat de bedoeling was. Als Wilhelm Tell (die de appel van het hoofd van zijn zoon moest schieten) zich had voorgenomen in ieder geval *niet zijn zoon te raken*, zou dit ironisch genoeg juist de kans vergroten dat hij zijn zoon zou treffen. Er is sprake van overcompensatie als iemand in overdreven mate doet wat gevraagd wordt. In het voorbeeld van Wilhelm Tell had hij bij overcompensatie ruim boven de appel geschoten. In de uitgevoerde experimenten lag de nadruk op de rol van visuele aandacht bij het optreden van onbedoelde effecten. Kijkgedrag, als operationalisering van visuele aandacht en prestatie werden gemeten bij verschillende taken waar deelnemers op een doel moesten mikken: penaltyschieten in voetbal, golfputten en darten. Bij de uitvoering van deze taken werden onbedoelde effecten geïnduceerd door gebruik van specifieke instructies, al dan niet in combinatie met een verhoging van de mentale belasting waaronder de taken uitgevoerd moesten worden.

In hoofdstuk 2 worden twee experimenten beschreven waarin het kijkgedrag en de prestatie van voetballers werden gemeten. In een laboratoriumopstelling schoten zij penalty's naar een scherm waarop een doel werd geprojecteerd met daarin een keeper. In het eerste experiment werd aangetoond dat er een nauwe relatie bestaat tussen kijkgedrag en prestatie: de voetballer schiet naar de plek waar hij naar kijkt. In het tweede experiment werden ironische effecten geïnduceerd door proefpersonen verschillende, negatief geformuleerde, instructies te geven voordat zij de penalty's namen. Bij de instructie: "schiet zo goed mogelijk, maar let er vooral op dat de keeper niet bij de bal kan komen", keken de voetballers vaak naar de keeper en eindigden hun schoten relatief dicht bij de keeper. Bij de instructie "schiet zo goed mogelijk en let er vooral op dat je in de open ruimte schiet" werd meer naar de open ruimte gekeken en beter geschoten. Deze resultaten impliceren dat bij perceptueel-motorische taken ironische effecten voorafgegaan worden door veranderingen in het kijkgedrag. Negatief geformuleerde instructies veroorzaken 'ironisch' kijkgedrag naar de keeper.

In de experimenten die in dit hoofdstuk zijn beschreven, dienden de voetballers binnen 1 seconde te schieten. Bovendien speelt bij penaltyschieten de keeper een belangrijke rol. De resultaten zijn dus niet zonder meer te generaliseren naar andere taken waar sporters op een doel mikken.

In hoofdstuk 3 wordt verder ingegaan op de relatie tussen kijkgedrag en prestaties bij onbedoelde effecten, maar nu bij het putten van golfballen. Putten is een taak waarbij geen sprake is van tijdsdruk en waarbij ook geen elementen zijn die potentieel afleiden van het doel (zoals een keeper bij penaltyschieten). Deelnemers aan het experiment, studenten, moesten in een laboratoriumopstelling golfballen putten op een indoor-golfbaan. Onbedoelde effecten werden wederom geïnduceerd door verschillende, negatief geformuleerde, instructies (“put zo goed mogelijk en let er vooral op dat de bal niet voor de hole blijft liggen”, of “idem, niet achter de hole”). Daarnaast werd een neutrale instructie gegeven (“put zo goed mogelijk”). Deelnemers moesten tijdens het uitvoeren van de ‘put’ terugtellen, waarmee de mentale belasting waaronder zij de taak uitvoerden verhoogd werd. De resultaten lieten zien dat hoe langer de deelnemers naar een bepaald gebied keken (naar de hole of ervoor of erachter) hoe vaker de bal eindigde in het gebied waarnaar langer gekeken was. Vervolganalyses toonden aan dat bij overcompensatie deze relatie duidelijk aanwezig was, zowel bij te kort geslagen ballen als ballen die voorbij de hole eindigden. Bij ironische effecten werd zo’n relatie alleen gevonden wanneer de instructie luidde er op te letten dat de bal niet voor de hole zou eindigen (wat dus juist wel gebeurde). Bij de andere negatieve instructie – laat de bal niet achter de hole eindigen – werd niet langer naar het gebied achter de hole gekeken, hoewel de bal daar wel vaker bleef liggen. Voor dit laatste, enigszins afwijkende resultaat, worden verschillende verklaringen geopperd. Ten slotte bleek dat over de hele linie bij negatieve instructies structureel minder lang naar de hoofdtarget (de hole) werd gekeken waardoor de prestatie afnam. De algemene conclusie van dit hoofdstuk is dat (visuele) aandacht een sleutelrol speelt bij het ontstaan van onbedoelde effecten.

