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I CAN'T TAKE MY EYES OFF OF IT – ATTENTION ATTRACTION EFFECTS OF IMPLEMENTATION INTENTIONS

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Implementation intentions ("If situation X is encountered, I will perform behavior Y") have been shown to improve goal attainment, relative to mere goal intentions, through automating action control. So far, they have only been examined with regard to three features of automaticity without testing the uncontrollability of implementation intention effects. In two studies on the impact of implementation intentions on visual attention, support was found for the uncontrollability of their effects. Implementation intentions attracted attention (i.e., a situational cue X disrupted attention from a focal task) even during the pursuit of different goals, more than goal intentions. In addition, the regulation of the action control through implementation intentions in response to these attention attraction effects was examined in a subsequent task. Improved performance co–occurred with attention attraction, indicating that no disengagement from the implementation intention took place. Implications for the application of implementation intentions are discussed.

Human goal pursuit is often not as successful as it could be because good opportunities to act are missed. Forming a goal intention defin-

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ing which goal one intends to achieve (e.g., "I intend to call my grandma") often does not suffice for taking advantage of all good opportunities to act (Gollwitzer & Sheeran, 2006). But goals can be furnished with implementation intentions specifying when, where, and how one plans to behave in order to achieve a certain goal ("If situation X is encountered, I will perform behavior Y!"; For example, "If I see a telephone, I will call my grandma.") By forming an implementation intention, the mental representation of the specified situational cue becomes highly accessible (Aarts, Dijksterhuis, & Midden, 1999) and a situation–behavior link is established (Webb & Sheeran, 2005). Thereby, implementation intentions have been shown to substantially improve goal attainment (Bamberg, 2000; Brandstätter, Heimbeck, Malzacher, & Frese, 2003; Brandstätter, Lengfelder, & Gollwitzer, 2001; Chasteen, Park, & Schwarz, 2001; Gollwitzer & Brandstätter, 1997; Milne, Orbell, & Sheeran, 1999; Sheeran & Orbell, 2000; Sheeran & Silverman, 2003; Verplanken & Faes, 1999; Webb & Sheeran, 2003, 2004; for a meta–analysis see Gollwitzer & Sheeran, 2006), relative to mere goal intentions. Thus, implementation intentions delegate action control from the self to the specified situational cues that directly elicit action.

This so–called strategic automaticity (Gollwitzer & Schaal, 1998, p. 124) of action control is central for the effects of implementation intentions (Gollwitzer & Sheeran, 2006). To date, the research on implementation intentions has demonstrated that the effects of implementation intentions carry three features of automaticity (e.g., Bargh, 1994, 1997; Bargh & Chartrand, 1999; Logan, 1988, 1992; Moors & De Houwer, 2006; Shiffrin & Dumais, 1981; Shiffrin & Schneider, 1977; Wegner & Bargh, 1998): Immediacy, efficiency, and lack of conscious intent. However, a further feature of automaticity is reduced controllability (e.g., Bargh, 1994, 1997; Moors & De Houwer, 2006; Shiffrin & Schneider, 1977; Schneider, Dumais, & Shiffrin, 1984). In this respect, not all the posited effects of implementation intentions' automaticity have been examined empirically.

The immediacy of implementation intention effects has been investigated in terms of the close temporal proximity between the occurrence of situational cues and the actual performance of an action specified in an implementation intention (e.g., Aarts & Dijksterhuis, 2000; Gollwitzer & Brandstätter, 1997, Study 3; Lengfelder & Gollwitzer, 2001, Study 2). Linking anticipated critical situations with intended behaviors by forming implementation intentions led

to the initiation of the specified behavior immediately after the occurrence of the anticipated situation (e.g., counter arguing at specified critical moments when a presumed racist expressed prejudiced beliefs, Gollwitzer & Brandstätter, 1997, Study 3). Thus, the effects of implementation intentions are automatic in terms of the immediacy of the action initiation in response to the occurrence of the specified situation.

The efficiency of implementation intention effects was examined in another set of experiments (Brandstätter et al., 2001, Studies 3 and 4) that manipulated the cognitive resources required to complete a task. In such dual task paradigms, implementation intentions led to faster responses to the specified situational cues than did mere goal intentions, without compromising responses to a simultaneously performed primary task, regardless of whether this primary task was easy or difficult to perform. Thus, the effects of implementation intentions are automatic in terms of the efficiency of the action initiation in response to the specified situations.

Finally, whether the situation specified in the implementation intention leads to action initiation without conscious intent has been examined. The subliminal presentation of situational cues of an implementation intention led to the activation of knowledge relevant to the intended goal pursuit and to faster cue classification compared to mere goal intentions (Bayer, Moskowitz, & Gollwitzer, 2004). In addition, the activation of the superordinate goal outside of awareness led to goal–directed behavior in response to the specified cue only when an implementation intention (but not a mere goal intention) was formed (Sheeran, Webb, & Gollwitzer, 2005). Thus, as implementation intentions are formed ahead of time by an intentional act of will, action initiation in response to the specified situation through implementation intentions does not require a second act of willing. So the effects of implementation intentions are also automatic in terms of not requiring conscious intent for action initiation.

Taken together, these studies provide convincing evidence of the automaticity of implementation intention effects in terms of their immediacy, efficiency, and lack of conscious intent. However, another important feature of automaticity, namely the uncontrollability (e.g., Bargh, 1994, 1997; Moors & De Houwer, 2006; Shiffrin & Schneider, 1977; Schneider et al., 1984) of implementation intention effects, still lacks a systematic examination. So far, it is not clear if the effects of implementation intentions are automatic in terms of the uncontrolla-

bility of their effects. But to increase the understanding of the type of automaticity created by implementation intentions and their potential consequences for goal pursuit, it is vital to answer the question of the uncontrollability of implementation intention effects.

