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Implementation Intentions and Efficient Action Initiation

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Implementation intentions ("If I encounter Situation X, then I'll perform Behavior Y!") are postulated to instigate automatic action initiation (P. M. Gollwitzer, 1993, 1999). In 4 studies, the hypothesis was tested that implementation intentions lead to immediate action initiation once the specified situation is encountered, even under conditions of high cognitive load. First, individuals whose action control is known to be hampered by disruptive cognitive business, such as opiate addicts under withdrawal (Study 1) and schizophrenic patients (Study 2), benefited from forming implementation intentions. Second, the beneficial effect of implementation intentions was also found in 2 experiments with university students (Studies 3 and 4) in which cognitive load was experimentally induced by using dual task paradigms. Results of the 4 studies suggest that forming implementation intentions instigates immediate action initiation that is also efficient.

The concept of intention is central to theorizing on human goal striving (e.g., Bandura, 1991; Fishbein & Ajzen, 1975; Gollwitzer & Moskowitz, 1996; Kuhl, 1984; Locke & Latham, 1990; Srull & Wyer, 1986; Wicklund & Gollwitzer, 1982; Wright & Brehm, 1989). In traditional theories on goal striving, the intention to achieve a certain goal is seen as an immediate determinant of goal achievement. Accordingly, for decades, research dealt with the factors that determine the formation of strong intentions (e.g., Ajzen & Fishbein, 1980; Atkinson, 1957; Fishbein & Ajzen, 1975; Heckhausen, Schmalt, & Schneider, 1985) and little attention was paid to the mechanisms mediating the effects of intentions on behavior. Over time, however, it became obvious that forming an intention is just one prerequisite for successful goal achievement, as there is a host of subsequent implemental problems that need to be successfully solved (e.g., Carver & Scheier, 1990; Gollwitzer, 1990, 1996; Heckhausen, 1991; Kuhl, 1984; Kuhl & Beckmann, 1994). After having set a goal, people often procrastinate acting on their intentions and thus fail to initiate goal-directed behavior. In everyday life people commonly strive for multiple—often even rivaling—goals, many of which are no simple "one-shot" affairs, but long-term projects that require repeated efforts (e.g., getting one's apartment renovated and finishing reading a novel). Thus, goal pursuits may come to an early halt because competing projects have temporarily gained priority, and the individual fails to successfully resume the original goal project (Gollwitzer, 1996; Heckhausen, 1991).

Getting started with or resuming an interrupted goal pursuit is rather simple when the necessary actions are well-practiced or routine and the relevant situational contexts release the critical behavior in a more or less automatic fashion (e.g., kiosks trigger buying a newspaper; the lecture hall triggers attending a lecture; Ouellette & Wood, 1998). Often, however, this fails to be the case as many behaviors are not part of an everyday routine. Consequently, an individual has to take pains to seize suitable opportunities to act on his or her goals. People often fail to take notice of good opportunities for initiating goal-directed behavior when attention is directed elsewhere (e.g., one is absorbed by a competing goal pursuit, wrapped up in demanding ruminations, or gripped by an intense emotional experience). Even if people actively search for a favorable opportunity in a given situational context, they may nevertheless fail to seize it simply because the opportunity presented itself only for a short moment and they did not respond in time.

The Distinction Between Goal Intentions and Implementation Intentions

Gollwitzer (1993, 1999) suggested that forming a certain type of intention called an *implementation intention* is a powerful self-regulatory strategy that alleviates such problems and thus promotes the immediate execution of goal-directed behaviors. Implementation intentions take the format of "If Situation X is encountered, then I will perform Behavior Y!" In an implementation intention a mental link is created between a specific future situation and the intended goal-directed response. Holding an implementation intention commits the individual to the performance of a certain goal-directed behavior once the critical situation is actually encountered.

Implementation intentions are to be distinguished from *goal intentions*. Goal intentions have the structure of "I intend to reach Z!" whereby "Z" may relate to a certain outcome or behavior to

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which the individual feels committed. Goal intentions are the type of intentions the majority of theories on goal striving have traditionally been concerned with (e.g., Ajzen, 1996; Bandura, 1991; A. J. Elliot & Sheldon, 1997; E. S. Elliott & Dweck, 1988; Emmons, 1996; Fishbein & Ajzen, 1975; Gollwitzer & Moskowitz, 1996; Kuhl, 1984; Locke & Latham, 1990; Srull & Wyer, 1986; Wicklund & Gollwitzer, 1982; Wright & Brehm, 1989). Implementation intentions are formed in the service of goal intentions and specify the when, where, and how of goal-directed responses. For instance, a possible implementation intention in the service of the goal intention "to write a letter to a friend" would link a suitable situational context (e.g., tonight after dinner at my desk at home) to an appropriate behavior (e.g., sending an e-mail message).

With respect to the functional characteristics of implementation intentions, Gollwitzer (1993, p. 173) spoke of a general principle called the "delegation of control to the environment" that is associated with three crucial features of automatic responding (e.g., Bargh, 1994, 1996, 1997; Logan, 1992; Shiffrin & Schneider, 1977). The situational context specified in the implementation intention is postulated to elicit the respective goal-directed behavior (a) immediately, (b) efficiently (i.e., not requiring much processing capacity), and (c) without conscious intent. In other words, it is assumed that forming implementation intentions leads to the automatic initiation of the specified behavior once the critical anticipated stimulus is actually encountered.

Implementation Intentions and the Rate of Goal Attainment

There is converging evidence that implementation intentions support goal achievement concerning diverse goal intentions, such as vigorous exercising (Milne, Orbell, & Sheeran, 1999), breast self-examination (Orbell, Hodgkins, & Sheeran, 1997), cervical cancer screening (Sheeran & Orbell, 2000), and resumption of functional activity after joint replacement surgery (Orbell & Sheeran, 2000), as well as eating healthy food (Verplanken & Faes, 1999). Implementation intentions also facilitate goal attainment when forgetting goal-directed behavior is likely (e.g., the regular intake of vitamin pills; Sheeran & Orbell, 1999; the signing of worksheets with very old people; Chasteen, Park, & Schwarz, in press), or when keeping deadlines is demanded (i.e., Gollwitzer & Brandstätter, 1997, Studies 1 and 2; Oettingen, Hönig, & Gollwitzer, 2000; Studies 2 and 3).

For example, Gollwitzer and Brandstätter (1997) conducted two field studies designed to test the hypothesis that goal intentions that are furnished with implementation intentions show a higher rate of goal attainment than mere goal intentions. In Study 1, participants were asked to name a personal project (e.g., writing a term paper) they intended to realize during Christmas break and to indicate whether they had formed implementation intentions. In Study 2, participants were asked under a pretext to write a report on Christmas Eve. Half of the participants were instructed to form implementation intentions with respect to when and where to perform this task. The other half of the participants did not specify time and place for acting on it. In both studies, having formed an implementation intention more than doubled the rate of goal completion. Whereas only about one third of the participants without implementation intentions completed the respective goal intention, about two thirds of the participants with an implementation intention were successful in realizing their goal intention.

Taken together, results from the studies listed above demonstrate that implementation intentions support the successful completion of goal intentions. Even though some of these studies checked on whether participants acted in the situations specified in their implementation intentions (e.g., Orbell et al., 1997, in which all but 1 participant did so), we do not know whether the effects of implementation intentions were actually produced through the postulated mechanism.

Automatic Action Initiation: The Issue of Efficiency

Consequently, to test the hypothesis that implementation intentions' delegation of control to situational cues is based on automatization of action initiation, it is necessary to analyze the actions people actually take in critical situations. It is necessary to check whether people who have formed an implementation intention indeed initiate goal-directed behaviors more immediately, efficiently, and without a conscious intent in the critical situation than do people without an implementation intention. In a first study on this issue, Gollwitzer and Brandstätter (1997, Study 3) followed this line of thought. Participants were instructed to form implementation intentions that specified favorable opportunities for presenting a convincing counter position to xenophobic statements made by a confederate. When participants were finally allowed to counter argue, they seized suitable opportunities for expressing themselves more immediately when having formed implementation intentions. In this study, however, cognitive load was not varied but was low throughout. Thus we do not know yet whether immediate action initiation caused by implementation intentions demands much or only little cognitive capacity. The hypothesis of automatic action initiation required a demonstration that implementation intentions trigger immediate action initiation not only under low mental load but even under increased mental load.