Het experiment in hoofdstuk 4 had als doel te onderzoeken of bij het penaltyexperiment (hoofdstuk 2) de negatieve instructie “niet” of het noemen van het te vermijden gebied “keeper” verantwoordelijk was voor het ontstaan van ironische effecten. In eenzelfde opstelling als die in hoofdstuk 2 is beschreven, werd behalve de negatieve instructie met het woord keeper er in

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(schiet zo goed mogelijk, maar let er vooral op dat de keeper niet bij de bal kan komen) ook een positief geformuleerde instructie gebruikt (schiet zo goed mogelijk en passeer de keeper). Daarnaast werd een neutrale instructie gegeven (schiet zo goed mogelijk). Uit de resultaten bleek dat ironische effecten door beide eerstgenoemde instructies in vrijwel dezelfde mate werden geïnduceerd. Dit impliceert dat in taken waar iemand mikt op een bepaald doel het noemen van het te vermijden gebied (in dit geval de keeper) voldoende lijkt te zijn om de kans op ironische effecten te vergroten.

Hoofdstuk 5 behandelt een experiment dat is uitgevoerd om meer inzicht te krijgen in rol die de laatste oogfixatie op het mikpunt speelt bij ironische effecten. De duur van die laatste fixatie is belangrijk voor een nauwkeurig (shot)resultaat. In eenzelfde opstelling als die in hoofdstuk 2 en 4 is beschreven, werden de prestatie en de duur van de fixatie op zowel keeper als open doelruimte gemeten. Uit de resultaten bleek dat ironische effecten optraden bij een te korte duur van de laatste fixatie op de open doelruimte. Soms was die laatste fixatie te kort doordat de deelnemers hun aandacht pas laat losmaakten van de keeper, soms doordat zij werden afgeleid door de keeper (hun oogfixatie ging van de keeper naar de open doelruimte en vervolgens weer terug naar de keeper).

Hoofdstuk 6 beschrijft het laatste experiment van dit proefschrift waarin de rol van angst bij het ontstaan van ironische effecten werd onderzocht. De deelnemers moesten dartpijlen gooien onder negatief en neutraal geformuleerde instructies in twee settings: staand laag in een klimwand en hoog in die wand. Uit de resultaten bleek dat vooral de combinatie van negatief geformuleerde instructies en een hoog angstniveau tot ironische effecten leidde. De studie laat zien dat bij angst, een vorm van mentale belasting, de kans op het optreden van ironische effecten toeneemt.

De experimenten laten zien dat bij onbedoelde effecten in het perceptueel-motorisch domein – zowel bij ironische effecten als bij overcompensatie – visuele aandacht een belangrijke rol speelt. In de belangrijkste theorie over ironische effecten - die van Wegner - speelt aandacht een sleutelrol. Volgens Wegner zullen gedachten die haaks staan op wat iemand bedoelt of wil, vervangen moeten worden door gedachten die in overeenstemming zijn met wat gewenst wordt. Negatieve instructies, het noemen van het te vermijden object,

