Acta Psychologica 184 (2018) 64–74

Contents lists available at ScienceDirect

Acta Psychologica

journal homepage: www.elsevier.com/locate/actpsy

More than planned: Implementation intention effects in non-planned situations

Maik Bieleke[a,b,1], Eve Legrand[c,*,1], Astrid Mignon[c], Peter M. Gollwitzer[a,d]

[a] Department of Psychology, University of Konstanz, Germany
[b] Graduate School of Decision Sciences, University of Konstanz, Germany
[c] SCALab CNRS UMR 9193, University of Lille, France
[d] Department of Psychology, New York University, USA

ARTICLE INFO

Keywords:
Implementation intentions
Self-regulation
Goal attainment
Generalization
Cognitive resources

ABSTRACT

Forming implementation intentions (i.e., if-then planning) is a powerful self-regulation strategy that enhances goal attainment by facilitating the automatic initiation of goal-directed responses upon encountering critical situations. Yet, little is known about the consequences of forming implementation intentions for goal attainment in situations that were not specified in the if-then plan. In three experiments, we assessed goal attainment in terms of speed and accuracy in an object classification task, focusing on situations that were similar or dissimilar to critical situations and required planned or different responses. The results of Experiments 1 and 3 provide evidence for a facilitation of planned responses in critical and in sufficiently similar situations, enhancing goal attainment when the planned response was required and impairing it otherwise. In Experiment 3, additional unfavorable effects however emerged in situations that were dissimilar to the critical one but required the planned response as well. We discuss theoretical implications as well as potential benefits and pitfalls emerging from these non-planned effects of forming implementation intentions.

1. Introduction

Forming implementation intentions (Gollwitzer, 1993, 1999, 2014) is a self-regulation strategy that helps people to attain their goals. It entails mentally linking a goal-directed response to a critical situation in an if-then format: "*If critical situation S is encountered, then I will initiate goal-directed response R!*" Thus, an implementation intention specifies exactly in which situation and how one wants to act towards realizing one's goals. This distinguishes them from mere goal intentions, which only specify a desired outcome (Triandis, 1977): *"I intend to reach outcome O!"* or *"I intend to show behavior X!"* Numerous empirical studies have demonstrated that implementation intentions promote goal achievement more effectively than goal intentions (meta-analytic reviews by Adriaanse, Vinkers, De Ridder, Hox, & De Wit, 2011; Bélanger-Gravel, Godin, & Amireault, 2013; Gollwitzer & Sheeran, 2006; Hagger & Luszczynska, 2014).

The pervasive effects of implementation intentions on goal attainment are assumed to rely on two cognitive processes (Gollwitzer, 1999; Webb & Sheeran, 2008). First, the mental representation of the critical situation specified in the if-part becomes a highly activated and easily accessible cue. As a consequence, the critical situation receives attentional and perceptual priority (Achtziger, Bayer, & Gollwitzer, 2012; Janczyk, Dambacher, Bieleke, & Gollwitzer, 2015) and is readily detected in the environment (Aarts, Dijksterhuis, & Midden, 1999; Webb & Sheeran, 2007). Second, a strong link is forged between the critical situation and the goal-directed response specified in the then-part. This renders the goal-directed response automatic, enabling an immediate (Gollwitzer & Brandstätter, 1997) and efficient (i.e., even when cognitive load is high; Brandstätter, Lengfelder, & Gollwitzer, 2001) initiation of it which does not need further conscious intent (Bayer, Achtziger, Gollwitzer, & Moskowitz, 2009) and is hard to control (Wieber & Sassenberg, 2006).

A compelling body of literature attests that implementation intentions promote goal attainment because they facilitate the automatic initiation of a planned response once a specified critical situation is encountered. Yet, surprisingly little attention has been paid to the consequences of having formed implementation intentions on goal striving when people encounter situations that were *not* specified in the if-then plan. Will people initiate planned responses in situations resembling the critical one? Can they withhold performing planned responses if such similar situations require different responding? And how efficiently will people initiate planned responses in situations dissimilar

* Corresponding author at: Department of Psychology, University of Lille, Rue du Barreau, BP 60149, 59650 Villeneuve-d'Ascq, France.
E-mail address: evl.legrand@gmail.com (E. Legrand).
[1] The first two authors contributed equally to this work.

http://dx.doi.org/10.1016/j.actpsy.2017.06.003
Received 15 December 2016; Received in revised form 25 May 2017; Accepted 13 June 2017
Available online 27 June 2017

to the critical situation? As implementation intentions are a heavily used and a widely recommended self-regulation strategy in several domains (e.g., health behavior, academic achievement, and interpersonal issues), answering these questions is mandatory from both a theoretical and practical point of view. We therefore systematically analyze the consequences of forming implementation intentions on goal striving in situations that are similar or dissimilar to critical situations and require planned or different responses.

Why should we expect that forming implementation intentions affects behavior in situations that were not specified in the if-then plan, and what would those effects probably look like? An interesting perspective on this question is provided by research on associative learning (e.g., Martin & Pear, 2016; Pierce & Cheney, 2004) which emphasizes that responses associated with a certain situation can be evoked in sufficiently similar situations as well (e.g., Bush & Mosteller, 1951; Pearce, 1987; Shepard, 1987). This *generalization effect* has been demonstrated for a variety of responses, including habitual (Verplanken, Aarts, van Knippenberg, & van Knippenberg, 1994; Wood, Tam, & Witt, 2005), emotional (Lissek et al., 2008), and attitudinal ones (Till & Priluck, 2000). In the domain of goal striving via implementation intentions, a generalization effect could be reflected in facilitated performance of a planned response not only in the critical situation but also in situations that are sufficiently similar. Support for this reasoning has been provided in a study on driving behavior (Brewster, Elliott, McCartan, McGregor, & Kelly, 2016), which demonstrated that implementation intentions formed to avoid speeding were effective in specified critical situations (e.g., "after I have been stuck behind a slow-moving vehicle") as well as in similar situations ("after I have been stuck in stationary traffic") but not in dissimilar situations ("when traffic lights turn against me"). We therefore assume that forming implementation intentions facilitates the initiation of the planned response both in critical and in sufficiently similar situations. Considered conjointly with the idea that the effects of implementation intentions are based on automated action control and therefore hard to control (e.g., Wieber & Sassenberg, 2006), we expect facilitated goal attainment in similar situations when the planned response coincides with the required response (as in Brewster et al.'s study) and unfavorable effects when a different response is required in those similar situations.

The generalization hypothesis remains silent on the consequences of forming implementation intentions in situations that are dissimilar to the critical one. Should we therefore expect that implementation intentions have no effect on goal attainment in these situations? Prior research suggests otherwise, demonstrating that people are less likely to initiate the planned response in situations they did not specify in their implementation intentions (Masicampo & Baumeister, 2012; Parks-Stamm, Gollwitzer, & Oettingen, 2007). This observation is commonly explained by referring to the limited availability of cognitive resources (Kahneman, 1973; Wegner, 1994): When people form implementation intentions (e.g., during the instruction phase of an experiment) cognitive resources are pulled towards establishing the association between the critical situation and the planned response (Martiny-Huenger, Bieleke, Oettingen, & Gollwitzer, 2016), which in turn implies a distraction from establishing other associations. As a consequence, the mental representation of alternative situation-response links might be selectively derailed during the actual task performance. Importantly, this cognitive distraction hypothesis should not be restricted to different situations requiring the planned response but should also apply to different situations requiring different responding – although prior research has not addressed this latter prediction explicitly. In the present research, we therefore expected implementation intentions to have unfavorable effects in situations that are dissimilar to the critical one, irrespective of whether these situations require the planned response (as observed in prior research) or not.

To conclude, a review of the existing literature makes it conceivable that forming implementation intentions affects goal attainment in a more complex way than often assumed, depending on the specific situations people encounter and the responses required in these situations. Based on the generalization hypothesis, we expect that the planned response will be facilitated in situations that are sufficiently similar to the critical one, which will in turn have beneficial effects on goal attainment when these situations require the planned response and unfavorable effects otherwise. Based on the cognitive distraction hypothesis, we predict unfavorable effects in situations that are dissimilar to the critical one irrespective of the required response.

In all of our experiments, we compared goal attainment between groups of participants who formed implementation intentions versus goal intentions. In cognitive experiments on implementation intention effects, enhanced goal attainment in critical situations (e.g., faster and/or more accurate responses) is commonly established by contrasting it to goal attainment with mere goal intentions (Gollwitzer & Sheeran, 2006). We therefore evaluated enhanced versus impaired goal attainment in non-planned situations in an analogous manner, always focusing on the comparison between implementation and goal intentions. For instance, supportive evidence for the generalization hypothesis requires that implementation intention participants respond faster and/or more accurately than goal intention participants not only in critical situations but also in similar situations requiring the planned response.