The negative effects of heightened cognitive load on action initiation, and the postulated alleviation of these effects by forming implementation intentions, can be studied in two different ways. First, researchers can focus on select groups of people whose action-control abilities suffer under mental distractions. Such groups were analyzed in Study 1 (opiate addicts under withdrawal) and Study 2 (schizophrenic patients). Study 1 was a field experiment in which participants were asked to perform an assigned task (i.e., writing a curriculum vitae) within a set time period. We hypothesized that forming relevant implementation intentions helps not only control participants (i.e., opiate addicts after withdrawal) to meet the task, but also those participants who still show withdrawal symptoms. In other words, implementation intention effects should not interact with the cognitive load (i.e., drug urge) experienced by the patients, and thus both patients under withdrawal and postwithdrawal patients should benefit from forming implementation intentions.

Study 2 was a laboratory experiment in which schizophrenic patients were asked to perform a go/no-go task (i.e., to press a button as quickly as possible when numbers appear, but not when letters are shown) under implementation intention instructions versus control instructions. The experimental manipulation consisted of instructing the participants to form the implementation intention to respond as quickly as possible to a specific number (i.e., a critical number) or to solely familiarize themselves with the critical number. We hypothesized that implementation intention instructions facilitate fast responses to the critical number to a larger degree than do control instructions that focus on familiarizing oneself with the critical number.

A second and different way of testing the efficiency of action initiation as a consequence of having formed implementation intentions is asking experimental participants (i.e., university students) to perform two tasks at the same time. In Studies 3 and 4 we used a dual-task paradigm (e.g., Heuer, 1996; Navon & Gopher, 1980; Wickens, 1980) that (a) permitted moving the focus of attention away from the intended situation by presenting it as part of the secondary task and (b) manipulated the mental load by varying the level of difficulty of the primary task. The primary task consisted of either working on meaningless syllables (Study 3) or performing a tracking task (Study 4). The primary task was presented to each participant at low and high difficulty levels, and in both studies it was designed in a fashion that demanded complete and steady attention. The secondary task was a go/no-go task as in Study 2. The experimental manipulation resembled that used in Study 2. We hypothesized that forming implementation intentions would speed up action initiation if the critical number occurred. Moreover, we expected that the implementation intention effect would be independent of the difficulty level of the primary task.

Study 1: Implementation-Intention Effects in Opiate Addicts Under Withdrawal

Substance dependency and substance abuse is guided by automatic processes as well as conscious processes (Tiffany, 1990). Whereby automatic processes relate to the routines a person has developed in consuming the drug, conscious processes create what is commonly referred to as a drug urge or craving (Marlatt, 1998). During withdrawal the automatic and conscious processes favoring the intake of the drug are countered with conscious self-regulatory attempts to suppress them. This leads to an enormous cognitive preoccupation, which has been found to disrupt everyday conduct. We predicted, however, that even patients under withdrawal (i.e., high cognitive load) should benefit from forming implementation intentions. Accordingly, the present study tested whether forming implementation intentions helps to perform ordinary behavioral projects not only in drug-dependent individuals who have successfully completed withdrawal but also in patients who are still showing withdrawal symptoms and thus can be assumed to suffer from intensive mental distractions.

Method

Participants

Forty-one patients (28 male and 13 female) at a German hospital specializing in opiate withdrawal participated in the present study. The main substance consumed by all patients was heroin, and some had in addition used various kinds of sedatives or cocaine. Age ranged from 16 to 39 years, with a mean of 25.1 years. One group of patients ($n = 20$) was randomly selected from the pool of patients who still showed symptoms of withdrawal (i.e., freezing, diarrhea, muscle pains and cramps, perspiration outbreaks); on average, patients had been hospitalized for 6 days. The other group of patients ($n = 21$) no longer showed any symptoms of withdrawal. These patients had been hospitalized for 17 days (on average). Patients in this group were matched with respect to gender, age, and level of education to the group of patients who still suffered withdrawal symptoms.

Procedure

As all of the patients were unemployed, the hospital administration offered workshops on how to find and apply for jobs. In the context of this effort to help them find employment, the patients were approached by a female experimenter at 10 A.M. of a given day. She explained that participation was voluntary and that the collected data were to be kept anonymous through the use of a sophisticated coding scheme. She furthermore stated that the study was designed to explore how young adults master a task relevant to finding a job: composing a curriculum vitae. Patients were shown a model curriculum vitae before they were asked to compose their own. The experimenter further explained that she would come back at 5 P.M. of the same day to collect the composed vitae.

After the approached patients had agreed to write a curriculum vitae in the designated time, and had thus formed a goal intention (all patients approached did), half of the patients in each group were randomly assigned to one of two conditions. In the irrelevant implementation-intention condition, participants were induced to make a plan (and report on a sheet of paper) as to where they intended to sit during lunch, when they wanted to have lunch, and how they intended to start lunch. In the relevant implementation-intention condition participants were requested to decide (and report on a sheet of paper) where they wanted to compose their vita, when they wanted to get started with it, and how they wanted to start composing their vita.

Before the experimenter left the participants on their own, she asked them to answer two items designed to assess commitment to composing a curriculum vitae ("I feel committed to compose a curriculum vitae" and "I feel I have to complete this task") and three items to assess self-efficacy ("Such tasks are easy for me," "I think I'll find the time to write the vita," and "This task doesn't seem to be difficult."). All items were accompanied by 9-point scales ranging from 1 (*don't agree*) to 9 (*fully agree*). When the experimenter returned 7 hr later at 5 P.M., she collected the written curriculum vitae.

Results and Discussion

Relevant and irrelevant implementation-intention participants in the withdrawal group showed close to the same, moderate commitment to the assigned task of composing a curriculum vitae (the mean of the two commitment items was $M = 4.20$ vs. $M = 4.00$, *ns*, in the two groups, respectively). Commitment scores for relevant and irrelevant implementation-intentions participants in the postwithdrawal patients group were nearly identical ($M = 4.15$ vs. $M = 4.10$, *ns*).

Still, relevant implementation-intention participants (12 out of 20 participants) were generally more effective in handing in a curriculum vitae at 5 P.M. than irrelevant implementation-intentions participants were (0 out of 21), $\chi^2(1, N = 41) = 17.82$, $p < .001$. Most importantly, in line with our predictions that mental distractions will not negatively affect implementation-intention effects, we observed that in the withdrawal-patient group, 8 out of 10 relevant implementation-intention participants handed in a curriculum vitae, whereas nobody (0 of 11) in the irrelevant implementation-intention group did so, $\chi^2(1, N = 21) = 14.23$, $p < .001$. In the postwithdrawal-patient group, we also observed a significant effect of relevant implementation intentions: 4 of the 10 relevant implementation-intention participants handed in the curriculum vitae, whereas nobody (0 of 10) in the irrelevant implementation-intention group did so, $\chi^2(1, N = 20) = 5.00, p < .05$.

Apparently, forming implementation intentions is a very helpful self-regulatory tool when it comes to translating goal intentions into action, and this occurs not only under low cognitive load (i.e., postwithdrawal patients) but also when cognitive load is high (i.e., withdrawal patients). As withdrawal patients are known to be highly distracted by thoughts attempting to control the drug urge, this finding supports the postulate (Gollwitzer, 1993, 1999) that action initiation that has been prepared in advance by forming implementation intentions is efficient and thus carries a vital feature of automaticity.

As it turned out, withdrawal patients tended to benefit even more from forming implementation intentions than did postwithdrawal patients, who are less plagued by distractive thoughts. The correlation between the formation of relevant implementation intentions and writing a curriculum vitae was $r = .82, p < .001$, in the withdrawal group and $r = .50$ in the postwithdrawal group, $Z = 1.79, p = .08$, indicating that the strength of the implementation-intention effect tended to be somewhat stronger in the withdrawal as compared with the postwithdrawal group. Two reasons for this come to mind: First, in a study with frontal lobe patients (Lengfelder & Gollwitzer, 2001) the patients who still had access to the conscious control of action (indicated by a high performance on the Tower of Hanoi, a problem-solving task that demands extensive effortful [conscious] planning) benefited less from forming implementation intentions than did the patients who did not (low performance on the Tower of Hanoi task). Possibly, the delegation of action control to situational cues through implementation intentions is particularly smooth if people stay away from tinkering with it on a conscious level. As high cognitive load hinders getting consciously involved with action initiation, whereas low cognitive load allows for it, withdrawal patients should have an even better chance to benefit from implementation intentions than postwithdrawal patients do (as is hinted at by the observed tendency of a stronger implementation-intention effect in withdrawal as compared with postwithdrawal participants).

Second, arguing from a more pragmatic perspective, we observed that the present hospital had a policy of involving postwithdrawal patients in various therapy sessions spread out over the day, whereas withdrawal patients were allowed to spend more time at rest. Accordingly, postwithdrawal participants had less free time on their hands and less control over their time. Indeed, when we compared withdrawal with postwithdrawal participants' self-efficacy ratings of being able to write the vita, the postwithdrawal participants tended to be less confident than the withdrawal participants, ($M = 5.8$ vs. $M = 6.4$), $t(40) = 1.31, p = .10$.