STUDYING THE UNCONTROLLABILITY OF IMPLEMENTATION INTENTIONS

Different definitions of uncontrollability have been suggested by research on automaticity (Bargh, 1994, 1997; Moors & De Houwer, 2006; Shiffrin & Schneider, 1977). Whereas Bargh (1994, 1997) restricts the use of the term uncontrollability to the inability to alter or to stop a process once started, Moors and De Houwer (2006) as well as Shiffrin and Schneider (1977) apply the term uncontrollable also to the inability to avoid the start of an act. For example, Shiffrin and Schneider (1977) classified automatic attentional processes (e.g., pop–out of certain targets in a visual search task) as uncontrollable. In the present research, we focus on uncontrollability as the inability to avoid the start of an act (see Moors & De Houwer, 2006; Shiffrin & Schneider, 1977). Thus, the uncontrollability of the effects of implementation intentions would be evidenced by people's inability to avoid the situational cues of an implementation intention automatically attracting attention. To examine such uncontrollability of implementation intention effects, different experimental paradigms are required than the facilitation paradigms that have been used to examine the other three features of automaticity mentioned above. In these facilitation paradigms, the automaticity of the effects of implementation intentions improved goal pursuit. This automaticity helped participants to successfully attain the implementation intention's superordinate goal without compromising responses to other cues (e.g., faster responses only to certain numbers in a recognition task, Brandstätter et al., 2001, Webb & Sheeran, 2004) and to attain alternative goals (e.g., speeding up lexical decisions, Aarts et al., 1999). Although the results of these facilitation paradigms do reflect automatic processes due to the speed of responses (Bargh & Chartrand, 2000; Neely, 1991), it would strengthen the case for uncontrollability of implementation intention effects to demonstrate that implementation intentions impact people's behavior even when they impair the successful attainment of their goals.

To this end, visual attention interference paradigms like the flanker task (Eriksen & Eriksen, 1974) seem well suited. In a flanker task, the critical cues are not relevant for the successful processing of the focal task at hand. Results in these paradigms reflect how participants' performance in a focal task is impaired by the uncontrollable attraction of attention to such critical cues (Eriksen & Eriksen, 1974). Such attention interference paradigms (e.g., flanker task, Eriksen & Eriksen, 1974; dichotic listening task, Johnston & Heinz, 1978) have to be differentiated from the dual task paradigms that have been employed to demonstrate the efficiency of the implementation intention effects (e.g., Brandstätter et al., 2001). Whereas in visual attention interference paradigms the ongoing task is used to create an intention to attend to the focal task and ignore the distractors, in dual task paradigms the ongoing task is used to create low and high cognitive load. In addition, the use of visual attention paradigms can contribute to the external validity of the findings as it is plausible that people more frequently specify visual rather than auditory cues when they form implementation intentions. Thus, a visual attention interference paradigm rather than a facilitation paradigm seems well suited to examine the uncontrollability of implementation intention effects.

It should be noted that in terms of their underlying mechanisms, interference paradigms as well as facilitation paradigms draw on implicit cognitive processes with regard to information processing. In both paradigms the accessibility of knowledge units from memory plays an important role when it comes to the processing of semantic cues. In a facilitation paradigm like the lexical decision task (e.g., Aarts et al., 1999), the facilitation of word or non–word categorizations is taken as an indicator of the accessibility of the word meaning. In an interference paradigm like the Stroop color–naming task (Stroop, 1935; MacLeod, 1991), the interference with naming the color in which a word is written is taken as an indicator of the accessibility of the word meaning. The accessibility of knowledge units from memory is not only important for semantic decision processes but can also be relevant for earlier stages of information processing like attentional processes (e.g., Higgins, 1989, 1996). Higher accessibility of a stored situational cue not only impacts categorizing cues that are in the focus of attention, but also leads to a higher probability that stimulus information relevant to that cue will receive attention in the first place (Bargh & Pratto, 1986; Roskos–Ewoldsen & Fazio,

1992). Thus, as implementation intentions increase the accessibility of the situational cue (Aarts et al., 1999, Webb & Sheeran, 2005) they should also impact attentional processes. This has already been postulated by Gollwitzer (1993) who assumed that people spontaneously pay attention to situational cues of an implementation intention and that people should be perceptually ready (Bruner, 1957) to detect the specified cues in their environment after forming implementation intentions. Thus, attentional attraction should qualify as a proxy for the accessibility of the mental representation of situational cues of an implementation intention. But whereas the accessibility in terms of facilitated responses has been convincingly demonstrated (Aarts et al., 1999, Webb & Sheeran, 2005), an empirical examination of the consequences of implementation intentions on attention is still missing (for an exception and its limitations see the work summarized below by Gollwitzer, Mertin, & Steller, 1992 cited in Gollwitzer, 1993).

Such attentional processes would not be critical when an ongoing goal pursuit already requires one to attend to the situational cues of an implementation intention. This is the case in facilitation paradigms, where the cues are behaviorally relevant for the task at hand (Aarts et al., 1999, Webb & Sheeran, 2005). However, they should become critical when an ongoing goal pursuit requires one to attend to different cues, and the situational cues of an implementation intention are also present. To date, it is not clear how the presence of implementation intention cues impact the pursuit of other goals. That is, will the situational cues of an implementation intention automatically attract attention even when they thereby impair an ongoing goal pursuit? To provide an answer to this question, the current research sought to demonstrate the uncontrollability of implementation intention effects in terms of their automatic effects on attention.

ATTENTIONAL PROCESSES OF IMPLEMENTATION INTENTIONS

How could it be shown that the situational cues of an implementation intention automatically attract attention? It is hard to assess the current focus of attention directly, but research has demonstrated that certain interference paradigms can be used to indirectly measure attention. As human attention is limited in capacity (Shiffrin & Schneider, 1977; Wickens, 1980), the automatic attraction of attentional

resources by the situational cue (X) of an implementation intention should leave fewer attentional resources for other information. As a consequence, responses to other information should diminish (i.e., reaction times may slow down in most of the paradigms). Several paradigms make use of this interference effect to measure the attention attracted by distractors (e.g., flanker task, Eriksen & Eriksen, 1974; dichotic listening task, Johnston & Heinz, 1978).

Using a dichotic listening task, the only research addressing the impact of implementation intentions on attention found that the situational cue specified in an implementation intention was disruptive to focused auditory attention (Gollwitzer, Mertin, & Steller, 1992, cited in Gollwitzer, 1993). In this task, participants had to shadow (i.e., repeat) words that were presented to one ear (attended channel) and to ignore words presented to the other ear (non–attended channel). In addition to this dichotic listening task, they had to turn off a probe light that was flashing in irregular intervals as a subsidiary second task. It was found that the shadowing performance and the response speed on the subsidiary second task were diminished if situational cues from implementation intentions were presented on a non–attended channel. These results nicely demonstrate that situational cues attract people's auditory attention even when working on a different task, if an implementation intention including these cues has been formed. Thus, these results seem to support the idea that the effects of implementation intentions are automatic in terms of the uncontrollability of their effects on attention.