2. Present research

Implementation intentions are well-known to enhance goal attainment by facilitating the initiation of planned responses upon encountering critical situations. However, the consequences of having formed implementation intentions in situations that were not specified in the if-then plan have not yet been investigated systematically. In the present research, we addressed this issue across three experiments with different variations of a stimulus classification task, instructing participants to classify various geometric objects as quickly as possible. Additionally, participants formed either goal or implementation intentions to quickly respond to a specified critical stimulus. In Experiment 1, we focused on how forming goal versus implementation intentions affects performance in trials with (1) stimuli that are similar to the critical one and also require the planned response versus (2) dissimilar situations requiring a different response. In Experiments 2 and 3, we varied the similarity of situations and responses independently from each other, which allowed us to additionally examine the effects of forming goal versus implementation intentions on behavior in (3) situations that are similar to the critical one but require a different response and in (4) dissimilar situations requiring the planned response. Moreover, we added baseline and posttask goal commitment measures to rule out the possibility that behavioral findings between conditions are confounded by differences in how strongly participants are committed to their performance goals. Based on prior research, however, we did not expect differential goal commitment (Webb & Sheeran, 2007).

3. Experiment 1

In Experiment 1, participants formed implementation intentions in which they planned to respond quickly to a critical stimulus. In line with implementation intention theory, we expected them to respond faster and/or more accurately to the critical stimulus than participants who had merely formed goal intentions. We also predicted that this beneficial effect on performance evinces for stimuli that were similar to the critical one and required the planned response as well (i.e., generalization effect). In contrast, we expected implementation intentions to induce slower and/or less accurate responses to stimuli that are different from the critical one and require different responding (i.e., cognitive distraction).

3.1. Method

3.1.1. Participants and design

We aimed for sample sizes similar to previous studies on goal versus implementation intentions and collected a convenience sample of 127 right-handed females (age: M = 21.2 years, SD = 3.7) who participated in Experiment 1. We excluded data from two participants because their response accuracy (M = 88.5% versus M = 97.6% in the remaining sample) was more than three interquartile ranges below the lower accuracy quartile of the sample (Tukey, 1977). An analogous analysis of response times (M = 465 ms) revealed no suspicious participants. We randomly assigned participants to a goal intention or an implementation intention condition and presented them with three types of trials in which (1) the critical stimulus S required the planned response R, (2) a similar stimulus S_S required the same response R, or (3) a dissimilar stimulus S_D required a different response R_D. Thus, the experiment adopted a 2-between (Condition: Goal Intention vs. Implementation Intention) × 3-within (Stimulus: SR vs. S_SR vs. S_DR_D) mixed-factorial design. We assessed response times and accuracy as dependent variables.

3.1.2. Materials

Participants classified five round and five angular geometric objects (see Table 1) by pressing a "round" or "angular" button, respectively. Among these objects were a square and a circle, and we assigned one of them as the critical stimulus S for which participants formed goal or implementation intentions to quickly perform the corresponding response R. Accordingly, there remained four similar stimuli S_S requiring the same response R and five dissimilar stimuli S_D requiring a different response R_D. For example, when the critical stimulus S was a square, the four other angular objects were S_SR stimuli and the five round objects were S_DR_D stimuli. Similarity was established a priori based on object shape. We presented stimuli on a 34.5 × 19.4 cm screen using E-Prime 2.0 (Psychology Software Tools, Pittsburgh, PA) and assessed responses with an E-Prime response box.

3.1.3. Procedure

We introduced participants to the task and instructed them to categorize ten geometric objects as round versus angular, and to make these classifications as quickly as possible. To make participants familiar with the task, they completed two blocks of practice trials. In each block, all ten geometric objects were presented in random order.

Goal intention versus implementation intention. Once participants had completed the practice trials, we instructed them to adopt the goal intention "I intend to categorize *[picture of the critical figure]* as fast as possible!" or the respective implementation intention "If I see *[picture of the critical figure]*, then I'll press *[the corresponding key]* as quickly as possible!" Participants were subsequently requested to learn and verbally repeat their goal or implementation intention three times to facilitate proper encoding of the information.

Categorization task. The task included 20 blocks, each comprising 10 trials. A trial started with the presentation of a fixation cross for 1000 to 2000 ms, followed by a geometric object. Once participants had categorized the object by pressing the "round" or "angular" response button (the assignment of buttons was counterbalanced), a blank screen was presented for 500 ms before the next trial started.

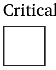
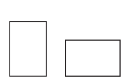
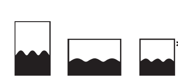
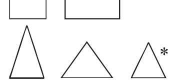
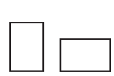
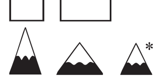
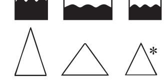
3.2. Results

3.2.1. Data analysis

Prior to the analysis, we removed 1.7% of the trials in which responses (a) were faster than 200 ms or slower than 2000 ms or (b) deviated by > 3 standard deviations from a participant's mean response time for a stimulus. We analyzed the remaining data using the software R, version 3.3.1 (R Core Team, 2016), and visualized our results with the ggplot2 package version 2.1.0 (Wickham, 2009). Response times and accuracies were subjected to linear (LMM) and generalized linear (GLMM) mixed-effects regression models, respectively, both provided in the lme4 package version 1.1-12 (Bates, Maechler, Bolker, & Walker, 2015).

(G)LMMs simultaneously estimate both fixed and random effects on the basis of non-aggregated data (Baayen, Davidson, & Bates, 2008), thus pertaining high statistical power. Furthermore, mixed-effects models are robust to imbalanced numbers of trials between experimental conditions and at the level of individual participants (Judd, Westfall, & Kenny, 2012). Finally, GLMMs handle discontinuous outcome variables (e.g., binary accuracy measures) more appropriately than traditional approaches like mixed ANOVAs. As a consequence of these various advantages, mixed-effects models have become increasingly popular as data analytical tools in psychological research and their usefulness over and beyond traditional ANOVA approaches has been widely recognized (e.g., Boisgontier & Cheval, 2016; Kliegl, Wei, Dambacher, Yan, & Zhou, 2010). In the present research, we specified both (1) experimental factors for an omnibus analysis of main and

Table 1
Sets of stimuli used in Experiments 1 to 3, with the example of a square as critical geometric object.

Critical object (SR): 		Response	
		Same (R)	Different (R_D)
Experiment 1 Stimulus	Similar (S_S)		——
	Dissimilar (S_D)	——	
Experiment 2 Stimulus	Similar (S_S)		
	Dissimilar (S_D)		
Experiment 3 Stimulus	Similar (S_S)		
	Dissimilar (S_D)		

Note. Geometric objects marked with an asterisk were also used as critical objects (counterbalanced).

Table 2
Sets of orthogonal contrasts used in Experiments 1 to 3, along with the statistical inference.