The present findings support the hypothesis that implementation intentions facilitate efficient action initiation (i.e., action initiation even in the face of distractions) as not only individuals with low amounts of mental distraction (i.e., postwithdrawal patients) benefited from forming implementation intentions, but also individuals with high amounts of mental distraction (i.e., withdrawal patients). It is important to note that this facilitation effect is not based on an increase in a person's commitment to the task at hand. In the present study, the strength of the goal commitment was observed to be close to identical in the relevant and irrelevant implementation-intention conditions for both groups of participants. Implementation intentions seem to delegate the control of goal-directed behavior (i.e., getting started with writing the vita) to situational cues (i.e., the when and where specified in a person's implementation intention), which in turn automatically trigger the behavior. Still, in the present study, we cannot tell whether people indeed acted immediately when the critical situation was encountered. Accordingly, we conducted a second experiment in which participants had to perform a go/no-go task in the laboratory, and thus responses to critical stimuli could be assessed on-line. Moreover, a different group of people (i.e., hospitalized schizophrenic patients) also known to be plagued by distractive thoughts participated in Study 2.

Study 2: Implementation-Intention Effects in Schizophrenic Patients

Schizophrenic patients are reported to have pronounced problems with action control (Salzinger, 1973). These are rooted in relevant perceptual, attentional, and memory malfunctioning (Braff, Saccuzzo, & Geyer, 1991), as well as in defective processes of executive control (Frith, 1987; Frith & Done, 1989; Kopp & Rist, 1993). Most important for the present line of thought, schizophrenic patients are known to be easily distracted by irrelevant information as they fail to filter it out, and therefore cannot focus exclusively on relevant information (Watzl & Rist, 1997). This is documented, for instance, in schizophrenic patients' comparatively lower digit attention span, particularly when distractive stimuli are presented simultaneously (Asarnow, Granholm, & Sherman, 1991).

Schizophrenic patients' vulnerability to distractions applies to internal and external stimuli alike. It is not surprising then that schizophrenic patients complain about feeling confused and disoriented and lacking control over their thoughts, feelings, and actions. Their mental situation is one of being caught in permanent dual- or multiple-task situations. The associated phenomenal experience has been impressively described by schizophrenic patients interviewed by McGhie and Chapman (1961):

> I can't concentrate. It's diversion of attention that troubles me. . . . The sounds are coming through to me, but I feel that my mind cannot cope with everything. It's difficult to concentrate on any one sound. It's like trying to do two or three things at a time. (p. 104)

Accordingly, if it could be shown that schizophrenic patients also benefit from forming implementation intentions, this would suggest that action initiation based on implementation intentions is facilitated in an efficient manner, as schizophrenic patients suffer under a chronically high cognitive load.

Method

Participants and Procedure

Twenty patients (6 male, 14 female) of a psychiatric hospital (Zentrum für Psychiatrie, Konstanz, Germany) who had been classified (on the basis of the *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed.; American Psychiatric Association, 1994) by the responsible psychiatrists as suffering from an acute schizophrenic episode participated in the present study. Patients were on average 34.5 years old and had been hospitalized for 3.6 months. Data on the following variables were obtained for all patients from the hospital's files: (a) total number of days patient spent in psychiatric hospitals, (b) number of days of present hospitalization, (c) age of patient when first placed under medication, (d) strength of medication over the last 10 days (i.e., chlorpromazine level), and (e) duration of present medication. Finally, each patient's score on the Brief Psychiatric Rating Scale (Mombour, Kockott, & Fliege, 1975; the ratings were made by each patient's responsible psychiatrist on 24 items, such as hostility, anxiety, hyperactivity, being disoriented, etc.) was inspected.

The control group consisted of 20 students and employees of the University of Konstanz (6 male, 14 female) who were matched to the patients regarding their age. For control participants the experiment was conducted in a laboratory cubicle, whereas the schizophrenic patients performed the experimental task in a separate room at the hospital. Participants were told that the study was concerned with factors influencing perceptual readiness.

Participants were placed in front of a personal computer to perform a go/no-go task. At the center of the screen, letters (i.e., *A*, *E*, *N*, *V*, and *X*) and numbers (i.e., *1*, *3*, *5*, *7*, and *9*) appeared in random order with a size of 2 cm for 1 s with an interstimulus interval of 1.5 s. Participants were instructed to press the key marked on the keyboard (i.e., the "+" key was marked with a red dot) as fast as possible whenever a number appeared, but not when a letter was shown. The computer recorded participants' response times (i.e., the time that passed between the presentation of a number and the pressing of the + key).

After a series of practice trials (lasting 2 min), participants had to perform two main trial blocks for 7 min each. For each of the two blocks, participants received further but differing instructions on how to perform the go/no-go task. The implementation-intention instruction asked participants to tell themselves: "If number 3 appears, I will respond particularly fast!" The familiarization instruction asked participants to speed up their responses to the number 3 by familiarizing themselves with it. For this purpose, they were given a sheet of paper that requested they fill in the number 3 at certain predesignated places. This familiarization instruction was used to control for the effects of experimenter demand associated with the implementation-intention instruction.

Half of the schizophrenic patients and half of the control participants performed the first main trial block under the implementation-intention instruction and the second main trial block under familiarization instructions, whereas the respective other participants started out with the familiarization instruction and then received the implementation-intention instruction.

Results and Discussion

First, we computed a mean for each participant's reaction times to the critical as well as the noncritical numbers (in milliseconds) separately for the first and second main trial block. We then computed a 2 within (numbers: critical vs. noncritical) × 2 within (instruction: implementation intention vs. familiarization) × 2 between (group: schizophrenic patients vs. control participants) × 2 between (order: implementation-intention instruction comes first vs. familiarization instruction comes first) factorial analysis of variance (ANOVA). It revealed a significant main effect for group, $F(1, 36) = 10.94$, $p < .002$, indicating that control participants ($M = 408$) responded faster to the presented numbers than the schizophrenic patients did ($M = 492$). Moreover, we observed significant main effects for the number factor (M critical = 433 vs. M noncritical = 467), $F(1, 36) = 39.34$, $p < .001$, and the instruction factor (M implementation intention = 435 vs. M familiarization = 465), $F(1, 36) = 22.96$, $p < .001$ (see Table 1).

Most important, the Instruction × Number interaction was significant, $F(1, 36) = 7.53$, $p < .01$, indicating that the comparatively faster responding to the critical number was less pronounced under the familiarization instructions (the speed up in responding to critical as compared with noncritical numbers was only 24.5 ms, 24.1 ms for schizophrenic patients and 24.9 ms for control participants) than under implementation-intention instructions (the speed up amounted to 42.5 ms, 49.4 ms for schizophrenic patients and 35.8 ms for control participants). Comparisons of the speed-up effects produced by implementation intentions as compared with familiarization were significant for the total sample, the schizophrenic sample only, and the control group only, all $ts > 2.15$, $ps < .05$.

Table 1
Mean Response Times (in Milliseconds) to Critical and Noncritical Numbers in Schizophrenic Patients and Control Participants as a Consequence of Implementation-Intention and Familiarization Instructions

	Schizophrenic patients (n = 20)		Control participants (n = 20)	
Type of instruction	Noncritical nos.	Critical no.	Noncritical nos.	Critical no.
Implementation intention	506 (144)	457 (99)	407 (34)	371 (32)
Familiarization	516 (114)	491 (122)	439 (58)	414 (64)

Note. Standard deviations appear in parentheses.

The Instruction × Number interaction was not qualified by interactions with the group or order factors, and there was no interaction with gender (all $Fs < 1.3$). Apparently, implementation intentions led to faster reaction times to the critical number 3 with male and female schizophrenic patients and control participants alike, and this was true whether the first or second main trial block in the go/no-go task was performed under implementation-intention instructions.

Finally, when we correlated the various indicators of the severity of patients' schizophrenic sickness with the speed-up effects (noncritical responses − critical responses) achieved by implementation intentions, no significant relations were observed: (a) The total number of days patients' spent in psychiatric hospitals correlation was −.13, (b) number of days of present hospitalization correlation was −.17, (c) age of patient at first time of hospitalization correlation was −.05; (d) strength of medication over the last 10 days (i.e., chlorpromazine level) correlation was −.16, (e) duration of present medication correlation was −.19, and (f) Brief Psychiatric Rating Scale correlation was −.17.