Although the dichotic listening task is commonly used to measure auditory attention, these results cannot be generalized to the area of visual attention as the different modalities have different processing attributes (Wickens, 1980, 1984). The visual attention system is more able than the auditory attention system to process information in parallel rather than serial fashion (Wickens, 1984). Therefore, attraction of attention by visual cues should be more difficult to obtain than by auditory cues. As it is plausible that implementation intentions will more frequently specify visual than auditory cues, a test of the uncontrollability of implementation intention effects on visual attention is strongly called for. Therefore, the first aim of the present research is to examine the uncontrollability of implementation intention effects on visual attention.

We predicted that implementation intentions lead to stronger attraction of attention to situational cues of implementation intentions

compared to goal intentions, even when it impairs the pursuit of the ongoing goal pursuit. As an indicator of the uncontrollability of these attention attraction effects, the attention toward other cues and thus the pursuit of the ongoing goal was hypothesized to be diminished. Fewer attentional resources were expected to remain if implementation intention cues occupy parts of our limited attentional capacity.

The second aim of the current research is to address the regulation of such uncontrollable effects of implementation intentions on attention. Even if people cannot control the attention attraction effects of implementation intentions in the situation, they could still become aware of these unwanted attention attraction effects. To avoid such unwanted attention attraction effects in the future, people could then disengage from their implementation intentions. Such disengagement would be evidenced if, after the interference task, implementation intentions do not improve goal attainment in the task for which they were originally formed. In other words, improved goal achievement in a task subsequent to the uncontrollable attraction of attention would indicate that, despite the interference, no disengagement from the implementation intention had taken place. As implementation intentions can direct selective attention preconsciously, we assume that participants are unaware of the unwanted attention attraction effects of implementation intentions. As a consequence, participants should not consciously disengage from their implementation intentions. Therefore, we predicted that implementation intentions lead to a better performance in the relevant task compared to goal intentions. In addition, based on the central role of attention in both tasks, a positive relationship was predicted between the attention attracted by the situational implementation cues in the interference task and performance in a subsequent cue detection task.

OVERVIEW OF PRESENT RESEARCH

The present research examines whether the effects of implementation intentions are automatic in terms of the uncontrollability of their effects on attention. If so, situational cues (X) should attract more attention after forming an implementation intention, compared to only holding the goal intention on which the implementation intention is based. To measure such automatic attraction of attention, implementation intention cues appeared during the pursuit of a

different goal. In two studies, attention attraction effects of implementation intentions compared to goal intentions were examined in a visual attention interference task measuring response latencies (i.e., a lexical decision task embedded in a flanker task). Moreover, to examine the regulation of the automated action control through implementation intentions in response to the attention attraction effects, the intended implementation intention effects were measured in a task on cue detection after the interference task.

STUDY 1

To examine attention attraction effects of implementation intentions, Study 1 used a manipulation with identical information in the implementation intention and the control intention condition to minimize the probability of differential accessibility of the situational cues.[1] Attention attraction effects were measured in a different task than the one the implementation intentions were formed for.

It was predicted that attention toward lexical decisions would be disrupted if unrelated situational cues from implementation intentions formed for a different task were present as irrelevant cues, because these cues attract attention. Hence, slower reaction times in the lexical decisions were expected in the implementation intention condition compared to the control condition if a situational cue was present, but not when neutral cues were present.

METHOD

Design and Participants

Study 1 had a mixed 2×2 design with Intention (implementation intention vs. control intention) as a between–subjects factor and Distractor (critical distractor, neutral distractor) as a within–subjects factor. In exchange for 5 Euros, 21 female and 6 male undergraduate

1. As one anonymous reviewer noted despite the equal number of critical cues in both conditions, other differences (e.g., processing time, depth of processing) might have affected accessibility. To control for accessibility more directly, future research could add a pure accessibility condition that contains the critical cues but without any association to a goal. We thank Jim Uleman for this idea.

students of the Friedrich–Schiller–University Jena, with a mean age of 23 years (range 18–28), took part in the experiment.

Procedure

Upon arrival in the laboratory, participants sat in front of a computer and learned that they would work on two different studies combined for convenience. First, participants worked on a categorization task that served to motivate the formation of a goal.

The categorization task was similar to the musical instrument and weapon implicit association test (Greenwald, McGhee, & Schwarz, 1998). Participants had to categorize cues by pressing either the left or the right control key on a computer keyboard. The task consisted of 10 trials in which words had to be categorized as pleasant versus unpleasant, 10 trials in which pictures had to be categorized as showing a music instrument or a weapon, and 20 trials with the value–incongruent combinations of music instruments and unpleasant words on one key and weapons and pleasant words on the other key. The congruent block and the relearning phase of the original implicit association test were not included, to keep the key that had to be pressed for a category constant throughout the whole study. To keep the key that had to be pressed for a category constant throughout the whole study, the congruent block and the relearning phase of the original implicit association test were not included. This was necessary to allow forming an implementation intention for a category key (e.g., left control key for music instruments, right control key for weapons) that is true during all trials of the task. Participants generally experience the value incongruent trials of an implicit association test as difficult (Monteith, Voils, & Ashburn–Nado, 2001). This experience was used to motivate participants for training before carrying out the categorization task a second time. This training was, in fact, the intention manipulation (see below). After the training, participants worked on an ostensibly unrelated study which was in fact the assessment of the attention attraction effect. This timing was justified by telling participants that the training takes some time to display its optimal effects. After the assessment of attention attraction, participants filled in a short questionnaire. The announced repetition of the first categorization task was actually not included in the study. Finally, participants were thoroughly debriefed, paid, and thanked.