	SR		S_SR		S_SR_D		S_DR		S_DR_D		Response times (LMM)			Errors (GLMM)		
	GI	II	GI	II	GI	II	GI	II	GI	II	β	*SE*	*z*	β	*SE*	*z*
Exp. 1																
C1	−2	−2	+1	+1					+1	+1	0.014	0.002	8.11***	−0.107	0.060	1.79°
C2	−1	+1	0	0					0	0	−0.019	0.011	1.79°	0.037	0.145	0.26
C3	0	0	−1	−1					+1	+1	−0.003	0.001	2.45*	0.098	0.045	2.15*
C4	0	0	−1	+1					0	0	−0.017	0.010	1.72°	−0.063	0.083	0.77
C5	0	0	0	0					−1	+1	−0.010	0.010	1.01	−0.058	0.080	0.73
Exp. 2																
C1	−4	−4	+1	+1	+1	+1	+1	+1	+1	+1	0.005	0.002	2.96**	−0.007	0.034	0.21
C2	−1	+1	0	0	0	0	0	0	0	0	−0.027	0.020	1.38	−0.041	0.167	0.24
C3	0	0	−3	−3	+1	+1	+1	+1	+1	+1	0.007	0.001	4.61***	−0.098	0.035	2.80**
C4	0	0	−1	+1	0	0	0	0	0	0	−0.032	0.019	1.69°	0.036	0.145	0.25
C5	0	0	0	0	−½	−½	−½	−½	+1	+1	−0.010	0.003	3.06**	0.203	0.074	2.75**
C6	0	0	0	0	−1	−1	+1	+1	0	0	0.003	0.003	1.21	−0.003	0.058	0.05
C7	0	0	0	0	−1	+1	0	0	0	0	−0.023	0.019	1.22	−0.189	0.107	1.77°
C8	0	0	0	0	0	0	−1	+1	0	0	−0.021	0.019	1.14	−0.067	0.106	0.63
C9	0	0	0	0	0	0	0	0	−1	+1	−0.025	0.019	1.31	−0.202	0.117	1.73°
Exp. 3																
C1	−4	−4	+1	+1	+1	+1	+1	+1	+1	+1	0.031	0.002	16.09***	−0.196	0.030	6.46***
C2	−1	+1	0	0	0	0	0	0	0	0	−0.061	0.019	3.20**	−0.152	0.157	0.96
C3	0	0	−3	−3	+1	+1	+1	+1	+1	+1	0.039	0.002	22.77***	−0.180	0.023	7.69***
C4	0	0	−1	+1	0	0	0	0	0	0	−0.049	0.018	2.70**	0.033	0.110	0.30
C5	0	0	0	0	−½	−½	−½	−½	+1	+1	−0.015	0.004	3.75***	0.259	0.046	5.63***
C6	0	0	0	0	−1	−1	+1	+1	0	0	0.009	0.004	2.58*	−0.309	0.036	8.50***
C7	0	0	0	0	−1	+1	0	0	0	0	−0.024	0.018	1.33	−0.290	0.089	3.26**
C8	0	0	0	0	0	0	−1	+1	0	0	−0.030	0.018	1.67°	−0.307	0.082	3.76***
C9	0	0	0	0	0	0	0	0	−1	+1	−0.028	0.018	1.56	−0.038	0.090	0.42

Note. Response times were log-transformed prior to the analyses. C1 to C9 = contrasts, GI = goal intention, II = implementation intention. SR = critical stimulus and response, S_SR = similar stimulus and same response, S_SR_D = similar stimulus and different response, S_DR = dissimilar stimulus and same response, S_DR_D = dissimilar stimulus and different response.

° $p < .10$.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

interaction effects and (2) planned orthogonal Condition × Stimulus contrasts reflecting our hypotheses (see Table 2) as fixed effects in (G) LMMs, and participants and stimuli as random effects.[2]

3.2.2. Response times

We first regressed log-transformed response times from trials with correct responses on Condition, Stimulus, and their interaction effect using an LMM analysis. This revealed a significant main effect of Stimulus, $\chi^2(2) = 66.26$, $p < .001$, that was governed by a significant interaction effect of Condition and Stimulus, $\chi^2(2) = 5.29$, $p = .005$. The main effect of Condition was not significant, $\chi^2(1) = 1.93$, $p = .164$. Second, we subjected the response time data to an LMM with our set of orthogonal contrasts. We found that responses in critical SR trials were significantly faster than responses in S_SR and S_DR_D trials, $\beta = 0.014$, $SE = 0.002$, $z = 8.11$, $p < .001$. Still, implementation intention participants tended to respond faster to critical SR stimuli than goal intention participants, $\beta = -0.019$, $SE = 0.011$, $z = 1.79$, $p = .075$. Further, we observed that responses in S_SR trials were slower than responses in S_DR_D trials, $\beta = -0.003$, $SE = 0.001$, $z = 2.45$, $p = .014$. A marginally significant difference between goal and implementation intention emerged in S_SR trials, $\beta = -0.017$, $SE = 0.010$, $z = 1.72$, $p = .085$, while there was no difference between conditions in S_DR_D trials, $\beta = -0.010$, $SE = 0.010$, $z = 1.01$, $p = .314$. The pattern of results is depicted in Fig. 1 (upper panel).

3.2.3. Accuracy

We subjected accuracy to a GLMM with Condition, Stimulus, and their interaction effect and observed a significant main effect of Stimulus, $\chi^2(2) = 6.34$, $p = .042$. Neither the main effect of Condition, $\chi^2(1) = 0.61$, $p = .436$, nor the interaction effect of Condition and Stimulus, $\chi^2(2) = 0.46$, $p = .796$, reached significance. We then regressed the accuracy data on our set of orthogonal a priori contrasts (Brauer & McClelland, 2005; Wilcox, 1987). Accuracy tended to be higher in SR compared to S_SR and S_DR_D trials, $\beta = -0.107$, $SE = 0.060$, $z = 1.79$, $p = .074$. Moreover, accuracy was lower in S_SR than S_DR_D trials, $\beta = 0.098$, $SE = 0.045$, $z = 2.15$, $p = .031$. None of the remaining contrasts reached conventional levels of significance, $ps > .440$. The pattern of results is depicted in Fig. 1 (lower panel).

3.3. Discussion

In Experiment 1, we investigated the effects of forming implementation intentions versus goal intentions on responses to specified critical stimuli (SR stimuli), stimuli that were similar to and required the same response as the critical stimulus (S_SR stimuli), and dissimilar stimuli requiring a different response (S_DR_D stimuli). We first observed that critical SR stimuli were classified faster than other stimuli across conditions. Additionally, implementation intention participants tended to categorize critical SR stimuli faster than goal intention participants, an observation that is in line with the literature (Gollwitzer & Sheeran, 2006). Second, S_SR stimuli were classified more slowly than S_DR_D stimuli across conditions, but implementation intention participants again tended to be faster than goal intention participants. Finally, the differences between goal and implementation intention participants in S_DR_D trials were not significant. Thus, the results of Experiment 1 are consistent with prior implementation intention research and lend some support for the hypothesized generalization of implementation intention to similar situations, whereas no support evinced for the predicted

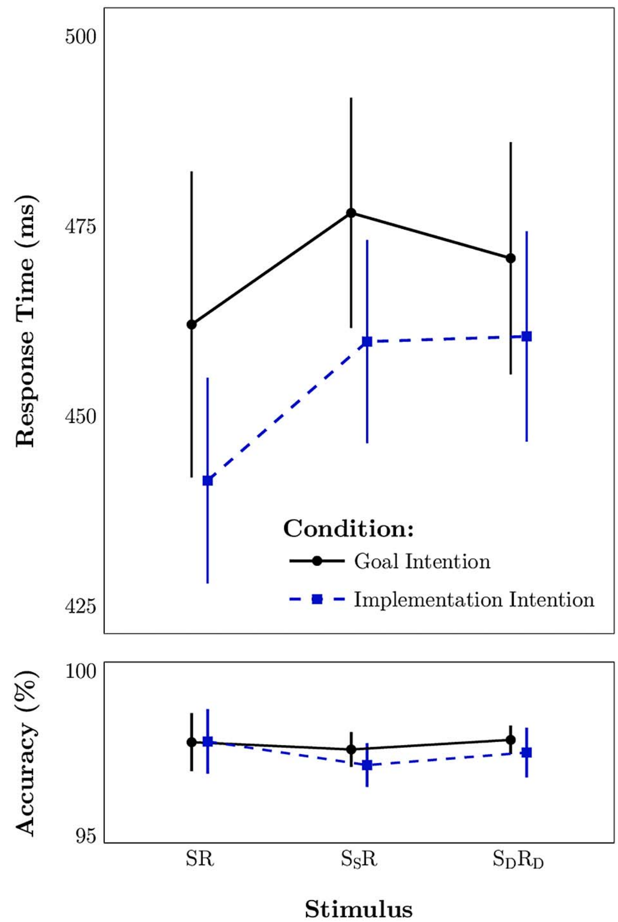


Fig. 1. Averaged response times and accuracies as a function of Condition (goal intention vs. implementation intention) and Stimulus (SR vs. S_SR vs. S_DR_D) in Experiment 1. Error bars represent standard errors of the mean.

cognitive distraction regarding dissimilar situations.

Why did we obtain mixed evidence regarding the generalization and the cognitive distraction hypothesis? One plausible reason pertains to the interpretation of similarity, which we had established a priori according to whether geometric objects were rectangular versus round (see Bayer et al., 2009, for a similar reasoning). However, there are two potential issues: our similar objects might have been more dissimilar than intended (e.g., triangles and squares comprise a different number of lines with different orientations), whereas our dissimilar objects might have been more similar than intended (e.g., the pear-shaped rounded object might have resembled a triangle more strongly than a symmetric circle). If such unintended effects indeed arose in Experiment 1, they are likely to have obscured the expected effects of implementation intentions on non-planned situations. In Experiment 2, we therefore used a set of geometric objects for which we established shape similarity more unequivocally.