Assuming that the schizophrenic patients in the present study experienced more distractive thoughts than our control participants did, these findings suggest that the accelerated responses achieved by implementation intentions are efficient in the sense that they are not vulnerable to a heightened cognitive load. This is also suggested by the observation that the severity of the patients' schizophrenic sickness did not correlate significantly negatively with the speed-up effects produced by implementation intentions.

The present study (as well as Study 1) used a special sample of individuals who are known to have deficits in selective attention and suffer from intrusive thoughts. Demonstrating that implementation intentions benefit action initiation even in such special groups strongly suggests that this facilitation is efficient. Still, it does not prove that people who are not chronically burdened by distractions can—as a consequence of having formed implementation intentions—act efficiently under conditions of high levels of cognitive load. In Studies 3 and 4 we attempted to explore this issue.

Study 3: Implementation-Intention Effects in a Dual-Task Situation

To induce high levels of cognitive load, we used a dual-task paradigm. The primary task consisted of working on meaningless consonant–vowel–consonant syllables. Participants had to either associate freely to these syllables (easy primary task) or repeat aloud and memorize them (difficult primary task). In the secondary task participants had to press a button as quickly as possible when numbers appeared, but not when letters were shown (go/no-go task). The participants were randomly assigned to experimental conditions. Whereas one half of the participants had to form an implementation intention to respond particularly quickly to a critical number, the other half of the participants only had to familiarize themselves with the critical number by writing it down several times. The dependent variables were the response times to critical and noncritical numbers.

Method

Participants

Sixty-eight male students enrolled at the Technical University of Munich participated in the study. Participants were contacted by phone and invited to participate in a study on attention processes. Participants had a mean age of 24.

Equipment, Materials, and Procedure

Apparatus. Both tasks were presented on a computer screen in two adjacent windows. The 1.2 cm × 1.2 cm windows were located side by side in the center of the monitor 1 cm apart from each other. The primary task was presented in the left window and consisted of either associating freely to (easy task) or repeating aloud and memorizing (difficult task) a list of meaningless syllables (e.g., taw, nax, gik). Each syllable was presented for 3 s. The order of presentation of syllables was randomized once and then held constant across participants.

The go/no-go task required the participants to react as quickly as possible to the numbers (i.e., 1, 3, 5, 7, or 9) but not to the letters (i.e., a, e, n, v, or x) presented in the right window. Numbers and letters were presented for 1 s each in a randomized temporal sequence (minimum temporal distance between two cues was 2 s, whereas maximum distance was 7 s) and in randomized order across trials and participants.

Participants were seated at a distance of 45 cm from the computer monitor. It was stressed that during the experiment participants were to ensure that their foreheads were always aligned to a string stretched at the required distance from the monitor. The distance of 45 cm ensured that focusing on the syllables presented in the left window kept the stimuli of the response-time task presented in the right window outside the foveal area, but inside the parafoveal area of the visual field (2° to 6°). According to Nelson and Loftus (1980), the stimuli presented in the parafoveal area are processed minimally and outside of awareness.

The primary task was designed in such a way that participants were forced to focus on the left window. Additionally, they were instructed to continuously focus their attention on the syllable task. The experimenter monitored participants' performance in the syllable task over an intercom system.

Task instructions. Participants were tested individually. The experimenter explained that during the experiment he would sit in the next room and communicate through an intercom system. Participants then received written instructions describing the study as an investigation of attentional processes and performance under stress. The ability to cope with stressful situations was said to be important, especially for performing well in common workday situations. Participants were told that a typical cause of stress is having to perform two tasks simultaneously and that the experiment would therefore consist of a dual-task paradigm.

The instructions continued as follows:

> In the primary task you will work on meaningless syllables; the secondary task is a response-time task that requires you to press a button as quickly as possible when certain stimuli appear. You will work on the two tasks in several blocks of trials, easy and difficult blocks alternating with one another. In the easy blocks, while performing the response-time task you will have to respond to the meaningless syllables by freely associating to them. In the difficult blocks you will have to repeat aloud and memorize the presented nonsense syllables while working on the response-time task. After the difficult blocks a memory test will be conducted. In each block you will be presented with 25 syllables.
>
> The secondary task is a so-called go/no-go task. You are supposed to press a button as quickly as possible when a number appears on the screen, but do not press the button when a letter appears. If you respond to a letter, this will be counted as a mistake.

The latter instruction was given to create the goal intention to perform the go/no-go task of quickly responding to numbers but not responding to letters.

Practice blocks. Participants then received the instructions for the practice blocks through the intercom. First, participants performed the easy and the difficult syllables tasks for 15 s each. Then they practiced the go/no-go task for 30 s. Finally, the syllables task and the go/no-go task had to be performed simultaneously, and a baseline measurement of participants' response times was taken. Ten syllables were presented four times each, and five numbers and five letters were presented twice each, resulting in an overall duration of 2 min per block. Thus, practice blocks of trials were somewhat shorter than the test blocks to follow. The order in which participants worked on the easy versus difficult syllables task was counterbalanced across participants.

Experimental manipulation. After the training block of trials the implementation-intention manipulation was carried out. Participants in the implementation-intention condition read the following instruction:

> Studies on perceptual readiness have shown that a certain mental exercise helps to increase one's reactivity. If you make a resolution to respond particularly fast to a specific number, you will be able to speed up your reaction time. Please choose your special number by drawing lots.

The experimenter offered a deck of five cards allegedly carrying five different numbers and asked the participant to draw one of them. All cards carried the number 5 on their back. Subsequently, participants had to read and fill out a form on which they were encouraged to firmly commit themselves to respond particularly fast to their chosen number by saying to themselves: "I definitely want to respond to number 5 as quickly as possible." This instruction was given to create an "if . . . then . . ." implementation intention, as it suggests a link of the occurrence of a specific Situation X (i.e., appearance of the number 5 on the screen) to an intended goal-directed Behavior Y (i.e., pressing the response button as quickly as possible).

The instruction for the familiarization condition was as follows:

> Studies on perceptual readiness have shown that a certain mental exercise helps to increase one's reactivity. If you prepare yourself for

a specific number, you will be able to speed up your reaction time. Please choose your special number by drawing lots.

The experimenter then ostensibly allowed participants to choose this number from a deck of cards. Thereafter, participants wrote the critical number 5 twenty-five times on a prepared form. The familiarization instruction was meant to control for the effects of priming number 5 and, even more importantly, for experimenter demand in the sense that the implementation-intention effect might be due to participants' mere compliance to the task instruction to respond particularly fast to the critical number.

Test trials. Before starting to work on the blocks of test trials, the experimenter briefly repeated the instruction for the go/no-go task and gave the signal to start. Each block of test trials lasted about 5 min. After the blocks of difficult trials in which participants had to repeat aloud and memorize the syllables, a free-recall memory test was conducted. In addition, after each block of trials participants had to answer a short questionnaire, on which they rated the difficulty of the respective syllable tasks by answering three items (e.g., "How difficult was it for you to work on the syllables?" "How straining was it for you to work on the syllables?" and "How much effort did you invest?"). These items were averaged for the easy and difficult task, respectively, to form a composite difficulty score (Cronbach's α = .89 for easy task, .77 for difficult task). Moreover, participants had to indicate how satisfied they were with their performance. Answer scales for all of these items ranged from 0 (*little*) to 9 (*very much*).

Design

We used a 2 (type of instruction: implementation intention vs. familiarization) × 2 (type of primary task: easy vs. difficult) × 2 (order of syllables tasks: easy/difficult vs. difficult/easy) × 2 (type of response: critical vs. noncritical number) factorial design with repeated measures on the second, third, and fourth factor.

Results and Discussion

Manipulation Check

The difficulty level of the primary task was manipulated successfully in that associating freely to the 25 meaningless syllables (easy task) was rated to be easier (M = 4.7) than repeating aloud and memorizing the syllables (difficult task; M = 5.3), $t(66) = 1.84$, $p = .07$. Moreover, participants were more satisfied with their performance in the easy (M = 4.3) than in the difficult (M = 2.5) syllables task, $t(67) = 6.78$, $p < .002$.

Speed of Discrimination in the Go/No-Go Task

To test the central hypothesis that forming implementation intentions speeds up responding to the specified critical opportunities, we averaged response times (in ms) to critical (5) and noncritical (1, 3, 7, 9) numbers within test trials. The mean response time of the five responses to the critical number (5) was subtracted from the mean response time of the 20 responses to the noncritical numbers (1, 3, 7, 9), yielding difference scores that represent the acceleration of critical in comparison with noncritical responses. Such difference scores control for intraindividual variance in the different phases of the experiment.