Manipulation

To manipulate participants' intentions, they were "trained" for the inconsistent trials of an implicit association task on flowers and insects. The training used different categories (flowers, insects) than the first categorization task (musical instruments, weapons). This change of categories served to avoid a heightened accessibility of the cues through the repeated activation in the first categorization task before the attention attraction measurement. In both conditions they formed the goal to press the left control key if they saw a flower or an unpleasant word, and to press the right control key if they saw an insect or a pleasant word. In the *implementation intention condition*, participants had to memorize four implementation intentions ("If I see an 'unpleasant' word, I press the left control key.", "If I see a 'pleasant' word, I press the right control key.", "If I see a 'flower', I press the left control key.", "If I see an 'insect', I press the right control key."). In the *control intention condition* participants had six goal intentions ("I respond to a 'flower' as quickly and accurately as possible.", "I respond to an 'insect' as quickly and accurately as possible.", "I respond to an 'unpleasant' word as quickly and accurately as possible.", "I respond to a 'pleasant' word as quickly and accurately as possible.", "I press the left control key as quickly and accurately as possible.", "I press the right control key as quickly and accurately as possible."). Thus, the situational cues of the implementation intentions ("flower," "insect," "pleasant word," and "unpleasant word") were included in the control intentions as well as in the implementation intentions to avoid differential activation of these cues between conditions. On the subsequent page, participants had to write down the memorized intentions. This part of the instructions was given on paper, whereas the rest of the study was conducted at the computer.

Measures

Attention Attraction. To measure *attention attraction* effects independently of performance effects of implementation intentions, a modified flanker task (Eriksen & Eriksen, 1974) was employed. In this task participants were presented with two cues on the computer screen. One cue was written in non–italic letters (distractor) and one in italic letters (target). Participant's task was to decide if the cue written in italic letters (target) was a word or a non–word (e.g., *cup*,

vase, vehicle, meirn, berse, felerod) by pressing either the left or the right control key. Thus, only the targets were relevant for the task. Including the target type as a factor in the analyses reported below did not lead to any significant effects involving this factor or to any changes in the reported results. Therefore, target type was not included in analyses reported below. Regarding the distractors participants were told that they were included just to increase the complexity of the task and should thus be ignored. But in fact the distractor cues served to operationalize the Distractor factor: Neutral distractors were neutral words (e.g., *clothing, vase*); critical distractors were the situational cues from the implementation intentions (*flower, insect*). In addition, non–words (e.g., *felerod, geluit)* were presented as distractors to support the plausibility of the cover story. The extent to which the response speed in this lexical decision task differs between trials with a critical distractor versus a neutral distractor indicates the attention attraction effect of the critical distractor.

Targets and distractors were placed vertically in the center of the screen (17 inch, 1024 × 768 dots) in 24 pt letters with double spacing between them. Overall, the flanker task consisted of 10 practice trials plus 64 trials. Each trial started 250 ms after the preceding trial with a fixation cross that was presented for 500 ms. Targets as well as distractors consisted of 32 words and 32 non–words. The distractors contained 8 critical words and 24 neutral words.

Two indices were calculated from the response time data. A neutral distractor index was computed using the mean reaction times to target cues (words and non–words) simultaneously present with a neutral distractor (neutral words). The critical distractor index consisted of the mean reaction times to target cues (words and non–words) that were simultaneously present with a critical word as distractor (i.e., the situational cues flower and insect).

Final Questionnaire. To control for intentional strategies the following questions were asked: "Did the training influence your performance on the word–or non–word task?" [1 (*not at all*) to 9 (*very much*)], "Did you have distracting thoughts that hindered you during the word or non–word task?" [1 (*very little distracting thoughts*) to 9 (*many distracting thoughts*)], "How concentrated were you during the tasks?" [1 (*not concentrated at all*) to 7 (*very concentrated*)], "How quick were you?" [1 (*not quick at all*) to 7 (*very quick*)] and "How difficult was the task for you overall?" [1 (*difficult*) to 7 (*easy*)].

RESULTS

Flanker Task

For the analysis of the flanker task, we omitted all responses that were faster than 150 ms, more than two standard deviations slower than the mean response time (> 1660 ms), or incorrect (overall 15.12% of the trials). Such relatively high levels of errors have also been reported by earlier studies (Chastain, Cheal, & Lydon, 1996; Eriksen & Eriksen, 1974; Eriksen & Schultz, 1979). A potential cause could have been the high amount of similarity between the targets written in italics and the distractors written in non–italics. Error rates in the flanker task did not differ between conditions ($M_{\text{implementation intention (ii)}}$ = 11.92, SD = 7.65, $M_{\text{control intention (ci)}}$ = 8.29, SD = 4.87), F (1, 25) = 2.20, p = .156, η^2_p = .081. In addition, error rates did not differ between trials with critical words as distractor and trials with control words as distractor, F (1, 25) = 0.06, p = .948, η^2_p = .001. With regard to the reaction times, yes and no answers have been combined as they did not differ between intention conditions[2].

In order to test the predictions about the attention attraction effects of intentions, a mixed MANCOVA was calculated with Intention (implementation intention vs. control intention) as a between–subjects factor, Distractor (critical distractor, neutral distractor) as a within–subjects factor, and the mean reaction time of the residual trials that were not included in the critical comparison (i.e., non–word distractors) as covariate to control for interindividual differences in mean response times.[3] The expected Intention × Distractor interaction was found, F (1, 24) = 4.35, p = .048, η^2_p = .153 (see Table 1). In line with the predictions, pairwise comparisons revealed that reactions to target cues appearing simultaneously with critical distractors took

2. There was no main effect, F (1, 25) = 0.12, p = .734, η^2_p = .005 and no interaction of yes and no answers with the intention condition, F (1, 25) = 1.04, p = .329, η^2_p = .040. Including a left button, right button factor in the MANCOVA revealed no main effect of the button, F (1, 24) = .06, p = .817, η^2_p = .003. Furthermore, the button factor did not interact with the intention factor, F (1, 24) = 1.08, p = .316, η^2_p = .043; nor did the covariate, F (1, 24) = .08, p = .774, η^2_p = .004.

3. There was a main effect of the covariate, F (1, 24) = 290.39, p < .001, η^2_p = .924, which implies that the mean response times differed between participants. No interaction between this covariate and distractor, F (1, 24) = .39, p = .537, η^2_p = .016 and no main effect of condition emerged, F (1, 24) = 3.05, p = .094, η^2_p = .113.