We also wanted to test our full set of hypotheses in Experiment 2, additionally examining performance in trials comprising stimuli that are similar to the critical one but require different responding as well as stimuli that are dissimilar to the critical one but require the planned response. We therefore devised a set of geometric objects in which stimulus and response similarity varied independently of each other (similar stimulus and same response, similar stimulus and different response, dissimilar stimulus and same response, and dissimilar stimulus and different response). This also facilitates following up the observed slower and less accurate responses in S_SR compared to S_DR_D trials in the goal and implementation intention conditions, as S_SR trials might have in fact comprised situations that were dissimilar to the critical situation.

[2] For mixed-effects models, there is yet no established way to calculate the required degrees of freedom for evaluating the significance of fixed effects with t and F statistics. However, with a sufficient number of participants and observations, t and F statistics effectively approximate normal and normalized χ^2 distributions (i.e.,$t(df) \rightarrow z$ and $F(df_n, df_d) \rightarrow \chi^2(df_n) / df_n$), respectively, for which significance can be unequivocally established. We therefore report z and χ^2 statistics along with their associated degrees of freedom and p values for all fixed-effects analyses.

4. Experiment 2

The purpose of Experiment 2 was threefold. First, we wanted to achieve a better test of our hypotheses by using geometric objects of unequivocally similar or dissimilar shape. This was implemented by using three similar rectangular shapes versus three similar triangular shapes. Second, we wanted to investigate whether forming goal and implementation intentions might have adverse effects when a stimulus similar to the critical stimulus requires a different response or a dissimilar stimulus requires the same response. This necessitates an independent variation of stimulus and response similarity. We thus created one set of empty objects and one set of filled objects and asked participants to classify the objects according to their resulting patterns rather than their shape. Finally, we added commitment questionnaires in order to check whether forming goal versus implementation intentions differentially affected goal commitment.

4.1. Method

4.1.1. Participants and design

We collected data in the same way as in Experiment 1, resulting in a sample of 64 right-handed females (age: $M = 19.6$ years, $SD = 1.7$). We excluded data from three participants because their response accuracy ($M = 60.4\%$ versus $M = 96.3\%$ in the remaining sample) was more than three interquartile ranges below the lower accuracy quartile of the sample (Tukey, 1977). An analogous analysis of response times ($M = 466$ ms) revealed no suspicious participants. We modified the task from Experiment 1 such that the geometric objects differed with regard to two attributes (i.e., shape and pattern), allowing us to dissociate stimulus and response similarity. This resulted in five types of trials: (1) the critical stimulus S required the planned response R, (2) a similar stimulus S_S required the same response R, (3) a similar stimulus S_S required a different response R_D, (4) a dissimilar stimulus S_D required the same response R, or (5) a dissimilar stimulus S_D required a different response R_D. Accordingly, the experiment adopted a 2-between (Intention: Goal Intention vs. Implementation Intention) × 5-within (Stimulus: SR vs. S_SR vs. S_SR_D vs. S_DR vs. S_DR_D) mixed-factorial design. We assessed response times and accuracy as dependent variables.

4.1.2. Materials

In contrast to Experiment 1, we used a set of twelve angular geometric objects (see Table 1) and varied their shape (rectangular vs. triangular) and pattern (empty vs. filled). Participants classified the objects according to their pattern by pressing a respective mouse button. Among the objects were a square and an equilateral triangle that were either empty or filled, and we assigned one of them as the critical stimulus S for which participants formed goal or implementation intentions to quickly perform the corresponding response R. Accordingly, there remained two similar stimuli S_S requiring the same response R, three similar stimuli S_S requiring a different response R_D, three dissimilar stimuli S_D requiring the same response R, and three dissimilar stimuli S_D requiring a different response R_D. For example, when the critical stimulus S was an empty square, the other two empty rectangles were S_SR stimuli, the three filled rectangles were S_SR_D stimuli, the three empty triangles were S_DR stimuli, and the three filled triangles were S_DR_D stimuli.

As in Experiment 1, similarity was established a priori based on stimulus shape. However, we also checked whether our definition of similarity conformed to people's perception of similarity in an online experiment (Amazon Mechanical Turk; Buhrmester, Kwang, & Gosling, 2011) with 40 participants (14 females, age: $M = 31.9$, $SD = 8.0$). They were first presented with one of the four critical stimuli and then rated how similar each of our twelve stimuli (including the critical stimulus itself) was to the critical stimulus on visual analogue scales ranging from 0% (looks completely different) to 100% (looks the same). In line with our definition of similarity, we found that stimuli with the same shape as the critical stimulus (i.e., S_SR and S_SR_D stimuli) were rated as significantly more similar to the critical stimulus than stimuli with a different shape (i.e., S_DR and S_DR_D stimuli).

4.1.3. Procedure

The procedure closely resembled that of Experiment 1 with few exceptions. First, to provide participants with a rationale for performing the task, it was introduced as dealing with road safety. Accordingly, we described the twelve geometric objects shown in Table 1 as road signs, presented them to participants along with the corresponding mouse buttons, and gave participants the goal to categorize the road signs as quickly as possible. Second, participants completed three blocks of 12 practice trials to become familiar with the task. If desired, however, participants could complete additional practice blocks. Each block of trials comprised 12 geometric objects in random order. Third, participants were requested to copy their goal ("I intend to categorize *[picture of critical figure]* as fast as possible") or implementation intention ("If I see *[picture of the critical figure]*, then I'll press the [*right/left*] key as quickly as possible") three times to facilitate proper encoding of the information. Fourth, participants completed a total of 240 trials upon finishing the practice trials. Finally, the geometric objects were presented at a random location on the screen after the fixation cross had disappeared.

Moreover, we wanted to check whether forming goal versus implementation intentions has differential effects on goal commitment. We therefore assessed goal commitment twice, once before participants started working on the task and once again after they had completed it. In each assessment, two items referred to all road signs used in the experiment: "How strong is your intention/motivation to categorize the road signs as quickly as possible?" and two items referred to the critical road sign specified in the goal or implementation intention: "How strong is your intention/motivation to categorize *[critical road sign]* as quickly as possible?" Participants answered our questions on 7-point Likert scales ranging from 1 = *not very strong* to 7 = *very strong*.

4.2. Results

4.2.1. Data analysis

We removed 1.50% of the trials as outliers, using the same criteria as in Experiment 1. We subjected response times and accuracies to omnibus analyses of Condition and Stimulus main and interaction effects and then tested a set of nine orthogonal fixed-effects contrasts (see Table 2), evaluating the significance of all effects with (G)LMM regression models.

4.2.2. Goal commitment

Participants were strongly committed to make quick categorizations throughout the experiment (all means between 5.9 and 6.4). Importantly, we found no differences between goal and implementation intentions on any assessment, $ps > .182$, ruling out differences in goal commitment as an explanation for behavioral differences.

4.2.3. Response times

We first regressed log-transformed response times from trials with correct responses on Condition, Stimulus, and their interaction effect using an LMM analysis. This revealed a significant main effect of Stimulus, $\chi^2(4) = 45.19$, $p < .001$. Neither the main effect of Condition, $\chi^2(1) = 1.81$, $p = .178$, nor the interaction effect of Condition and Stimulus, $\chi^2(4) = 3.15$, $p = .533$, reached significance. Second, we subjected the response time data to an LMM with our set of orthogonal contrasts. Contrasts 1 and 2 revealed that responses in critical SR trials were significantly faster compared to responses in all other trials, $\beta = 0.005$, $SE = 0.002$, $z = 2.96$, $p = .003$, while implementation intention participants did not respond significantly faster to SR stimuli than goal intention participants, $\beta = -0.027$, $SE = 0.020$, $z = 1.38$, $p = .167$. Similarly, Contrasts 3 and 4 showed