When we computed a 2 (type of instruction: implementation intention vs. familiarization) × 2 (type of primary task: easy vs. difficult) × 2 (order of syllables task: easy/difficult vs. difficult/easy) factorial ANOVA on these scores, a significant main effect for the type of instruction factor emerged, $F(1, 64) = 6.19$, $p < .02$. No other main effects or interactions were significant (all $ps > .16$). As predicted, forming implementation intentions accelerated responding to the critical number as compared with noncritical numbers to a greater extent (M = 34, SD = 52) than having familiarized oneself with the critical number (M = 5, SD = 42; see Figure 1, left side).

It is interesting that in the implementation-intention condition the acceleration with respect to the critical number did not occur at the cost of responding quickly to noncritical numbers. The mean response time to noncritical numbers in the implementation-intention condition (M = 637, SD = 115) was not significantly different from the respective mean in the familiarization condition (M = 628, SD = 93), $t < 1$.

To make sure that the implementation-intention effect was not due to any differences in reactivity before the experimental ma-

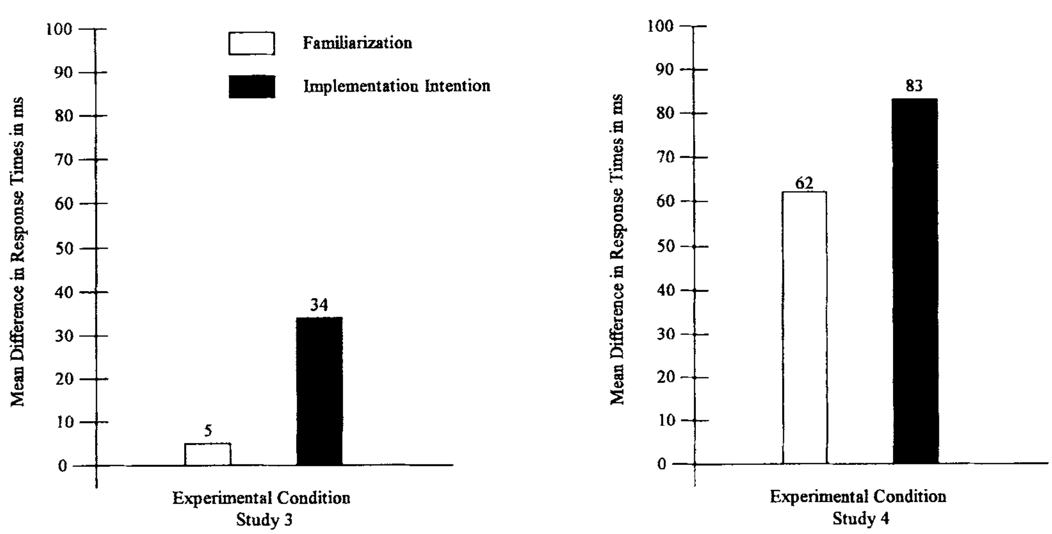

Figure 1. Mean response times to noncritical numbers minus mean response times to critical numbers (in milliseconds) under implementation and familiarization instructions: Study 3 (left side) and Study 4 (right side).

nipulation, we compared the respective difference scores (i.e., noncritical − critical response times) in the training block of trials for participants in the implementation-intention versus the familiarization condition. As it turned out, the two conditions did not differ from one another (implementation-intention condition: M = 143, SD = 109; familiarization condition: M = 184, SD = 160), $t(64)$ = 1.23, *ns*. The positive scores indicate that even in the practice block, participants responded faster to the critical number (M = 651, SD = 96) than to the noncritical numbers (M = 814, SD = 156), $t(66) = 9.67, p < .001$. Possibly, the number *5* is more readily detected than other numbers because of its appearance or a heightened frequency of use.

Some readers might object that implementation-intention participants may have paid more attention to the button-press response in general, and thus were in a better position to differentiate between critical and noncritical numbers. However, numbers and letters were presented in a strictly randomized order, making it impossible for participants to predict the appearance of the critical numbers. Thus, even if implementation-intention participants had more closely attended to the go/no-go task than familiarization participants had, noncritical numbers should have likewise benefited (which was not the case, however). Second, if implementation-intention participants had focused more on the go/no-go task than familiarization participants had, the former should have performed comparatively worse on the memory test. Actually, however, participants in the two conditions did not differ with respect to their performance on the memory test (implementation-intention condition: M = 6.5, SD = 3.2; familiarization condition: M = 6.3, SD = 2.1), $t(66)$ = .34, *ns*.

Participants who had formed an implementation intention to respond particularly fast to the specific number *5* were indeed able to speed up their response to this number. Notably, this acceleration effect did not imply costs with respect to responding to noncritical numbers. Familiarization participants who had written the critical number 25 times to speed up their response were not as successful. Just familiarizing oneself with an opportunity to act is apparently not sufficient to guarantee swift action initiation.

In the present study the critical stimuli were presented in the parafoveal area of the visual field (as part of the secondary task in a dual-task situation), while a primary task with foveally presented stimuli had to be performed in parallel. Apparently, implementation intentions are effective even if a person's attention is not focused on the intended opportunities. We found it even more interesting that the speed-up effect of implementation intentions was the same, regardless of whether the primary task was easy or difficult to perform. The immediacy of responding induced by forming an implementation intention thus does not seem to be very effortful as it does not require a large amount of cognitive capacity—it can be observed even when the primary task in a dual-task situation is difficult rather than easy. This finding strongly supports the assumption that implementation intentions lead to automatic action initiation. However, as the present paradigm allows no on-line assessment of the respective performances in the primary task, we can only speculate on whether or not task interference between secondary and primary task actually took place.

A more reliable test of our automaticity hypothesis requires a dual-task paradigm that allows for the assessment of task interference. More specifically, if implementation intentions rely on automatic processing, task interference, operationalized as a decrement of task performance in the secondary task whenever the difficulty of the primary task is increased, should not affect the speed-up effects produced by implementation intentions. As Heuer (1996) put it, "probably the most important operational criterion for automatization is the reduction of dual-task performance decrements" (p. 144). In the present dual-task arrangement, the two tasks used were structurally different in that their output channels were not identical (i.e., vocal reactions in the syllable task versus motor responses in the go/no-go task) and thus task interference cannot be studied effectively.

In Study 4, a new paradigm was developed and used that allows the assessment of the effects of implementation intentions with respect to task interference by using structurally similar tasks and by providing on-line data on participants' performance of both tasks at the same time.

Study 4: Implementation-Intention Effects and Task Interference

If implementation intentions indeed establish automatic action initiation, the initiation of the respective intended behavior should be fast (referring to immediacy) and independent of the amount of mental load a person is experiencing (referring to efficiency). This was shown in Study 3. Study 4 went beyond this demonstration by testing whether using implementation intentions to facilitate action initiation also reduces mental load. Accordingly, the dual-task paradigm used in Study 4 entailed a similar secondary task but a very different primary task than had been used in Study 3. In contrast to Study 3, in the go/no-go task of Study 4 the critical targets were presented within the area of foveal perception. They were presented within a circle moving across a computer screen that also served as tracking target. The primary task of Study 4 was a motor tracking task (i.e., tracking the circle with a square). Within this primary task, difficulty was manipulated by reducing the size of the tracking square. On-line measures were taken for both the primary and secondary tasks.

This dual-task paradigm was designed according to the following basic principles: First, in dual-task research interference is thought to depend on the nature of the tasks and on the extent to which two tasks rely on the same resources (Cohen, Dunbar, & McClelland, 1990; Heuer, 1996; Heuer & Schmidtke, 1996). Therefore, we constructed two structurally similar tasks that both used the same input channel (visual perception) and the same output channel (motor response). Second, task difficulty was varied systematically by increasing difficulty in the same type of primary task. Third, participants were forced to work on both tasks simultaneously. To achieve this, we used one target for both tasks. Although the form of presentation differed, the secondary task (go/no-go task) was very similar to the one used in Study 3, except for the fact that the critical targets (i.e., numbers and letters) were presented within the area of foveal perception (i.e., within the circle that served as tracking target).

Method

Participants

Thirty-three (16 female and 17 male) university students from the experimental participants pool of the Max-Planck-Institute for Psychological Research in Munich participated in this study. Their mean age was 24.8 years. The sample we are referring to in this section consists of a subsample of university students who participated in a bigger study comparing the effects of implementation intentions on university students' performances to the effects they have on the performances of patients with frontal brain lesions and nonfrontal brain lesions (Lengfelder & Gollwitzer, 2001).