TABLE 1. Mean estimates (standard deviations) of response times from the flanker task as a function of Intention and Distractor and mean number (standard deviation) of marked ds from the letter detection task as a function of Intention (Study 1, $N = 27$; Study 2, $N = 34$).

	Implementation Intention Condition	Control Intention Condition
Study 1		
Flanker task		
Critical distractors	1048.29 (81.02)[a]	982.72 (80.97)[b]
Neutral distractors	998.81 (33.93)	986.78 (33.94)
Study 2		
Flanker task		
Critical distractor (*d*)	969.41 (73.65)[a]	896.27 (78.28)[b]
Neutral distractors	973.84 (48.16)	993.64 (51.20)
Letter detection task		
Total numbers of *d* letters marked	29.06 (4.19)[a]	26.00 (3.31)[b]
Number of difficult detectable *d* letters marked	3.61 (2.18)[a]	2.50 (2.31)[b]

Note. Within rows, means having different superscripts [a b] differ significantly at a level of $p < .05$.

longer in the implementation intention condition ($M = 1048.29$ ms, $SD = 81.02$ ms) than in the control intention condition ($M = 982.72$ ms, $SD = 80.97$ ms), $F(1, 24) = 4.34$, $p = .048$, $\eta^2_p = .153$. No differences in reactions between the implementation intention ($M = 998.81$ ms, $SD = 33.93$ ms) and the control intention condition ($M = 986.78$ ms, $SD = 33.94$ ms) occurred when neutral distractors simultaneously appeared with target cues, $F(1, 24) = 1.06$, $p = .314$, $\eta^2_p = .042$.

Questionnaire

The items of the final questionnaire revealed no differences between conditions, all Fs $(1, 25) < 0.25$. Participants in the implementation intention condition as well as in the control intention condition perceived little attention attraction ("Did the training influence your performance on the word or non–word task?," $M_{ii} = 3.54$, $SD = 2.60$, $M_{ci} = 3.13$, $SD = 1.69$; "Did you have distracting thoughts that hindered you during the word or non–word task?," $M_{ii} = 2.69$, $SD = 1.75$, $M_{ci} = 3.00$, $SD = 1.89$) and did not differ on the control questions ("How concentrated were you during the tasks?," $M_{ii} = 6.54$, $SD =$

1.45, M_{ci} = 6.80, SD = 1.32; "How quick were you overall?," M_{ii} = 5.69, SD = 1.18, M_{ci} = 5.80, SD = 1.82; "How difficult were the tasks for you overall?," M_{ii} = 6.15, SD = 1.91, M_{ci} = 6.27, SD = 1.91).

DISCUSSION

In Study 1 situational cues from implementation intentions attracted attention more than goal intentions, when they appeared as distractors during the pursuit of a different goal. Participants' responses slowed down when a situational cue from an implementation intention appeared close to a target stimulus. This was found comparing participants holding an implementation intention with participants holding only the goal intention. These groups did not differ in their response speed when other distractors were shown. Self–reports suggested that participants were unaware of attention attraction effects. In sum, this study provides the first evidence for the automaticity of the attention attraction effects of implementation intentions' visual cues, in terms of their uncontrollability relative to mere goal intentions.

Nonetheless, Study 1 leaves two open questions. First, the behavior (pressing control keys) specified in the intentions was the same as that which served to measure the attention attraction effects in the unrelated flanker task. Thus, the distraction found in the flanker task might be limited to cases where not only the situational cue of the implementation intention is present during the pursuit of a different goal, but where the behaviors are also the same. Thus, the alternative explanation that the demonstrated interference just occurred as response competition on the level of the motor system cannot be fully excluded.

Second, Study 1 does not examine the second aim of the present research. No behavioral information about the regulation of the automated action control through implementation intentions in response to the attention attraction effects is provided. Participants indicated in the questionnaire that they were unaware of the attention attraction effects. But it is not clear if the implementation intentions still produce their effects on goal pursuit, or if they lose their functionality after the uncontrollable attention attraction effects impair the pursuit of the different goal.

STUDY 2

Study 2 was designed to exclude the alternative explanation that the interference found in the flanker task in Study 1 resulted solely from response competition on the level of the motor system. Does the attention attraction effect of implementation intentions depend on interference by the situational cue, or does it depend on the associated behavior? In other words, is the interference limited to cases in which the behavior specified in the implementation intention has to be performed to pursue another goal, as in Study 1? We expected that the attention attraction effect would generalize to situations where any behavior is performed, because it is only driven by attentional resources and not by the motor system.

To test this prediction, we developed a task in which the implementation intention behavior was different from the behavior for the flanker task. Participants formed an implementation intention for a letter detection task in which they marked instances of a certain letter in a printout of a text with a pen. Usually many letters are overlooked because texts are not processed letter by letter; instead, simple words are recognized as a whole (i.e., missing–letter effect, Healy, 1994). Webb and Sheeran (2004) provided evidence that implementation intentions improve the performance in this task substantially. As in Study 1, participants first formed implementation intentions for the letter detection task, then they worked on the flanker task, and finally they had to mark all *d*s in a short text.

When an implementation intention cue (*D/d*) was present as a distractor in the flanker task, slower reactions were expected in the implementation intention condition compared to the control intention condition. No performance differences between conditions were hypothesized when a neutral cue was present as distractor. Thus, an Intention by Distractor interaction was predicted.

In addition, Study 2 was designed to examine the second aim of the present research, namely the regulation of automatic action control through implementation intentions in response to the attention attraction effect. We predicted that people do not disengage from their implementation intentions because they are unaware of the unwanted attention attraction effect. Thus, better performance in the letter detection task was expected in the implementation intention condition compared to the control intention condition. Also, because in both tasks attentional processes are central for successful goal pursuit, a positive correlation between the extent of attention attraction

in the flanker task and performance in the letter detection task was expected.

METHOD

Design and Participants

In this experiment Intention (implementation intention vs. control intention) was a between–subjects factor and Distractor (critical distractors, neutral distractors) was a within–subjects factor. In exchange for 5 Euros, 18 female and 19 male undergraduate students of the Friedrich–Schiller–University Jena, with a mean age of 22 years (range 18–34) took part. Three participants had to be excluded from the analysis because they did not follow the instructions. In an open–ended question in the final questionnaire they indicated that they formed additional implementation intentions related to the phonetic information of the words for the letter detection task.