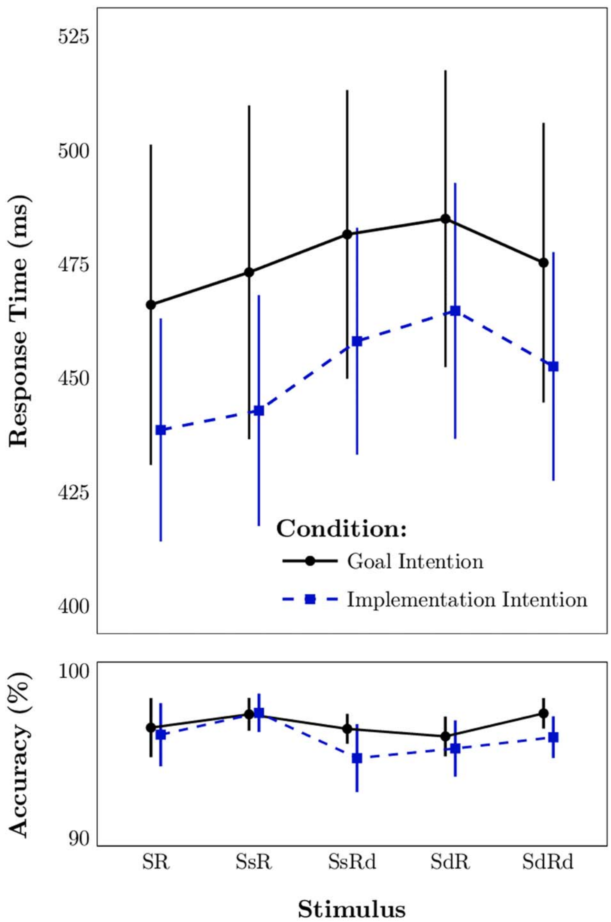


Fig. 2. Averaged response times and accuracies as a function of Condition (goal intention vs. implementation intention) and Stimulus (SR vs. S_SR vs. S_SR_D vs. S_DR vs. S_DR_D) in Experiment 2. Error bars represent standard errors of the mean.

significantly faster responses in S_SR trials compared to S_SR_D, S_DR, and S_DR_D trials, $\beta = 0.007$, $SE = 0.001$, $z = 4.61$, $p < .001$, and implementation intention participants tended to respond faster in S_SR trials than goal intention participants, $\beta = -0.032$, $SE = 0.019$, $z = 1.69$, $p = .092$. Contrasts 5 and 6 revealed that responses in S_SR_D and S_DR trials did not differ from each other, $\beta = 0.003$, $SE = 0.003$, $z = 1.21$, $p = .225$, while they were jointly slower than responses in S_DR_D trials, $\beta = -0.010$, $SE = 0.003$, $z = 3.06$, $p = .002$. Finally, Contrasts 7 to 9 revealed no differences between goal and implementation condition regarding S_SR_D, S_DR, and S_DR_D trials, $ps > .190$. The pattern of results is depicted in Fig. 2 (upper panel).

4.2.4. Accuracy

We subjected accuracy to a GLMM with Condition, Stimulus, and their interaction effect and observed a significant main effect of Stimulus, $\chi^2(4) = 16.14$, $p = .003$. Neither the main effect of Condition, $\chi^2(1) = 2.24$, $p = .135$, nor the interaction effect of Condition and Stimulus, $\chi^2(4) = 3.51$, $p = .476$, reached significance. We then regressed the accuracy data on our set of orthogonal contrasts. Contrast 3 revealed that responses in S_SR trials were significantly more accurate than responses in S_SR_D, S_DR, and S_DR_D trials, $\beta = -0.098$, $SE = 0.035$, $z = 2.80$, $p = .005$, and Contrast 5 further showed less accurate responses in S_SR_D and S_DR trials than in S_DR_D trials, $\beta = 0.203$, $SE = 0.074$, $z = 2.75$, $p = .006$. Finally, according to Contrasts 7 and 9 implementation intention participants tended to respond less accurately than goal intention participants when a different response was required in S_SR_D, $\beta = -0.189$, $SE = 0.107$, $z = 1.77$, $p = .077$, or S_DR_D trials, $\beta = -0.202$, $SE = 0.117$, $z = 1.73$, $p = .083$. None of the remaining contrasts reached conventional levels of significance, $ps > .520$. The pattern of results is depicted in Fig. 2 (lower panel).

4.3. Discussion

In Experiment 2, we investigated the effect of forming implementation intentions versus goal intentions on responses to a specified critical stimulus (SR stimuli), as well as on responses to stimuli that were similar to the critical stimulus and required the same versus a different response (S_SR and S_SR_D stimuli, respectively) and on responses to stimuli that were dissimilar to the critical stimulus and required the same versus a different response (S_DR and S_DR_D stimuli, respectively). We replicated our finding from Experiment 1 that critical SR stimuli were classified faster than other stimuli. Additionally, we observed a facilitative effect for S_SR stimuli; responses to these stimuli were both faster and more accurate than responses to stimuli that were dissimilar and/or required a different response. Although implementation intention participants were numerically faster on both SR and S_SR trials than goal intention participants, the difference failed to reach significance in SR trials and was only marginally significant for S_SR trials. Forming goal and implementation intentions had adverse consequences as well, hampering responses to S_SR_D and S_DR stimuli in comparison to S_DR_D stimuli. However, no differences between goal and implementation intention evinced other than a trend for implementation intention participants to respond less accurately in dissimilar situations requiring a different response than the planned one.

Judging by the numerical pattern of results, the findings in Experiment 2 were in line with predictions of the generalization and the cognitive distraction hypothesis. However, we failed to find conclusive support for either hypothesis, as differences between conditions did not reach (at least marginal) significance for most stimuli, including the critical one. There are two plausible reasons for this. First, Experiment 2 had only half the sample size of Experiment 1 and might thus have been underpowered for detecting differences between conditions. Second, the task might have been easier than the one used in Experiment 1, as participants had to discern between two object patterns only rather than ten shapes. It is well known that for easy tasks goal intentions already suffice for enhancing goal attainment, and no further improvements can be attained with implementation intentions (Gollwitzer & Brandstätter, 1997; Wieber, Odenthal, & Gollwitzer, 2010). To address these issues, we increased the sample size in Experiment 3 and again modified the categorization task such that categorizations could no longer rely on pattern differences only, thus making categorization decisions considerably more difficult.

5. Experiment 3

The main purpose of Experiment 3 was to obtain more powerful tests of differences between goal and implementation intentions. This was achieved first by increasing the sample size, thus enhancing power for detecting differences between conditions. Second, we made the categorization task more difficult by requiring participants to categorize the geometric objects not only by their pattern but additionally by their shape. As implementation intentions are known to be more effective than goal intentions when it comes to performing well on difficult (vs. easy) tasks, this should amplify potential differences in response times and accuracies between the two conditions.

5.1. Method

5.1.1. Participants and design

We collected data in the same way as in the previous two experiments, resulting in a sample of 93 right-handed females (age: $M = 20.4$ years, $SD = 2.0$). Four participants mixed up the assignment of the two response keys to stimuli and we recoded their responses accordingly. We excluded data from 13 participants because their response accuracy (M = 52.9% versus M = 92.1% in the remaining sample) was more than three interquartile ranges below the lower accuracy quartile of the sample (Tukey, 1977). An analogous analysis of response times revealed that one of the excluded participants also made extremely slow responses (M = 1945 ms versus M = 773 ms in the remaining sample) but did not reveal any additional suspicious participant. We used the same 2-between (Intention: Goal Intention vs. Implementation Intention) × 5-within (Stimulus: SR vs. S_SR vs. S_SR_D vs. S_DR vs. S_DR_D) mixed-factorial design as in Experiment 2.

5.1.2. Materials and procedure

Materials and procedure were almost identical to Experiment 2. The only difference was that participants could no longer classify the geometric objects just by their pattern attribute (see Table 1). Instead, we assigned empty rectangles and filled triangles to one response category, and filled rectangles and empty triangles to the other response category, thereby increasing task difficulty.

5.2. Results

5.2.1. Data analysis

We removed 6.51% of the trials as outliers, using the same criteria as before. We subjected response times and accuracies to omnibus analyses of Condition and Stimulus main and interaction effects and then tested a set of nine orthogonal fixed-effects contrasts (see Table 2), evaluating the significance of all effects with (G)LMM regression models.

5.2.2. Goal commitment

Participants were strongly committed to make quick categorizations throughout the experiment (all means between 5.9 and 6.3). Importantly, we found no differences between goal and implementation intentions on any assessment, $ps > .623$, ruling out differences in goal commitment as an explanation for behavioral differences.