Procedure, Equipment, and Materials

Participants were asked to perform a dual task that combined a primary task of tracking with a secondary go/no-go task. Both tasks were presented on a computer screen, and a headrest was used to maintain a constant distance of 50 cm between the participants' eyes and the screen. The target stimulus of both tasks, a circle of 1.7 cm diameter, that corresponded with the foveal visual angle of 1° to 2° providing maximal visual acuity (Nelson & Loftus, 1980), moved with a speed of 3 cm/sec within a delineated area (18 × 24.5 cm^2) on the screen in randomly designed curves. Participants were instructed to perform the two tasks simultaneously.

Manipulation of task difficulty in the primary task. The tracking task demanded continuous attention and was presented to the participants as the primary task. To perform the tracking task, the participants had to enclose the wandering circle in a square that could be moved by pushing the mouse on a 52 × 65 cm^2 mouse pad. To increase task difficulty the size of the tracking field was reduced from 4 × 4 cm^2 (low difficulty) to 2.2 × 2.2 cm^2 (high difficulty). Both of these squares are placed within the visual angle of 4° to 6°, the area of parafoveal perception as described by Nelson and Loftus (1980). The tracking performance measure was the percentage of overlap of square (tracking field) and circle (target field). Measures were taken every second as well as whenever the mouse button was pressed (see below). Before each trial (see below) the mouse had to be returned to the starting line on the 52 × 65 cm^2 pad in front of the participant.

Manipulation of implementation intentions in the secondary task. The go/no-go task demanded only temporary attention and was therefore described as a secondary task. Participants were asked to press the mouse button immediately if a number appeared in the circle and to forego pressing if a letter appeared (go/no-go paradigm). Participants were told to react as quickly as possible. Participants were instructed to press the mouse button particularly fast whenever the number *3* appeared and to forego pressing whenever a letter appeared. This way we established critical targets (i.e., the number *3*), noncritical targets (i.e., the numbers *1, 5, 7*, and *9*) and distractor targets (i.e., the letters *a, e, n, v*, and *x*). Participants were informed that the aim of the study was to analyze the speed of encoding of information that is depicted on traffic signs, in particular those signs that refer to low speed zones of 30 km/hr. Therefore response times to the number *3*—presented under distracting circumstances—would be of great interest for us. The targets were presented for 1 s in changing intervals (2 s–7 s) in fixed prerandomized order (each phase consisted of three randomized sequences containing the numbers *1, 3, 5, 7*, and *9*). The dependent variable was the speed of the button-press responses.

Two different instructions were given to the participants to create implementation-intention trials versus control trials; the order of instruction was varied according to the task condition (see below). In both instructions (implementation-intention instruction and familiarization instruction) participants were told that they could accelerate their button-press responses by applying certain mental strategies. Those two instructions were the same as the instructions used to create the implementation-intention condition or the familiarization condition in Study 3 (see above for more details), except in Study 4 participants had to look at the number *3* printed on a card while forming their implementation intention to press particularly fast if the number *3* appeared. As in Study 3 the familiarization instruction was meant to control for the effects of priming the number *3* and, even more importantly, for experimenter demand.

Design

The experiment had three trial blocks. The first block consisted of practice trials in which the go/no-go task and the tracking task had to be performed both separately and in combination at both levels of difficulty. The second block contained four phases. Each phase represented a different level of difficulty in an easy–difficult–difficult–easy order (each phase lasted 150 s). For the sake of simplicity we used only one order of difficulty. The easy–difficult–difficult–easy ordering was chosen as it allowed the participants to begin with the less demanding task. The second block of trials had to be performed either under implementation-intention instructions or familiarization instructions. The third block again presented four phases in an easy–difficult–difficult–easy order, which now had to be performed under implementation-intention instructions when the second block had been performed under familiarization instructions or vice versa. In one instruction condition (F/I condition), participants began to work on the dual task under familiarization instructions (F) followed by implementation-intention instructions (I). In the other instruction condition (I/F condition), participants began to work under implementation-intention instructions followed by familiarization instructions. The participants were matched with respect to gender and randomly assigned to the two instruction conditions (familiarization instruction followed by implementation-intention instruction—F/I condition—and the reverse condition—I/F).

The design used in this study was a mixed factorial design that consisted of one between-factor and four within-factors. The between-factor variable was order of instructions (F/I vs. I/F). The within-factor variables were type of instruction (F vs. I), critical/noncritical responses (3 vs. 1, 5, 7, 9), difficulty of the tracking task (easy vs. difficult), and phases (1, 2, 3, 4). As dependent variables we used participants' speed of button-press responses in the go/no-go task and the percentage of overlap in the tracking task.

Results

Speed of Discrimination in the Go/No-Go Task

To compare critical responses to noncritical responses, we computed individual difference scores. The difference scores were computed for the eight phases of the two blocks of test trials (mean response time of the 12 noncritical responses − mean response time of the three critical responses per phase). These scores represent the individual acceleration of critical as compared with noncritical responses.

A 2 (order of instructions: F/I vs. I/F) × 2 (type of instruction: F vs. I) × 2 (difficulty of the tracking task: easy vs. difficult) factorial ANOVA yielded a significant main effect for type of instruction, $F(1, 32) = 9.80$, $p < .01$. No other main effects or interaction effects turned out to be significant; only the interaction effect of order of instructions with type of instruction showed a tendency toward significance, $F(1, 32) = 3.46$, $p = .072$. As is reported below in more detail (see *Order of Experimental Manipulation*) the order of instructions did affect the performance under familiarization instructions but not under implementation-intention instructions.

The mean differences (in ms) of noncritical and critical response times under implementation intentions ($M = 83$, $SD = 47$) and familiarization ($M = 62$, $SD = 43$) differed significantly, $t(32) = 2.96$, $p < .01$ (see Figure 1, right side). This effect was not due to a general slowdown of noncritical responses when having formed implementation intentions ($M = 560$, $SD = 54$) as compared with the speed of noncritical responses when having familiarized oneself with the critical number ($M = 550$, $SD = 61$), $t(32) = 1.57$, *ns*. Note that the response times to the noncritical numbers in the test trials were equivalent to the response times to noncritical numbers in the practice trials ($M = 550$, $SD = 60$).

It should also be noted that in the practice trials equal difference scores (mean response time of the 12 noncritical responses − mean response time of the three critical responses per phase) were found in the later F/I condition ($M = -38$, $SD = 80$) and the later I/F condition ($M = -31$, $SD = 90$), $t < 1$. As the negative differences of the practice trials indicate, participants had—prior to instructions—reacted even more slowly to the critical number *3* ($M = 590$, $SD = 90$) than to the other numbers ($M = 550$, $SD = 60$), $t(32) = 2.33$, $p < .05$. Remember that the opposite had been observed for the critical number *5* in Study 3. Apparently, the speed of noncritical responses in the practice trials does not affect the implementation-intention effect.

Speed-Up Effects of Implementation Intentions Under Increased Mental Load

As the hypothesis of the automatization of action initiation through implementation intentions implies, the speed-up effects produced by implementation intentions should show up in the easy and difficult tracking phases alike. When we compared the difference scores under implementation-intention instructions that were achieved in phases of easy versus difficult tracking, no significant differences occurred (M easy = 90, $SD = 50$; M difficult = 80, $SD = 60$), $t(32) = 1.26$, *ns*. Apparently, the amount of mental load did not affect the speeding up of critical compared with noncritical responses under implementation-intention instructions.

Order of Experimental Manipulation

The implementation-intention effect was independent of the order of experimental manipulation (I/F condition vs. F/I condition). Spearman correlation coefficients were computed to assess whether the implementation-intention instructions would produce stronger effects when given first or second. Order of instructions (1 = I/F condition, 2 = F/I condition) was not significantly correlated with the difference scores (mean response time of the 12 noncritical responses − mean response time of the three critical responses per phase) under implementation-intention instructions ($r = -.04$, *ns*), but was significantly negatively correlated with the difference scores under the familiarization instructions ($r = -.35$, $p = .05$). The significant negative correlation between order of instructions and the difference scores under familiarization instructions indicates that the experimental group receiving the familiarization instructions before the first block of test trials (F/I condition) performed better under the familiarization instruction than the experimental group receiving the familiarization instruction before the second block of test trials (I/F condition), when the first block of test trials had already been performed under implementation-intention instructions. This unexpected finding could mean that when familiarization instructions were given prior (F/I condition) to implementation-intention instructions, participants had to build and use their own strategies to achieve a speed up of their responses, and some of these participants may even have spontaneously used implementation intentions. Whereas in the I/F condition, when familiarization was given as a second instruction and participants were explicitly instructed to use an alternative strategy to implementation intentions, it was more difficult for these participants to speed up their reactions.