(niet de keeper, passeer de keeper), vestigen de aandacht op dat object. Onze experimenten laten zien dat dit inderdaad dikwijls het geval lijkt te zijn bij ironische effecten in het perceptueel-motorische domein: de (visuele) aandacht gaat uit naar de keeper, is te kort gericht op de open ruimte, of is, bij het putten van een golfbal, gericht op plaatsen voor of achter de hole. Ook het verschijnsel overcompensatie lijkt te passen in de theorie van Wegner. Bij overcompensatie ('niet voorbij de hole') is de intentie de bal zeker niet verder te slaan dan de hole. Als de bal ruim voor de hole blijft liggen, is die bedoeling gerealiseerd. Volgens Wegners theorie zal de aandacht dus uitgaan naar wat gewenst wordt, dat wil zeggen naar plaatsen voor de hole. Het kijkgedrag bij overcompensatie in ons golfexperiment is in overeenstemming met deze redenering.

Het vervangen van ongewenste gedachten door gedachten die wel in overeenstemming zijn met wat iemand wil (de open ruimte, de appel), vergt aandacht. In de theorie van Wegner wordt daarom voorspeld dat ironische effecten eerder zullen optreden wanneer er minder aandachtscapaciteit is. Angst legt beslag op de aandachtscapaciteit. De uitkomsten van ons laatste experiment, waarin de combinatie van angst en negatieve instructie tot ironische effecten leidde, lijken daarmee eveneens goed te passen in de theorie van Wegner.

Voor de praktijk is het belangrijk om in leer- en prestatieomgevingen, waarin perceptueel-motorische taken uitgevoerd moeten worden, geen negatief geformuleerde instructies te gebruiken en evenmin instructies waarin het te vermijden gebied wordt benoemd. Mensen kijken waar ze richten en richten waar ze kijken en het gebruik van 'slechte' instructies kan het verkeerde richtpunt benadrukken. Een instructie waarin het juiste richtpunt wordt benoemd (de hole, de open ruimte of bulls-eye in de beschreven experimenten) verdient dan ook verre de voorkeur.

Omdat Wilhelm Tell er in geslaagd is de appel van het hoofd van zijn zoon te schieten, mogen wij aannemen dat Tell het woord "appel" gebruikt heeft in een positief verwoorde (zelf)instructie en dat zijn oog langdurig gefixeerd was op de appel voordat hij de pijl losliet. Intuïtief heeft hij daarmee de aanbevelingen uit dit proefschrift al 700 jaar geleden opgevolgd.

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Zusammenfassung

(Summary in German)

Unerwünschte Effekte während der Ausführung von Zielaufgaben

Das Ziel der vorliegenden Arbeit war es, mehr Einblicke über die Bedingungen zu gewinnen, unter denen ungewollte Effekte während der Ausführung von perzeptuell-motorischen Aufgaben auftreten. Ungewollte Effekte können unterschieden werden in *ironische Effekte* und *Überkompensation*. Ironische Effekte sind, wenn sich eine Person genau entgegengesetzt zu dem verhält, was sie eigentlich erreichen wollte.

Wenn Wilhelm Tell, der gezwungen wurde den Apfel vom Kopf seines Sohnes zu schießen, sich zum Beispiel vorgenommen hätte, in jedem Fall nur *nicht seinen Sohn zu treffen*, so würde gerade diese Absicht ironischer Weise die Wahrscheinlichkeit vergrößern ihn zu treffen. Der Begriff Überkompensation hingegen beschreibt das Verhalten wenn jemand – nicht gegensätzlich – sondern im übertriebenen Sinne handelt. In dem Beispiel des Schwyzer Kreuzbogenschützen Tell hätte dieser den Pfeil weit oberhalb vom Apfel geschossen, was im Übrigen den Tod von Vater und Sohn bedeutet hätte.