5.2.3. Response times

We first regressed log-transformed response times from trials with correct responses on Condition, Stimulus, and their interaction effect using an LMM analysis. This revealed significant main effects of Stimulus, $\chi^2(4) = 934.64$, $p < .001$, and Condition, $\chi^2(1) = 4.12$, $p = .042$, that were governed by a significant interaction effect of Condition and Stimulus, $\chi^2(4) = 23.97$, $p < .001$. Second, we subjected the response time data to an LMM with our set of orthogonal contrasts. Contrasts 1 and 2 revealed that responses in critical SR trials were significantly faster compared to responses in all other trials, $\beta = 0.031$, $SE = 0.002$, $z = 16.09$, $p < .001$, and that implementation intention participants responded significantly faster to SR stimuli than goal intention participants, $\beta = -0.061$, $SE = 0.019$, $z = 3.20$, $p = .001$. Similarly, Contrasts 3 and 4 showed significantly faster responses in S_SR trials compared to S_SR_D, S_DR, and S_DR_D trials, $\beta = 0.039$, $SE = 0.002$, $z = 22.77$, $p < .001$, and that implementation intention participants responded faster in S_SR trials than goal intention participants, $\beta = -0.049$, $SE = 0.018$, $z = 2.70$, $p = .007$. Contrast 5 demonstrated that responses in S_SR_D and S_DR trials taken together were slower than responses in S_DR_D trials, $\beta = -0.015$, $SE = 0.004$, $z = 3.75$, $p < .001$, and Contrast 6 showed that responses in S_SR_D trials were in turn significantly faster than responses in S_DR trials, $\beta = 0.009$, $SE = 0.004$, $z = 2.58$, $p = .010$. According to Contrast 8, implementation intention participants tended to be faster than goal intention participants in S_DR trials, $\beta = -0.030$, $SE = 0.018$, $z = 1.67$, $p = .095$. And finally, Contrasts 7 and 9 revealed no differences between the goal and implementation conditions on S_SR_D and S_DR_D trials, $ps > .110$. The pattern of results is depicted in Fig. 3 (upper panel).

5.2.4. Accuracy

We subjected accuracy to a GLMM with Condition, Stimulus, and their interaction effect and observed significant main effects of Stimulus, $\chi^2(4) = 254.63$, $p < .001$, and Condition, $\chi^2(1) = 9.58$, $p = .002$, that were governed by a significant interaction effect of Stimulus and Condition, $\chi^2(2) = 22.55$, $p < .001$. We then regressed the accuracy data on our set of orthogonal contrasts. Contrast 1 revealed that responses in SR trials were significantly more accurate than responses in all other trials, $\beta = -0.196$, $SE = 0.030$, $z = 6.46$, $p < .001$, and Contrast 3 showed significantly more accurate responses in S_SR trials compared to S_SR_D, S_DR, and S_DR_D trials, $\beta = -0.180$, $SE = 0.023$, $z = 7.69$, $p < .001$. Contrasts 2 and 4 did not reach significance, $ps > .330$, suggesting no differences between conditions regarding these effects. According to Contrast 5, accuracy was significantly lower in S_SR_D and S_DR trials compared to S_DR_D trials, $\beta = 0.259$, $SE = 0.046$, $z = 5.63$, $p < .001$; however, Contrast 6 also revealed that accuracy was in turn significantly lower in S_DR compared to S_SR_D trials, $\beta = -0.309$, $SE = 0.036$, $z = 8.50$, $p < .001$. Finally, Contrasts 7 and 8 demonstrated that implementation intention participants were significantly less accurate than goal intention participants in both S_SR_D trials, $\beta = -0.290$, $SE = 0.089$, $z = 3.26$, $p = .001$, and in S_DR trials, $\beta = -0.307$, $SE = 0.082$, $z = 3.76$, $p < .001$. No such difference was observed in S_DR_D trials, as suggested by the non-significance of Contrast 9. The pattern of results is depicted in Fig. 3 (lower panel).

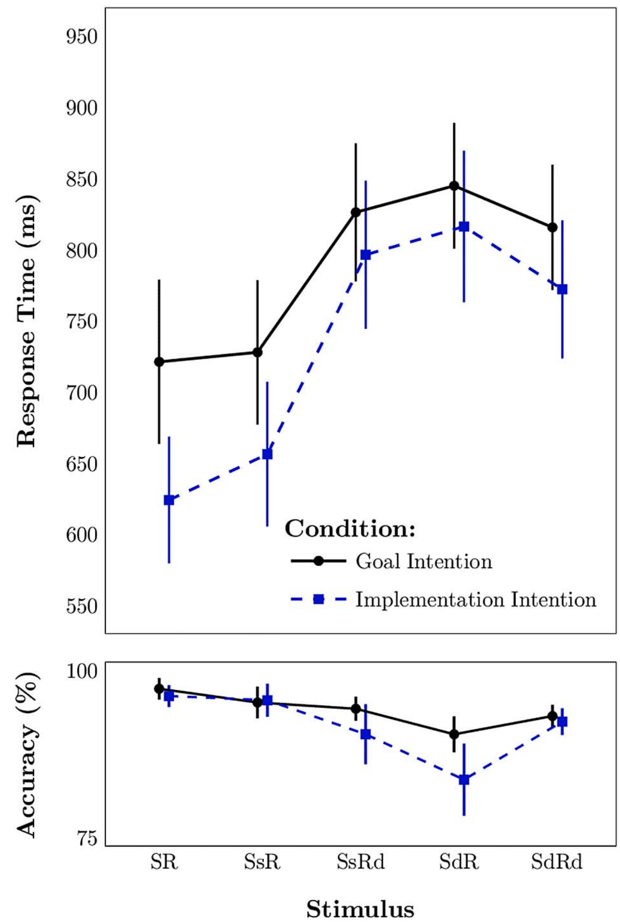


Fig. 3. Averaged response times and accuracies as a function of Condition (goal intention vs. implementation intention) and Stimulus (SR vs. S_SR vs. S_SR_D vs. S_DR vs. S_DR_D) in Experiment 3. Error bars represent standard errors of the mean.

5.3. Discussion

We conducted Experiment 3 with a larger sample and used a more difficult task than in Experiment 2 to amplify potential differences between goal and implementation intentions. In line with Experiments 1 and 2, forming goal and implementation intentions facilitated responses to critical (SR) stimuli, rendering them faster and more accurate than responses to other stimuli. We observed a similar facilitative effect on responses in S_SR trials, which were faster than responses on trials with stimuli that were dissimilar and/or required a different response. Importantly, both effects were more pronounced among implementation intention participants, who responded significantly faster to SR and S_SR stimuli than goal intention participants.

As in Experiment 2, forming goal and implementation intentions hampered responses to S_SR_D and S_DR stimuli in comparison to S_DR_D stimuli. However, implementation intention participants responded less accurately in both S_SR_D and S_DR trials than goal intention participants, although the latter effect was accompanied by slightly faster response times in the implementation intention condition. Accordingly, forming implementation intentions had specific adverse effect on responses to stimuli that were similar to the critical one but required a different response and dissimilar stimuli requiring the same response. No such effect evinced for dissimilar stimuli requiring a different response. This pattern of effects fully supports the generalization hypothesis and lends partial support to the cognitive distraction hypothesis.

6. General discussion

Forming implementation intentions (if-then plans; Gollwitzer, 1993, 1999, 2014) is a powerful self-regulation strategy that helps people attaining their goals. Considerable research indicates that implementation intentions exert their effects by facilitating the automatic initiation of a goal-directed response upon encountering a critical situation. The present research is the first systematic investigation of the consequences of forming implementation intentions for goal attainment in non-planned situations. Specifically, we investigated whether forming implementation intention facilitates the initiation of planned responses in the critical as well as in sufficiently similar situations (generalization effect), thereby enhancing goal attainment when the planned response is required and impairing it otherwise. Moreover, we examined whether implementation intentions decrease goal attainment in situations that are dissimilar to the critical one, irrespective of whether the planned response is required or not (cognitive distraction).

Taken together, the results of Experiments 1 and 3 provide support for the generalization hypothesis. Statistically significant effects evinced in Experiment 3, in which implementation intention participants responded faster than goal intention participants to similar stimuli requiring the planned responses but in turn committed more errors when similar stimuli required different responding. This pattern suggests that implementation intentions facilitate the planned responses in sufficiently similar situations and thus complements prior findings showing that this facilitation effect is difficult to control (Wieber & Sassenberg, 2006). Moreover, we obtained somewhat mixed support for the cognitive distraction hypothesis. Specifically, in Experiment 3 we replicated the finding that forming implementation intentions hampers responses to situations that are dissimilar to the critical one but require the same response (Masicampo & Baumeister, 2012; Parks-Stamm et al., 2007). However, no significant impairment emerged for stimuli that were both dissimilar and required a different response. Of course, the failure to observe such an impairment cannot be taken as evidence against the cognitive distraction hypothesis. Still, our results leave open the possibility that implementation intentions do not generally detract cognitive resources from establishing associations beyond those spelled out in their if-then plans.