Performance on the Primary Task (Tracking Task) and Its Interrelation to Performance on the Secondary Task (Go/No-Go Task)

Difficulty effects in the primary task (tracking). An increase in task difficulty (by reducing the size of the mouse field) led to a significant decrease in average tracking performance. Average overlap of mouse field and target field during difficult phases of tracking ($M = 82.08\%$, $SD = 4.59\%$) proved to be significantly lower than in the easy phases of tracking ($M = 97.15\%$, $SD = 1.04\%$), $t(32) = 25.84$, $p < .001$.

General effects of the secondary task (go/no-go task) on the primary task (tracking task). Implementation intentions produced no performance effect. The tracking performance (percentage of overlap) under the implementation-intention instructions ($M = 89.89\%$, $SD = 2.54\%$) and under familiarization instructions ($M = 89.34\%$, $SD = 3.57\%$) did not differ, *ns*.

Task interference from the primary task (tracking task) to the secondary task (go/no-go task). To ensure that the intended task interference had actually taken place, we took a look at the performance in the go/no-go task in relation to the level of difficulty in the tracking task. We observed that the performance in the go/no-go task was dependent on the level of difficulty in the tracking task under certain circumstances: Figure 2 shows a slowdown of critical responses under both types of instructions in phases of difficult tracking as compared with phases of easy tracking. The same was true for the noncritical responses, but only under familiarization instructions. Under implementation-intention instructions noncritical response times followed a negative linear trend.

Trend tests of critical and noncritical responses in the easy–difficult–difficult–easy phases under familiarization instructions

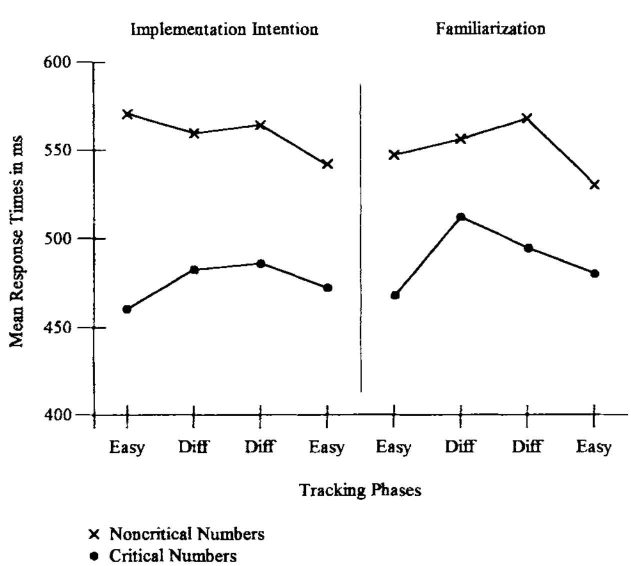

Figure 2. Mean response times to noncritical and critical numbers in easy and difficult (Diff) tracking phases under implementation-intention and familiarization instructions (in milliseconds): Study 4.

revealed—because of the "ABBA" design—a significant quadratic trend over the four phases for critical responses, $F_{\text{linear}}(1, 32) = .30$, *ns*; $F_{\text{quadratic}}(1, 32) = 8.93$, $p < .01$, $\eta^2 = .22$, as well as noncritical responses, $F_{\text{linear}}(1, 32) = 2.40$, *ns*; $F_{\text{quadratic}}(1, 32) = 11.14$, $p < .01$, $\eta^2 = .26$. The same was true for critical responses following implementation intentions, $F_{\text{linear}}(1, 32) = 0.92$, *ns*; $F_{\text{quadratic}}(1, 32) = 4.71$, $p < .05$, $\eta^2 = .13$, whereas noncritical responses followed a significant negative linear trend when implementation intentions had been formed, $F_{\text{linear}}(1, 32) = 7.46$, $p < .05$, $\eta^2 = .19$; $F_{\text{quadratic}}(1, 32) = .49$, *ns*. In other words, under implementation-intention instructions the participants' noncritical responses grew faster over time. We take this observation to mean that the initiation of the critical response under implementation-intention instructions releases cognitive capacities that can be used to improve a person's responding to the noncritical numbers in the course of the four phases (i.e., to benefit from training over the course of time). Responses to the critical numbers could not benefit from practice as they were very fast already.

Discussion

The same effect that has been demonstrated in Studies 2 and 3 was also found in Study 4. Participants in Study 4 sped up their responses to a critical target (the number *3*) compared with noncritical targets by forming implementation intentions to a larger degree than was achieved by familiarization with the critical number. This acceleration effect was not affected by an increase in task difficulty of a dual task. Furthermore, this effect was in contrast to slow responses to critical targets in the practice trials and was not due to a decrease in noncritical response times under implementation-intention instructions. Forming implementation intentions had no effect on performance in general, but enhanced performance selectively whenever the critical situational cues were encountered. It is important to note that all participants responded faster to critical targets than to noncritical targets under both types of instructions. This implies that both participants under the implementation-intention instructions as well as those under familiarization instructions were committed to the goal of responding particularly fast to the number *3*. However, the effect was significantly stronger when participants had formed implementation intentions as compared with having familiarized themselves with the critical number. Priming (familiarization instruction) thus seems to be less effective in producing an acceleration of button-press responses than forming implementation intentions is.

As had been expected, the effect of implementation intentions was independent of the order of instructions. We had no specific hypothesis regarding the effects of order of instruction on the response times under familiarization instructions. However, when implementation-intention instructions preceded familiarization instructions (I/F condition), the latter produced a smaller speed-up effect than when familiarization instructions preceded implementation-intention instructions (F/I condition). It appears that people can successfully disengage from their implementation intentions in the I/F condition. In the F/I condition, however, some participants may have spontaneously engaged in forming implementation intentions, as the usage of the implementation-intention strategy was not explicitly discouraged when the familiarization instruction was given.

According to resource theories of information processing (Ackermann, Schneider, & Wickens, 1984; Navon & Gopher, 1980; Norman & Bobrow, 1975; Wickens, 1980) automaticity in one task leads to better performance in a parallel task, as resources that are no longer necessary can be transferred. Effects of transfer in the sense of a "reduction of dual-task performance decrements" (Heuer, 1996, p.144) could also be observed in our data. Difficult tracking resulted in a decrease in tracking performance, but resulted only partly in a decrease in response time. Even though critical response times under implementation-intention instructions and under familiarization instructions as well as noncritical response times under familiarization instructions were slower in phases of difficult tracking and faster in phases of easy tracking, practice effects over the four phases were found in the time course of noncritical response times under implementation-intention instructions only. Implementation intentions seem to reduce mental load during dual-task performance and, therefore, allow for the emergence of practice effects.

In summary, the patterns of data obtained in Study 4 strongly support the notion that the initiation of critical responses under implementation-intention instructions relies on automatic processing (Gollwitzer, 1993, 1999), as these observations are well suited to fulfill the two main criteria of automaticity (i.e., immediacy and efficiency; Bargh, 1997; Logan, 1992).

General Discussion

In four studies, having formed implementation intentions had a beneficial effect on the initiation of goal-directed behavior. In Study 1, opiate addicts under withdrawal who had formed an implementation intention with respect to when, where, and how to write a curriculum vitae were more successful in implementing their goal intention than opiate addicts under withdrawal who had not formed an implementation intention.

Moreover, in Studies 2, 3, and 4, it was demonstrated that people with an implementation intention indeed act immediately on the specified opportunity as postulated by implementation-intention theory (Gollwitzer, 1993, 1999). In a sample of schizophrenic patients (Study 2) as well as in two student samples (Studies 3 and 4) committing oneself to a specific situational context (i.e., a critical number) to initiate relevant goal-directed behavior (i.e., pressing a button in a go/no-go task) sped up the initiation of this behavior at the critical stimulus. Notably, having formed an implementation intention did not lead to a general increase in effort or concentration but had a very specific effect, as the response only to critical but not to noncritical stimuli was facilitated. This is in line with evidence from several other studies that point to the immediacy effect of implementation intentions (e.g., Aarts & Dijksterhuis, 2000; Gollwitzer & Brandstätter, 1997, Study 3; Lengfelder & Gollwitzer, 2001, Study 2).

More importantly, the implementation-intention effect occurred efficiently in the sense that it did not demand large amounts of attentional resources as supported by two types of evidence. First, implementation intentions were successful in promoting goal-directed behavior, even among persons whose action control is known to suffer under mental distraction, such as opiate addicts under withdrawal and schizophrenic patients (Studies 1 and 2). Second, the dual-task paradigms used in Studies 3 and 4 prevented participants from fully concentrating on the critical situations (i.e., the numbers *5* or *3*, respectively) presented in the go/no-go task. In both studies the implementation-intention effect was independent of the difficulty level of the primary task. That is, having formed an implementation intention sped up action initiation not only when participants were simultaneously performing an easy primary task, but also when participants were simultaneously performing a difficult primary task that placed a high demand on their attentional resources. Moreover, in Study 4 in the implementation-intention condition, a negative linear trend in the response times to the noncritical number could be observed that was absent in the familiarization condition. This observation suggests that having formed an implementation intention freed cognitive capacities that could then be used to realize a training effect in the noncritical responses (see Heuer, 1996).