In den durchgeführten Experimenten, die in dieser Arbeit beschrieben wurden, stand die Beantwortung der Frage im Mittelpunkt, welche Rolle die visuelle Aufmerksamkeit beim Auftreten von ungewollten Effekten hat. Dementsprechend wurde das Blickverhalten, als operationalisiertes Merkmal der visuellen Aufmerksamkeit, und die erbrachten Leistungen von Testpersonen während der Ausführung von verschiedenen perzeptuell-motorischen Aufgaben gemessen (Strafstoßschießen im Fußball, Golf-Putten und Darten). Während der Ausführung dieser Aufgaben wurden ungewollte Effekte induziert. Dies wurde teilweise schon durch die Eingabe von spezifischen Instruktionen erreicht oder aber auch in Kombination mit der Erhöhung von mentalen Anforderungen.

Im zweiten Kapitel dieser Arbeit sind zunächst zwei Experimente beschrieben worden, in denen das Blickverhalten und die Strafstoßleistung von Fußballspielern analysiert wurde. In diesen Laborexperimenten schossen die Teilnehmer Fußbälle gegen eine Projektionswand auf der ein Tor mit einem Torwart abgebildet war. In dem ersten Experiment konnte gezeigt werden, dass es eine starke Beziehung zwischen dem Blickverhalten und der Strafstoßleistung gab: die Fußballspieler schossen in denjenigen Bereich des Tores, in den sie auch zuvor geblickt hatten. In dem zweiten Experiment wurden ironische Effekte induziert. Dies wurde realisiert in dem die Testpersonen unter

verschiedenen negativ formulierten Anweisungen Strafstöße ausführten. Nach der Instruktion „schieße den Ball so gut wie möglich, aber achte vor allem darauf, dass der Torwart nicht an den Ball kommen kann“, blickten die Fußballer mehr zum Torwart und landeten die Fußbälle auch öfter in der Nähe des Torwarts. Durch die Anleitung „schieße den Ball so gut wie möglich und achte vor allem darauf dass du den Ball in den freien Torraum schießt“ wurde mehr in den freien Torraum geschaut und platzierter geschossen. Diese Resultate implizieren, dass den ironischen Effekten während der Ausführung von perzeptuell-motorischen Aufgaben ein verändertes Blickverhalten vorausgeht oder – anders formuliert – negativ formulierte Anweisungen verursachen ‚ironisches‘ Blickverhalten.

Vorgabe in den zwei Experimenten war, dass die Fußballspieler innerhalb einer Sekunde den Ball gegen die Projektionsfläche schießen mussten. Außerdem spielte das Verhalten des Torwarts in der Szenerie eines Strafstosses eine wichtige Rolle.

Insofern sind die Resultate, die in diesem Kapitel beschrieben worden sind, nicht ohne Weiteres auf alle Sportler oder Personen, die perzeptuell-motorische Aufgaben ausführen, übertragbar. Im dritten Kapitel wurde deshalb ebenfalls auf die Beziehung zwischen Blickverhalten und motorischer Leistungsfähigkeit eingegangen, jedoch nun während des Puttens von Golfbällen. Die Aufgabe, einen Golfball zu putten, wurde gewählt, weil Zeitdruck während der Aufgabenausführung keine Rolle spielt und störende Elemente (wie z.B., der Torwart beim Strafstossschießen) die Teilnehmer potentiell nicht ablenken würden. Die Teilnehmer (Sportstudenten) hatten die Aufgabe, in einem laborexperimentellen Versuchsaufbau Golfbälle über einen Abstand von 1.80 m auf eine Golfloch-große Markierung zu putten, die auf einem künstlichen Golfgreen lag. Um ungewollte Effekte zu induzieren wurden wiederum verschiedene negativ formulierte Instruktionen verwendet („putte den Ball so gut wie möglich, aber achte vor allem darauf, dass der Ball nicht vor dem Loch liegen bleibt“ oder „idem dito, putte den Ball nicht hinter das Loch“). Zusätzlich wurde eine neutrale Anweisung gegeben, mit der die Leistungen, die unter den zwei negativen Instruktionen erzielt worden sind, zu vergleichen waren. Des Weiteren mussten die Teilnehmer während der Aufgabenausführung hörbar rückwärts Zählen, wodurch die mentale Belastung der Aufgabenstellung erhöht wurde. Die Resultate von diesem Experiment zeigten, dass je länger die