Procedure

The procedure followed the one of Study 1 except for the following alterations. There was no categorization task in the beginning, but participants were immediately informed about the letter detection task and started with the "training" that served to manipulate the intention (see below). The flanker task following right after the manipulation used two single letters (instead of two words) as stimuli. The letters were placed vertically in the center of the screen and were presented with double spacing between them. Target letters were written in italics, distractor letters in non–italics. Participants had to indicate whether the target letter was a vowel (*a, e, i, u*) by pressing the left control key or a consonant (*d, k, m, s*) by pressing the right control key. The situational cue from the implementation intention (i.e., the letter *d*) served as critical distractor and a set of other consonant letters as control distractors (*k, m, s*). In addition, vowels (*a, e, i, u*) were presented as distractors to support the plausibility of the cover story. Overall, the flanker task consisted of 64 trials plus 10 practice trials. Targets as well as distractors consisted of 32 vowels and 32 consonants. The consonants used as distractors contained 8 critical *d* consonants and 24 neutral consonants. Including the target type as a

factor in the analyses reported below did not lead to any significant effects involving this factor or to any changes in the reported results. Therefore, target type was not included in analyses reported below. After the flanker task, participants worked on a letter detection task, which was included to measure improved performance effects of implementation intentions. The materials were taken from Müsseler, Koriat, and Niβlein (2000). The letter detection task consisted of twelve sentences (see Appendix) that were printed on a standard paper–size sheet in portrait format in 12 pt Times New Roman. Participants had 80 seconds to work through these sentences and to mark all *d* letters. The sentences contained 39 *d*s in function words as well as other words. The letter detection task followed the flanker task to ensure that the goal for the letter detection task was uncompleted during the measurement of the attention attraction effect in the flanker task. Finally, participants filled in a short questionnaire, were thoroughly debriefed, paid and thanked.

Manipulation

The Intention manipulation was labeled as training for the letter detection task. First, participants in both conditions formed the goal to mark all *D/d* letters in the letter detection task. Next, they had to memorize and to write down intentions that were introduced as a useful method to improve their performance in the upcoming letter detection task. In the experimental condition, participants memorized an implementation intention ("If I see a letter *'D/d'* I will mark it."). In the control intention condition, the intention for the letter detection task was just a repetition of the goal, as it occurred in the task instructions ("I will mark all letters *'D/d'*).

Measures

Flanker Task. Two indices were calculated for the analysis of the flanker task: the mean response time on trials with neutral distractors (*k, m, s*) and the mean response time on trials with the critical distractor (*d*). For the analysis of the relation between the attention attraction effect and the improved performance effect of implementation intentions, an attention attraction score was computed by subtracting the mean response time on trials with neutral distractors from the mean response time on trials with critical distractors.

Performance. The absolute number of marked *d*s in the letter detection task was used as a measure of performance. Overall 39 *d*s had to be marked, including 6 that were difficult to detect in specific function words (i.e., "the", in German "der", "die", and "das").

Questionnaire. The items of the final questionnaire assessed the perceived attentional attraction "Did you have distracting thoughts that hindered you during the processing of the vowel or consonant task?": 1 (*very few distracting thoughts*) to 9 (*many distracting thoughts*); the perceived impact of the intentions on the performance "Did the training improve your performance in the vowel or consonant task?,": 1 (*not at all*) to 7 (*very much*); "How do you rate your performance with regard to marking all *d*s in the letter detection task?,": 1 (*many d*s *overlooked*) to 7 (no *d overlooked*); as well as control questions "How difficult were the tasks for you?,": 1 (*difficult*) to 7 (*easy*).

RESULTS

Flanker Task

For the analysis of the flanker task, all responses faster than 150 ms or two standard deviations slower than the mean response time (> 1888 ms), as well as wrong answers, were omitted (overall 8.92% of the trials). Error rates in the flanker task did not differ between conditions, F (1, 32) = 0.77, p = .387, η^2_p = .023. In addition, error rates did not differ between trials with critical consonants as distractors and trials with control consonants as distractors, F (1, 32) = 0.24, p = .881, η^2_p = .001. With regard to reaction times, yes and no answers were combined because they did not differ between intention conditions.[4]

As in Study 1, a mixed MANCOVA was calculated with Intention (implementation intention vs. control intention) as a between–subjects factor, Distractor (critical distractor, neutral distractor) as a

4. There was no main effect, F (1, 32) = 2.267, p = .148, η^2_p = .066 and no interaction of yes and no answers with the intention condition, F (1, 32) = 0.05, p = .946, η^2_p = .001. Including a left button, right button factor in the MANCOVA revealed no main effect of button, F (1, 31) = .45, p = .513, η^2_p = .014. Furthermore, the button factor did not interact with the intention factor, F (1, 31) = 0.01, p = .982, η^2_p = .001; nor did the covariate, F (1, 31) = .30, p = .595, η^2_p = .009.

within–subjects factor, and the mean reaction time of the residual trials that were not included in the critical comparison (i.e., vowel distractors) as a covariate.[5] In line with our hypothesis, the Intention × Distractor interaction was found, F (1, 31) =11.38, p = .002, η^2_p = .269 (see Table 1). Pairwise comparisons revealed that reaction times to target cues appearing simultaneously with critical distractors were longer in the implementation intention (M = 969.41 ms, SD = 73.65) than in the control intention condition (M = 896.27 ms, SD = 78.28 ms), F (1, 31) = 8.03, p = .008, η^2_p = .206. No differences in reaction times between the implementation intention (M = 973.84 ms, SD = 48.16 ms) and the control intention condition (M = 993.64 ms, SD = 51.20 ms) were found when target cues appeared simultaneously with neutral distractors, F (1, 31) = 1.22, p = .277, η^2_p = .038.

Letter–Detection Task

For the letter detection task the predicted effect of intention was found, F (1, 32) = 5.47, p = .026, η^2_p = .146. Participants in the implementation intention condition (M = 29.06, SD = 3.31) marked significantly more *d*s compared to participants in the control intention condition (M = 26.00, SD = 4.19). Importantly, these differences also occurred for the 6 difficult–to–detect *d*s included in the task. Participants in the implementation intention condition (M = 3.61, SD = 2.18) marked more such *d*s compared to the control intention condition (M = 2.5, SD = 2.31), F (1, 31) = 4.17, p = .049, η^2_p = .115.