In Studies 2, 3, and 4, all participants were instructed to speed up their response to the critical target. Although, in general, participants managed to speed up their responses to the critical number to a certain degree, this effect was much stronger when implementation intentions had been formed. Obviously, both familiarization and implementation-intention participants made an effort to meet the experimenter's expectations and fulfill the task. Thus, the implementation-intention effect cannot merely be attributed to an effect of experimenter demand or one of public commitment. In the same vein, the implementation-intention effect cannot be explained by a priming effect, as participants in the familiarization condition wrote the critical number more than 20 times on a sheet of paper, a procedure that should have produced a high activation of the semantic and figural characteristics of the critical number.

The results of the four studies taken together provide clear evidence that forming implementation intentions instigates processes of action initiation that carry two crucial characteristics of automaticity, namely, the immediacy and efficiency of a response or process (Bargh, 1994, 1996, 1997; Bargh & Chartrand, 1999; Logan, 1988; Shiffrin & Dumais, 1981; Shiffrin & Schneider, 1977). Once the specified opportunity is encountered, the intended behavior is initiated immediately and efficiently. In Study 3, the critical situations were presented outside a person's focus of attention, that is, under conditions of reduced consciousness, and still implementation intentions managed to speed up action initiation. Still open, however, is the question as to whether action initiation would occur by itself without any conscious monitoring. To settle this issue, opportunities for acting would have to be presented outside of conscious awareness.

Similarities and Differences Between Implementation Intentions and Habits

Obviously, implementation intentions and habits or highly routinized skills are very similar regarding their functional characteristics (e.g., Guthrie, 1959). They lead to an immediate and efficient execution of specific behaviors on appearance of specified situational contexts. In an implementation intention, a mental link between an anticipated situation and a certain goal-directed behavior is established that sets the basis for the automatic initiation of the respective behavior to occur. In this respect, implementation intentions resemble Anderson's (1983, 1992) concept of production rules that can be conceptualized as an "IF . . . THEN . . ." relation linking a certain stimulus condition in the environment to appropriate actions. Research on automaticity and skill acquisition shows that to become automatic, these "IF . . . THEN . . ." sequences require frequent and consistent pairing of the environmental stimulus with the relevant behavior (e.g., Anderson, 1992; Bargh, 1997; Logan, 1988; Newell & Rosenbloom, 1981; Shiffrin & Dumais, 1981; Shiffrin & Schneider, 1977; Speelman & Maybery, 1998).

Implementation intentions and habits differ in terms of how automaticity originates. With implementation intentions, a single mental act is necessary to lay the ground for an automatic process to occur (Gollwitzer, 1993, 1999). In contrast, skills and habits become automatic only through "one's frequent and consistent . . . behavioral responses to a given set of environmental features" (Bargh, 1997, p. 10; see also Schneider & Fisk, 1984; Shiffrin & Schneider, 1977).

Implementation Intentions as a Self-Regulatory Tool

Forming an implementation intention is a conscious mental act that has automatic consequences. Implementation intentions therefore represent a self-regulatory tool that can willfully be used whenever the smooth initiation of goal-directed behavior is at stake. In this sense, implementation intentions represent a case of strategic automaticity (Bargh & Gollwitzer, 1994; Gollwitzer, 1999), "a mix of automatic and controlled processing features" (Bargh, 1996, p. 178). The strategic character of implementation intentions becomes evident in the fact that their effect lasts only as long as the individual still holds the respective implementation intention, as illustrated by the correlation between order of experimental instruction and speed-up effects of familiarization instructions in Study 4. It indicates that implementation intentions ceased to have an effect as soon as the individual deactivated the intention to act on the specified opportunity following the experimental instruction to use a different strategy than forming an implementation intention.

Notably, the implementation-intention effect seems to be more pronounced the more difficulties in initiating goal-directed behavior are encountered. Forming implementation intentions was especially beneficial to a sample of frontal lobe patients (Lengfelder & Gollwitzer, 2001, Study 2), who are known to be highly impaired in regulating goal-directed behavior. Moreover, implementation intentions were most effective in completing difficult instead of easy goals (Gollwitzer & Brandstätter, 1997, Study 1). Taken together, these findings imply that the less routine the implementation of a specific goal is per se, the more effective the forming of implementation intentions can be for goal achievement.

Forming implementation intentions is a powerful self-regulatory strategy that attenuates problems associated with the initiation of goal-directed behaviors (Gollwitzer, 1993, 1996) and thus supplements a whole array of other action-control strategies (e.g., emotion control, motivation control; Kuhl, 1984; Kuhl & Beckmann, 1994) that are available to an individual who wants to secure successful goal achievement. Using implementation intentions to promote goal attainment should not, however, be confused with placing oneself into an implemental mindset (Gollwitzer, 1990; Taylor & Gollwitzer, 1995). The latter is achieved by planning the when, where, and how of the various steps to goal attainment and produces its beneficial effects by activating a cognitive orientation (e.g., cognitive tuning toward implementation-related information; Gollwitzer, Heckhausen, & Steller, 1990; illusions of control; Gollwitzer & Kinney, 1989; positive illusions about one's competencies or one's vulnerability to risks; Taylor & Gollwitzer, 1995; or closed mindedness; Gollwitzer & Bayer, 1999) that creates an unequivocal action orientation that hinders questioning the choice and pursuit of the goal at hand. Forming implementation intentions, on the other hand, is an attempt to decide in advance on how one wants to respond if a certain anticipated critical situation is encountered. It produces its beneficial effects not by inducing a cognitive orientation that facilitates goal pursuit in general; rather, it helps goal pursuit by automatizing the initiation of a distinct goal-directed response in the presence of a certain critical situation.

An important self-regulatory competence refers to reacting flexibly to changing situational demands. One might ask, then, whether implementation intentions lead to a certain rigidity in the sense that people stick to the opportunities specified in their implementation intentions and thus fail to take advantage of unanticipated good opportunities for actions. Given the fact that forming implementation intentions automatizes action initiation, which then demands little cognitive resources, it is conceivable that people having formed implementation intentions would possess the cognitive capacities necessary to notice and make use of alternative opportunities to act. Further research is necessary to tackle the issues of rigidity and flexibility.

The demonstration that goal striving can become partly regulated by automatic processes widens the scope of goal theories that postulate that goals are selected and put into operation primarily through deliberate conscious choice and guidance (e.g., Bandura, 1991; Carver & Scheier, 1990; E. S. Elliott & Dweck, 1988; Wicklund & Gollwitzer, 1982). Thus, the concept of implementation intentions constitutes a further step in the analysis of the intricate interplay between willful and automatic processes in goal striving (Bargh, 1997). The functioning of implementation intentions as an example of goal-dependent automaticity (see Bargh, 1997; Hommel, 2000) provides further evidence against the "false dichotomy" (Bargh, 1996, p. 170; Pashler, 1994) between processes that are either controlled or automatic, in that the consciously controlled act of forming implementation intentions leads to automatic processing.

Practical Implications

In addition to their theoretical significance, our findings have several interesting implications for applied settings. First, as the data of Studies 1 and 2 demonstrate, drug addicts under withdrawal and schizophrenics who had formed implementation intentions were more successful in completing a goal intention than were patients who had not formed an implementation intention. Hospitalized patients often suffer from a lack of initiative leading to a neglect of basic daily routines (e.g., tidying their room) as well as a neglect of activities of greater importance (e.g., applying for a new job). Teaching patients the strategy of forming implementation intentions might be an important supplement to existing therapy programs. A second field of application is health psychology. Forming implementation intentions has been shown to support health-related behavior such as regular exercise (Milne et al., 1999), regular intake of pills (Sheeran & Orbell, 1999), or eating healthy food (Verplanken & Faes, 1999). Obviously, implementation intentions supported people in their endeavor to establish new behavioral routines that had to compete against "old and bad habits." In addition to instructing the participants of public health programs on what to do (i.e., inducing goal intentions) one might want to also suggest committing oneself to when, where, and how to show the respective health-related behaviors (i.e., induce implementation intentions). A third area of application is the workplace, where people usually have to manage multiple concurring tasks and obligations (e.g., Algera, 1998). As a consequence, important duties are often unduly postponed. Forming implementation intentions might help to structure the diversity of demands and to secure the timely execution of work tasks.

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