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Teilnehmer zu einem bestimmten Gebiet blickten (zum Loch, davor oder dahinter), desto öfter der Ball auch in diesem Gebiet landete. Anschließende Analysen belegten, dass bei der Überkompensation die Beziehung zwischen Blickverhalten und Endposition der Bälle deutlich vorhanden war, dies traf sowohl bei den zu kurz als auch bei den zu lang geputteten Bällen zu. Wenn ironische Effekte auftraten, wurde solch eine Beziehung lediglich gefunden, wenn die Teilnehmer instruiert worden waren, den Ball nicht zu kurz zu putten (was sie trotz der Instruktion taten). Bei der anderen negativen Instruktion („putte den Ball nicht hinter das Loch“) wurde nicht länger auf das Gebiet hinter dem Loch geschaut, obwohl der Ball dort öfter landete. Für dieses abweichende Resultat wurden verschiedene Erklärungen aufgestellt.

Am auffälligsten erschien es jedoch, dass während der Umsetzung von negativen Instruktionen strukturell weniger lang zum Hauptziel (dem Golf-Loch) geschaut worden war. Die allgemeine Schlussfolgerung in diesem Kapitel ist dementsprechend, dass bei dem Entstehen von ungewollten Effekten im perzeptuell-motorischen Bereich der (visuellen) Aufmerksamkeit eine Schlüsselrolle zukommt.

Das Experiment das im vierten Kapitel beschrieben worden ist, zielte darauf ab herauszufinden, ob bei dem vorigen Strafstoßexperiment (Kapitel 2) die negative Instruktion „nicht“ oder das Benennen des zu vermeidenden Gebietes „Torwart“ verantwortlich für das Entstehen von ironischen Effekten war. Mit demselben Versuchsaufbau, wie im zweiten Kapitel bereits beschrieben, wurde neben der negativen Instruktion mit dem Wort „Torwart“ („schieße so gut wie möglich, aber achte vor allem darauf, dass der Torwart nicht an den Ball kommen kann“) eine weitere experimentelle, jedoch positiv formulierte Instruktion verwendet: „schieße so gut wie möglich, aber achte vor allem darauf dass du an dem Torwart vorbei schießt“. Zusätzlich wurde eine neutrale Instruktion genutzt („schieße den Ball so gut wie möglich“), um die Auswirkungen der beiden experimentellen Instruktionen auf das Blickverhalten und die Strafstoßleistungen vergleichen zu können. Die Resultate zeigten dass die experimentellen Instruktionen nahezu im gleichen Maße ironische Effekte induzierten. Dieses Resultat impliziert damit, dass in Aufgaben, in denen Personen auf bestimmte Gebiete zielen, für das Auftreten von ironischen Effekten bereits das Benennen von einem zu vermeidenden Gebiet (Torwart) ausreichend ist.

Das fünfte Kapitel beschreibt ein Experiment, das ausgeführt wurde, um bei der Entstehung von ironischen Effekten die Wichtigkeit des letzten Blickkontaktes auf einen Zielpunkt festzustellen. Um optimale Resultate bei perzeptuell-motorischen Aufgabenstellungen zu erzielen, ist es im Allgemeinen wichtig, die letzte Blickfixation auf den Zielpunkt halten. Wiederum wurde der Versuchsaufbau der vorherig beschriebenen Strafstoßexperimente (Kapitel 2 und 4) verwendet. Diesmal wurden jedoch nicht nur die Dauer der Blickfixationen, die auf den Torwart gerichtet waren, analysiert, sondern auch die Blickkontakte in die Analyse einbezogen, die auf den freien Torraum als eigentlichen Zielpunkt gerichtet waren. Das Resultat dieser Analyse zeigte, dass eine zu kurze Blickfixation auf den freien Torraum dafür verantwortlich zu sein scheint, dass ironische Effekte auftreten. Dass die letzte Blickfixation zu kurz ausfiel lag zum einen daran, dass die Teilnehmer ihre Aufmerksamkeit zu spät vom Torwart loslösten, oder aber zum anderen, dass sie sich durch den Torwart ablenken ließen (die Blickfixationen der Testpersonen gingen in diesen Fällen vom Torwart zum freien Torraum und wieder zurück zum Torwart).