In line with our hypothesis, a positive relation between attention attraction effect and performance was found (r = .37, N = 34, p = .028). The more attention the *d*s attracted in the flanker task, the better was the performance in the letter detection task.

Questionnaire

Participants did not experience a different amount of distraction in the flanker task (M_{ii} = 2.44, SD = 0.92, M_{ci} = 3.06, SD = 1.77), F (1, 32) =

5. There was a main effect of this covariate, F (1, 31) = 519.25, p < .001, η^2_p = .944, which implies that the mean response times differed between participants. No interaction between this covariate and distractor, F (1, 31) = 1.24, p = .273, η^2_p = .039; and no main effect of condition emerged, F (1, 31) = 2.34, p = .136, η^2_p = .070.

1.69, $p = .203$, $\eta^2_p = .050$. The intentions were perceived as slightly more useful in the implementation intention condition ($M = 4.89$, $SD = 0.96$) than in the control intention condition ($M = 4.07$, $SD = 1.53$), $F(1, 32) = 3.52$, $p = .070$, $\eta^2_p = .102$. In addition, the perceived performance in the letter detection task was rated as higher in the implementation intention condition ($M = 4.94$, $SD = 1.06$) than in the control intention condition ($M = 3.93$, $SD = 1.48$), $F(1, 32) = 5.30$, $p = .028$, $\eta^2_p = .142$. The tasks were rated as equally difficult in both condition ($M_{ii} = 5.00$, $SD = 1.63$; $M_{ci} = 5.11$, $SD = 1.64$), $F(1, 32) = 0.39$, $p = .845$, $\eta^2_p = .001$.

DISCUSSION

Study 2 found support for both hypotheses of the current research. Regarding the first hypothesis, automatic attention attraction effects of implementation intentions (relative to goal intentions) occurred during the pursuit of a goal different from the one for which the implementation intentions were originally formed. These results replicate the findings of Study 1. Study 2 also demonstrates that the attention attraction effect of situational cues from implementation intentions generalizes to situations where any behavior is shown, because it is merely driven by attentional resources and not by response competition on the level of the motor system. In line with our hypothesis, participants slowed down in the flanker task when situational cues from implementation intentions appeared as distractors, compared to participants that did not form an implementation intention. No differences in reaction times were found between intention conditions when target cues were presented with a neutral distractor.

With regard to the second hypothesis of the current research, we found, as predicted, that performance in the letter detection task was better in the implementation intention compared to the control intention condition. Participants in the implementation intention condition marked more *d*s overall as well as more difficult–to–detect *d*s than participants in the control intention condition. These results replicate the findings of Webb and Sheeran (2004). Furthermore, the expected positive correlation between the attention attraction effects and the improved performance effects of implementation intentions was found. The more intentions attracted attention in the unrelated flanker task, the better was the performance in the letter–detection

task. The questionnaire indicated that participants recognized the beneficial effects of the implementation intention in the letter detection task but also that, as in Study 1, they were unaware of the disruptive effects in the flanker task.

GENERAL DISCUSSION

The first aim of the present research was to demonstrate the automaticity of implementation intention effects in terms of the uncontrollability of their effects. More precisely, it was predicted that implementation intentions lead to attention attraction effects for their correspoinding situational cues, above and beyond goal intentions. The second aim was to examine the regulation of action control through implementation intentions in response to attention attraction effects. It was expected that implementation intention effects on attention are uncontrollable not only in the sense that they attract people's attention. Additionally, people were expected to be unaware of these unwanted attention attraction effects and therefore do not disengage from their implementation intentions. Overall, the results of the present studies confirmed these predictions. In two studies stronger attention attraction effects of situational cues were found for participants that formed an implementation intention compared to participants that formed only a goal intention to act. Situational cues from implementation intentions attracted attention during the pursuit of a different goal (i.e., flanker task) that was unrelated to the goal for which the implementation intention was formed. These attention attraction effects of implementation intentions were found for cues included in an implementation intention but not for the same cues when they were part of a control intention.

The current findings extend previous studies on effects of implementation intentions on attention (Gollwitzer, Mertin, & Steller, 1992, cited in Gollwitzer, 1993), as they demonstrate such effects in the domain of visual rather than auditory attention. This is especially relevant as it is plausible that implementation intentions more frequently refer to visual rather than auditory cues. The current experiments provide clear evidence that implementation intention cues automatically attract attention more than goal intentions. This impact of implementation intentions on attentional processes demonstrates that the effects of implementation intentions carry features of automaticity not only in terms of their efficiency, immediacy, and

lack of conscious intent but also in terms of the uncontrollability of their effects.

Also, our results imply that implementation intentions impact attention more than the impact of goal intentions that has been suggested by research on attention (e.g., MacLeod, 1991)[6] and prospective memory (e.g., intention superiority effect, Goschke & Kuhl, 1993; Freeman & Ellis, 2003; Hicks, Cook, & Marsh, 2005; Marsh, Cook, & Hicks, 2006).

Moreover, the presented studies demonstrate that attention attraction effects generalize to situations involving other behaviors, because it is driven merely by attentional resources and not by response competition on the level of the motor system. Implementation intentions that specified the same behavior as the behavior demanded in the interference task (Study 1), as well as implementation intentions that specified a different behavior than the behavior demanded in the interference task (Study 2), led to attention attraction effects relative to goal intentions.

Study 2 also provided evidence for the second aim of the present research. Despite the attention attraction effects, improved performance was found in the subsequent task for which the implementation intention had originally been formed. Thus, the disruptive effects of the implementation intentions on performance in the attention attraction task did not undermine the improved performance resulting from implementation intentions. In addition, a positive relation between attention attraction effects and the performance in the subsequent task was found. The more attention a situational cue attracts, the better is the performance during goal pursuit. Even though there was only initial evidence for this in the current study, one might speculate that the attention attraction effects from implementation intentions lead to an increase in performance because when situational cues attract attention, this lowers the risk that good opportunities to act are missed. Further research might seek more evidence for this process assumed by Gollwitzer and Sheeran (2006).