Rather than causing a general cognitive distraction, strengthening the association between a critical situation and a planned response in an if-then plan might more selectively derogate the strength of association (1) between the critical situation and alternative responses, and (2) between the planned response and alternative situations, without affecting how strongly alternative situations and alternative responses are associated to each other. This reasoning is compatible with research on goal systems theory (Kruglanski et al., 2002), which has predicted and observed that strengthening the association between two goal-related concepts selectively attenuates their associations with other concepts (Bélanger, Schori-Eyal, Pica, Kruglanski, & Lafrenière, 2015; Zhang, Fishbach, & Kruglanski, 2007). Future research might follow up our results by explicitly testing whether the effects of implementation intentions on goal attainment in different situations is better explained by general cognitive distraction or selective attenuation of alternative situation-response associations; this could be done by complementing measures of goal attainment with assessing perceived instrumentality of the different situations and responses (e.g., Bayuk, Janiszewski, & Leboeuf, 2010).

The present research makes an important contribution to the ongoing discussion about whether goal striving with implementation intentions is better characterized as flexible or tenacious (Gollwitzer, Parks-Stamm, Jaudas, & Sheeran, 2008). Only recently it has been demonstrated that situational circumstances (i.e., the cost of performing the goal-directed response) may tip the balance between flexibility and tenacity (Legrand, Bieleke, Gollwitzer, & Mignon, 2017). Our results provide several additional perspectives on the flexible and tenacious characteristics of goal striving by implementation intentions. Attesting to flexibility, implementation intentions turned out to facilitate the initiation of the planned response not only in the specified critical situation but also in sufficiently similar situations, with beneficial effects on goal attainment whenever this planned response was in fact required in these situations. This is an important observation because the exact features of a critical situation might often be difficult to anticipate, and research indicates that making a large number of plans, one for each anticipated potential critical situation, is not advisable (Verhoeven, Adriaanse, De Ridder, De Vet, & Fennis, 2013). Furthermore, the features of an anticipated critical situation might change over time and it seems desirable that implementation intentions nevertheless remain effective. The generalization effects observed in the present research indicate that this is possible, thereby suggesting an explanation for the commonly observed long-term effectiveness of implementation intentions (e.g., Holland, Aarts, & Langendam, 2006; Martin, Sheeran, Slade, Wright, & Dibble, 2011).

Our research also showed that action control by implementation intentions was characterized by tenacity, in the sense of hampering goal attainment for instance when a situation similar to the critical one required different responding. This effect resembles so-called habit capture errors in which habitual responses are performed although the situation requires different responding (James, 1890; Norman, 1981; Reason, 1979) and therefore attests to Gollwitzer's (1999) notion of implementation intentions as “instant habits.” These capture errors might be difficult to avoid, in particular because simply specifying multiple responses in implementation intentions interferes with their effectiveness and is thus not advisable (Vinkers, Adriaanse, Kroese, & De Ridder, 2015). Yet, capture errors are an issue only if people encounter situations in which performing the goal-directed planned behavior is disadvantageous in terms of their super-ordinate goals. This seems unlikely in several everyday life settings in which implementation intentions are commonly used to enhance goal attainment. For instance, people with an implementation intention to buy healthy food when shopping in the grocery store are unlikely to encounter similar situations (e.g., shopping in the supermarket or at the local market) in which purchasing healthy food is disadvantageous. However, one might also think of situations in which capture errors interfere with super-ordinate goal attainment (e.g., when a planned route to work is incorrectly taken at the weekend as well).

Another tenacious characteristic of action control by implementation intentions evinced in situations that were dissimilar to the critical one but nevertheless required the planned response. Interestingly, this effect emerged although participants had knowledge about all possible situations prior to the task, whereas prior research only observed it when alternative opportunities emerged unexpectedly during task performance (Masicampo & Baumeister, 2012; Parks-Stamm et al., 2007). In everyday life settings in which failures to seize alternative opportunities for goal attainment could be costly, we advise people to adopt an abstract mindset (e.g., asking themselves why they want to attain a goal) to increase the probability of switching to alternative means of goal attainment (Bayuk et al., 2010; Wieber, Sezer, & Gollwitzer, 2014). Alternatively, people could use implementation intentions to plan to engage in indulging behaviors in opportune situations (e.g., "If I'm on the cycle ergometer in the gym, then I will watch my favorite TV series!"), thus reducing these behaviors in less opportune situations (e.g., when doing the chores). Research on consumer behavior (Milkman, Minson, & Volpp, 2014) and clinical therapy (Borkovec, Wilkinson, Folensbee, & Lerman, 1983) suggests this to be a viable strategy, and future research might investigate whether implementation intentions can be used to make them more effective.

7. Conclusion

Forming implementation intentions (Gollwitzer, 1993, 1999, 2014) is a self-regulation strategy that helps people to attain their goals by facilitating the initiation of planned responses upon encountering critical situations. The present research is the first systematic investigation of the consequences of forming implementation intentions for goal attainment in non-planned situations. Results from two of three experiments provide affirmative evidence for a facilitation of planned responses in critical and in sufficiently similar situations, enhancing goal attainment when the planned response was required and impairing it otherwise. In one experiment, however, implementation intentions additionally had unfavorable effects when dissimilar situations required the planned response.

Acknowledgments

This research was supported by a Ministerial grant delivered by the French government and a Fulbright grant delivered by the Franco-American Fulbright commission to Eve Legrand. Maik Bieleke and Peter M. Gollwitzer gratefully acknowledge financial support from the German Research Foundation (DFG) through the Research Unit "Psychoeconomics" (FOR 1882). The authors thank Camille Lombart, Lucile Riverieux and Sophie Vatin for their assistance with data collection.

References

Aarts, H., Dijksterhuis, A., & Midden, C. (1999). To plan or not to plan? Goal achievement or interrupting the performance of mundane behaviors. *European Journal of Social Psychology*, *29*, 971–980. http://dx.doi.org/10.1002/(SICI)1099-0992(199912)29:8 < 971::AID-EJSP963 > 3.0.CO;2-.

Achtziger, A., Bayer, U. C., & Gollwitzer, P. M. (2012). Committing to implementation intentions: Attention and memory effects for selected situational cues. *Motivation and Emotion*, *36*, 287–300. http://dx.doi.org/10.1007/s11031-011-9261-6.

Adriaanse, M. A., Vinkers, C. D. W., De Ridder, D. T. D., Hox, J. J., & De Wit, J. B. F. (2011). Do implementation intentions help to eat a healthy diet? A systematic review and meta-analysis of the empirical evidence. *Appetite*, *56*, 183–193. http://dx.doi.org/10.1016/j.appet.2010.10.012.

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and item. *Journal of Memory and Language*, *59*, 390–412. http://dx.doi.org/10.1016/j.jml.2007.12.005.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*, 1–48. http://dx.doi.org/10.18637/jss.v067.i01.

Bayer, U. C., Achtziger, A., Gollwitzer, P. M., & Moskowitz, G. B. (2009). Responding to subliminal cues: Do if-then plans facilitate action preparation and initiation without conscious intent? *Social Cognition*, *27*, 183–201. http://dx.doi.org/10.1521/soco.2009.27.2.183.

Bayuk, J. B., Janiszewski, C., & Leboeuf, R. A. (2010). Letting good opportunities pass us by: Examining the role of mindset during goal pursuit. *Journal of Consumer Research*, *37*, 570–583. http://dx.doi.org/10.1086/654892.

Bélanger, J. J., Schori-Eyal, N., Pica, G., Kruglanski, A. W., & Lafrenière, M.-A. (2015). The "more is less" effect in equifinal structures: Alternative means reduce the intensity and quality of motivation. *Journal of Experimental Social Psychology*, *60*, 93–102. http://dx.doi.org/10.1016/j.jesp.2015.05.005.

Bélanger-Gravel, A., Godin, G., & Amireault, S. (2013). A meta-analytic review of the effect of implementation intentions on physical activity. *Health Psychology Review*, *7*, 23–54. http://dx.doi.org/10.1080/17437199.2011.560095.

Boisgontier, M. P., & Cheval, B. (2016). The anova to mixed model transition. *Neuroscience & Biobehavioral Reviews*, *68*, 1004–1005. http://dx.doi.org/10.1016/j.neubiorev.2016.05.034.

Borkovec, T. D., Wilkinson, L., Folensbee, R., & Lerman, C. (1983). Stimulus control applications to the treatment of worry. *Behaviour Research and Therapy*, *21*(3), 247–251. http://dx.doi.org/10.1016/0005-7967(83)90206-1.