Mit dem sechsten Kapitel wurde das letzte Experiment innerhalb dieser Arbeit beschrieben, das im Wesentlichen darauf abzielte, die Bedeutung von Angst beim Entstehen von ironischen Effekten zu untersuchen. Hierzu mussten die Teilnehmer unter einer negativen und einer neutralen Instruktion Dartpfeile werfen und dies jeweils unter bzw. ohne unter dem Einwirken von Angst zu stehen: in einer Kletterwand oben – und am Fuße der Kletterwand stehend. Die Ergebnisse dieser Studie zeigten, dass vor allem die Kombination zwischen der negativen Instruktion und einem hohen Angstniveau ironische Effekte verursachten. Im Besonderen zeigte diese Studie, dass Angst (eine Form von mentaler Belastung) die Wahrscheinlichkeit für das Auftreten von ironischen Effekten erhöht.

Die Experimente, die in dieser Arbeit beschrieben worden sind, zeigten, dass bei ungewollten Effekten (sowohl bei dem Auftreten von ironischen Effekten als auch bei der Überkompensation) im perzeptuell-motorischen Bereich die visuelle Aufmerksamkeit eine wichtige Rolle spielt. In der bedeutsamsten Theorie über ironische Effekte, die von Daniel Wegner entwickelt worden ist, spielt die Aufmerksamkeit eine Schlüsselrolle. Nach Wegners Meinung würden (durch verschiedene mentale Prozesse) die Gedanken, die nicht dem zu erreichenden Ziel entsprechen, durch Gedanken ersetzt werden, die mit dem

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gewünschten Resultat übereinstimmen. Sowohl negative Instruktionen („nicht zum Torwart“) als auch das Nennen von dem zu vermeidenden Gebiet („am Torwart vorbei schießen“) beeinflussen die Aufmerksamkeit, indem sie sich auf dieses Gebiet ausrichtet. Die ausgeführten Experimente zeigten in der Tat, dass dies überwiegend der Fall zu sein scheint wenn ironische Effekte im perzeptuell-motorischen Bereich auftreten: die (visuelle) Aufmerksamkeit wurde auf den Torwart ausgerichtet, zielte zu kurz auf den freien Torraum ab, oder war während des Golfputtens auf die Gebiete vor oder hinter dem Loch ausgerichtet. Im Weiteren scheinen die unwillkommenen Überkompensationseffekte ebenfalls durch die Theorie von Wegner erklärt werden zu können. Wenn Überkompensation auftritt, zum Beispiel während der Instruktion „nicht am Loch vorbei putten“, dann ist es sicherlich die Intention den Ball nicht weiter zu putten als zum Golfloch. Wenn also der Ball weit vor dem Loch liegen bleibt, dann ist dieses (zuvor erwünschte) Ziel auch erreicht. Wegner argumentiert in seiner Theorie dass die Aufmerksamkeit auf das zumeist erhoffte Resultat ausgerichtet wird. Im Bezug auf das Golfbeispiel müsste die (visuelle) Aufmerksamkeit auf das Gebiet vor dem Golfloch gerichtet werden. Genau das passierte während des Auftretens von Überkompensation in dem Golfexperiment und stimmt somit mit der Argumentation von Wegner überein.