Taken together, the present research provides evidence for the automaticity of implementation intention effects in terms of the uncontrollability of their effects on attention. Implementation intentions attracted attention even when they thereby impaired the

6. We thank an anonymous reviewer for pointing to the role of motivationally significant cues in other research on attention.

pursuit of a different goal. In addition, participants in the presented studies indicated that they were unaware of the attention attraction effects during the pursuit of a different goal, and they also did not disengage from it in response to the attention attraction effects. The implications of this uncontrollability of attention attraction effects of implementation intentions are twofold. On the one hand, this uncontrollability of the attentional effects of implementation intentions ensures that good opportunities to act are not missed. But on the other hand, the attraction of attention through implementation intentions can lead to costs, because other important cues are prevented from getting enough attention, and the pursuit of competing important goals could suffer. In other words, unless the disruption of attention is critical for the success of the ongoing goal pursuit, the attraction of attention by situational cues relevant to a different goal becomes an unintended interference, instead of a valuable pointer to a good opportunity to pursue the alternative goal one would have otherwise overseen.

The current research provided initial evidence for both outcomes of these uncontrollable effects of implementation intentions on attention. Implementation intentions improved the detection of letters difficult to detect, but also impaired the response speed in the flanker task during distractor trials (compared to a goal intention). Therefore whenever possible, implementation intentions should be formed that include situational cues that exclusively occur in goal–relevant contexts. Otherwise the pursuit of other goals might be impaired as a consequence of the automatic attraction of attention by situational cues from an implementation intention. This could be especially important because, although participants seem to recognize the positive effects of implementation intentions (see Study 2), they do not seem to recognize the disruptive effects of implementation intentions on their attention. Thus, one might speculate that participants monitor the effects of implementation intentions only during the pursuit of the relevant superordinate goal intention. But due to our small sample size and low statistical power, such concerns remain speculative.

Overall, unwanted attention attraction effects of implementation intentions should not outweigh the benefits of implementation intentions for goal pursuit because they are expected to occur only under specific circumstances: The superordinate goal of the implementation intention has to be actively held, and the implemen-

tation intention cues have to be present during an alternative goal pursuit that is attentionally demanding.

What does this mean for the phone call example from the introduction? Forming the implementation intention 'If I see a telephone, I will call my grandma' is a simple act that can be done even shortly before an important business meeting. But it could be that during the meeting, one will find oneself uncontrollably glancing at a telephone behind a conversation partner, even if one tries to maintain eye contact. However, once the meeting is over, the implementation intention will ensure that the telephone will not escape one's attention and the grandma will be called. Whereas the current studies examined the uncontrollability of implementation intentions in terms of their effects on attention, it is also worthwhile to look at their uncontrollability in terms of their effects on behavior. Indeed such research is underway. Wieber and Sassenberg (2006) have shown that implementation intentions lead to automatic behavior initiation even when a different goal is pursued and that behavior may therefore not serve the focal goal.

One related aspect the present research did not examine is whether the implementation intention cues will still attract attention in an uncontrollable fashion after the goal has been completed or canceled. Whereas good evidence is available that the cancellation as well as the completion of goal intentions leads to the inhibition of their mental representation (Marsh, Hicks, & Bink, 1998; Marsh, Hicks, & Bryan, 1999; Marsh et al., 2006), it is an open question whether the automatic attention attraction effects of implementation intentions compared to goal intentions vanish if the associated goal is completed or a disengagement from the goal takes place. Further research is needed to rule out the possibility of unintended attention attraction effects after goal completion. This research should examine what impact the goals' respective status has on attention attraction effects of implementation intentions.

A final issue is whether goals alone, under certain circumstances, also lead to uncontrollable attention effects. Recent research by Moskowitz (2002) has analyzed this issue. His idea was that activating goals strongly, through manipulations based on self–completion theory, might do the job. In Study 2, he activated people's goal to act in an egalitarian way by first pointing out the importance of this goal and then instructing people to describe two events where they did not behave in an egalitarian way. Only with such an uncompleted

goal, but not with an affirmed goal to act in an egalitarian way (i.e., when people described two events where they did behave in an egalitarian way), was attention drawn toward goal–relevant items, even when these items were to be ignored and when responses occurred too fast for conscious control. Thus uncompleted goals (but not affirmed goals) also seem capable of producing such preconscious effects on attention. But these effects of uncompleted goals differ from those of implementation intentions with regard to their origin. Whereas implementation intentions are formed by an intentional act of will, uncompleted goals result from unwanted obstacles to goal attainment.

To conclude, the present studies provide good evidence for the automaticity of implementation intention effects in terms of the uncontrollability of their effects on attention. Situational cues from implementation intentions attracted people's attention more than mere goal intentions, even during the pursuit of different goals. In addition, people were unaware of these attention attraction effects and did not disengage from the implementation intentions. Notwithstanding potential costs of their uncontrollability, automatic attentional effects seem to be an integral part of successful action control through implementation intentions.

APPENDIX

German sentences used in the letter detection task containing the letter D/d. All D/d letters are underlined. Difficult detectable d letters are additionally written in italic letters.

In vielen Gegen*d*en südlich der Alpen ist *d*as Wetter meist sehr schön.

Das schöne Dorf im bayerischen Wald zog im Sommer viele Besucher an.

Für alle Studenten ist es unerlässlich, dass prinzipiell *d*er Text zum Referat intensiv gelesen werden muss.

Fast auf der ganzen Welt ist ein Deo Teil der modernen Kosmetik.

Oft wechselt *d*as Wetter auch mehrmals am gleichen Tag.

Für die Kunstwissenschaft ist es wichtig, dass ein Dia einen möglichst authentischen Ein*d*ruck eines Kunstwerks vermittelt.

Vor allem für Haushalte von Berufstätigen ist *d*ie Anstellung einer Putzfrau unvermeidlich.

Bei armen Leuten wird ein Dach mit Stroh gedeckt.

Weder Fleisch noch Fisch, sondern eine gesunde Lebensweise mit Gemüse ist *d*ie Alternative für Vegetarier.

Nicht nur für Betende, sondern auch für Kunstinteressierte ist ein alter Dom interessant und besuchenswert.

Westlich der Stadt München liegen *d*ie Orte Stuttgart und Ulm nahe beieinander.

Ein gutes Dia ist meist farbstärker als ein Negativ.

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