Das Austauschen von unerwünschten Gedanken (die nicht bei den erwünschten Resultaten passen) durch Gedanken, die mit dem ersehnten Resultat übereinstimmen (der freie Torraum, den Apfel treffen), erfordert Aufmerksamkeit. In der Theorie von Wegner wird darum auch vorhergesagt, dass ironische Effekte auftreten würden sobald sich die Aufmerksamkeitskapazität erschöpft hat. Angst gilt z.B. als Faktor, der die Aufmerksamkeitskapazität erschöpft.

Die Ergebnisse des letzten Experiments dieser Arbeit, in der die Kombination zwischen einer negativen Instruktion und Angst zu ironischen Effekten führte, scheinen ebenfalls gut durch die Theorie von Wegner erklärt werden zu können.

Für die Sportpraxis zeigen die Resultate dieser Arbeit, dass es bei der Ausführung perzeptuell-motorischer Aufgaben sowohl in Trainings- als auch in Wettkampfsituationen sehr wichtig zu sein scheint, keine negativ formulierten Instruktionen zu verwenden und genauso wenig Instruktionen zu nutzen, in der das zu vermeidende Gebiet genannt wird.

Menschen sehen dorthin wohin sie zielen und zielen dorthin wohin sie sehen. Insofern kann die Verwendung von ‚schlechten‘ Instruktionen auch ein verkehrtes Zielgebiet hervorheben. Eine Instruktion, in der der richtige Zielpunkt genannt wird (das Loch, der freie Torraum oder Bull's eye in den beschriebenen Experimenten) sollten bevorzugt werden.

Weil Wilhelm Tell es geschafft hat, den Apfel vom Kopf seines Sohnes zu schießen, dürfen wir davon ausgehen, dass Tell den „Apfel“ als Wort in einer positiv formulierten (Selbst)Instruktion verwendet hat und dass er sein Auge lange auf den Apfel fixiert hatte, bevor er den Pfeil abschoss. Dementsprechend hat Wilhelm Tell die Ratschläge aus dieser Arbeit bereits vor 700 Jahren intuitiv korrekt ausgeführt.

Dankwoord

(Acknowledgements)

Dankwoord

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List of publications

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Publications in international journals

- Bakker, F.C., Oudejans, R.R.D., Binsch, O., & Van der Kamp, J. (2006). Penalty shooting and gaze behavior: Unwanted effects of the wish not to miss. *International Journal of Sport Psychology*, 37, 265-280.
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Submitted for publication

- Binsch, O., Bakker, F.C., & Oudejans, R.R.D. (2010). Anxiety and ironic effects in aiming at a far target.

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- Binsch, O., Oudejans, R.R.D., Bakker, F.C., & Savelsberg, G.J.P. (2006). Unwanted effects in aiming tasks are mediated by changes in gaze behavior. *Proceedings of the 9th European Workshop of Ecological Psychology*. Groningen, The Netherlands.
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Curriculum Vitae

Curriculum Vitae

Olaf Binsch was born in Walsrode, Germany, on January 28, 1969 and he grew up in Ahlden, a beautiful village in the heart of the Lüneburger Heide, with his parents, brother and sister. After he attended elementary school, middle school and received his education in carpentry, he voluntarily joined the German military service, the Bundeswehr, for 12 years. At the Bundeswehr, he was educated in the infantry domain and was a member of the national military sports orienteering team where he competed at several European- and World Championship events. To complete his pre-university education he attended evening school, at Silbermann-Kolleg in Münster, before studying Sports Sciences and Movement Sciences at the University of Bielefeld and the VU University Amsterdam, The Netherlands. In 2003, he earned his master's degree in sport sciences with a major in sport psychology and worked as a manager in the Dutch sport industry prior to starting his PhD-project reported in this dissertation. Currently, he is a scientist at the Netherlands Organisation for Applied Scientific Research – TNO, at the department of Human Factors in Soesterberg. His areas of interest include human performance (under pressure), stress, emotions, cognitions, and modeling as well as all facets of soldier modernization programs. Olaf Binsch is living in The Hague, together with his girlfriend and son.