Brandstätter, V., Lengfelder, A., & Gollwitzer, P. M. (2001). Implementation intentions and efficient action initiation. *Journal of Personality and Social Psychology*, *81*, 946–960. http://dx.doi.org/10.1037//0022-35I4.81.5.946.

Brauer, M., & McClelland, G. (2005). L'utilisation des contrastes dans l'analyse des données : Comment tester les hypothèses spécifiques dans la recherche en psychologie. *L'Année Psychologique*, *105*, 273–305. http://dx.doi.org/10.3406/psy.2005.29696.

Brewster, S. E., Elliott, M. A., McCartan, R., McGregor, B., & Kelly, S. W. (2016). Conditional or unconditional? The effects of implementation intentions on driver behavior. *Journal of Experimental Psychology: Applied*, *22*, 124–133. http://dx.doi.org/10.1037/xap0000072.

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk: A new source of inexpensive, yet high-quality, data? *Perspectives on Psychological Science*, *6*, 3–5. http://dx.doi.org/10.1177/1745691610393980.

Bush, R. R., & Mosteller, F. (1951). A model for stimulus generalization and discrimination. *Psychological Review*, *58*, 413–423. http://dx.doi.org/10.1037/h0054576.

Gollwitzer, P. M. (1993). Goal achievement: The role of intentions. *European Review of Social Psychology*, *4*, 141–185. http://dx.doi.org/10.1080/14792779343000059.

Gollwitzer, P. M. (1999). Implementation intentions: Strong effects of simple plans. *American Psychologist*, *54*, 493–503. http://dx.doi.org/10.1037/0003-066X.54.7.493.

Gollwitzer, P. M. (2014). Weakness of the will: Is a quick fix possible? *Motivation and Emotion*, *38*, 305–322. http://dx.doi.org/10.1007/s11031-014-9416-3.

Gollwitzer, P. M., & Brandstätter, V. (1997). Implementation intentions and effective goal pursuit. *Journal of Personality and Social Psychology*, *73*, 186–199. http://dx.doi.org/10.1037/0022-3514.73.1.186.

Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology*, *38*, 69–119. http://dx.doi.org/10.1016/S0065-2601(06)38002-1.

Gollwitzer, P. M., Parks-Stamm, E. J., Jaudas, A., & Sheeran, P. (2008). Flexible tenacity in goal pursuit. In W. Gardner, & J. Shah (Eds.), *Handbook of motivation science* (pp. 325–341). New York, NY: Guilford Press.

Hagger, M. S., & Luszczynska, A. (2014). Implementation intention and action planning interventions in health contexts: State of the research and proposals for the way forward. *Applied Psychology. Health and Well-Being*, *6*, 1–47. http://dx.doi.org/10.1111/aphw.12017.

Holland, R. W., Aarts, H., & Langendam, D. (2006). Breaking and creating habits on the working floor: A field-experiment on the power of implementation intentions. *Journal of Experimental Social Psychology*, *42*(6), 776–783. http://dx.doi.org/10.1016/j.jesp.2005.11.006.

James, W. (1890). *The principles of psychology*. New York, NY: Henry Holt and Co.

Janczyk, M., Dambacher, M., Bieleke, M., & Gollwitzer, P. M. (2015). The benefit of no choice: Goal-directed plans enhance perceptual processing. *Psychological Research*, *79*, 206–220. http://dx.doi.org/10.1007/s00426-014-0549-5.

Judd, C. M., Westfall, J., & Kenny, D. A. (2012). Treating stimuli as a random factor in social psychology: A new and comprehensive solution to a pervasive but largely ignored problem. *Journal of Personality and Social Psychology*, *103*, 54–69. http://dx.doi.org/10.1037/a0028347.

Kahneman, D. (1973). *Attention and effort*. Englewood Cliffs, NJ: Prentice-Hallhttp://dx.doi.org/10.2307/1421603.

Kliegl, R., Wei, P., Dambacher, M., Yan, M., & Zhou, X. (2010). Experimental effects in individual differences in linear mixed models: Estimating the relationship between spatial, object, and attraction effects in visual attention. *Frontiers in Psychology*, *1*, 1–12. http://dx.doi.org/10.3389/fpsyg.2010.00238.

Kruglanski, A. W., Shah, J. Y., Fishbach, A., Friedman, R., Chun, W. Y., & Sleeth-Keppler, D. (2002). A theory of goal systems. *Advances in Experimental Social Psychology*, *34*, 331–378. http://dx.doi.org/10.1016/S0065-2601(02)80008-9.

Legrand, E., Bieleke, M., Gollwitzer, P. M., & Mignon, A. (2017). Nothing will stop me? Flexibly tenacious goal striving with implementations. *Motivation Science*, *3*, 101–108. http://dx.doi.org/10.1016/j.brat.2008.02.005.

Lissek, S., Biggs, A. L., Rabin, S. J., Cornwell, B. R., Alvarez, R. P., Pine, D. S., & Grillon, C. (2008). Generalization of conditioned fear-potentiated startle in humans: Experimental validation and clinical relevance. *Behaviour Research and Therapy*, *46*, 678–687. http://dx.doi.org/10.1016/j.brat.2008.02.005.

Martin, G., & Pear, J. (2016). *Behavior modification: What it is and how to do it* (10th ed.). New York, NY: Routledge.

Martin, J., Sheeran, P., Slade, P., Wright, A., & Dibble, T. (2011). Durable effects of implementation intentions: Reduced rates of confirmed pregnancy at 2 years. *Health Psychology*, *30*, 368–373. http://dx.doi.org/10.1037/a0022739.

Martiny-Huenger, T., Bieleke, M., Oettingen, G., & Gollwitzer, P. M. (2016). From thought to automatic action: Strategic and spontaneous action control by if-then planning. In B. Gawronski, R. Deutsch, & W. Hofmann (Eds.), *Reflective and impulsive determinants of behavior* (pp. 69–84). New York, NY: Psychology Press.

Masicampo, E. J., & Baumeister, R. F. (2012). Committed but closed-minded: When making a specific plan for a goal hinders success. *Social Cognition*, *30*, 37–55. http://dx.doi.org/10.1521/soco.2012.30.1.37.

Milkman, K. L., Minson, J. A., & Volpp, K. G. M. (2014). Holding the hunger games hostage at the gym: An evaluation of temptation bundling. *Management Science*, *60*, 283–299. http://dx.doi.org/10.1287/mnsc.2013.1784.

Norman, D. A. (1981). Categorization of action slips. *Psychological Review*, *88*, 1–15. http://dx.doi.org/10.1037/0033-295X.88.1.1.

Parks-Stamm, E. J., Gollwitzer, P. M., & Oettingen, G. (2007). Action control by implementation intentions: Effective cue detection and efficient response initiation. *Social Cognition*, *25*, 248–266. http://dx.doi.org/10.1521/soco.2007.25.2.248.

Pearce, J. M. (1987). A model for stimulus generalization in Pavlovian conditioning. *Psychological Review*, *94*, 61–73. http://dx.doi.org/10.1037/0033-295X.94.1.61.

Pierce, W. D., & Cheney, C. D. (2004). *Behavior analysis and learning* (3rd ed.). Mahwah, NJ: Lawrence Erlbaumhttp://dx.doi.org/10.4324/9780203726624.

R Core Team (2016). *R: A language and environment for statistical computing.* Vienna: R Foundation for Statistical Computing. Retrieved from http://www.r-project.org/.

Reason, J. T. (1979). Actions not as planned: The price of automatization. In G. Underwood, & R. Stevens (Eds.), *Aspects of consciousness* (pp. 1–67). London: Academic Press.

Shepard, R. N. (1987). Toward a universal law of generalization for psychological science. *Science (New York, N.Y.)*, *237*, 1317–1323. http://dx.doi.org/10.1126/science.3629243.

Till, B. D., & Priluck, R. L. (2000). Stimulus generalization in classical conditioning: An initial investigation and extension. *Psychology and Marketing*, *17*, 55–72. http://dx.doi.org/10.1002/(SICI)1520-6793(200001)17:1 < 55::AID-MAR4 > 3.0.CO;2-C.

Triandis, H. C. (1977). *Interpersonal behavior*. Monterey, CA: Brooks/Cole.

Tukey, J. W. (1977). *Exploratory data analysis*. Reading, MA: Addison-Wesley.

Verhoeven, A. A. C., Adriaanse, M. A., De Ridder, D. T. D., De Vet, E., & Fennis, B. O. B. M. (2013). Less is more: The effect of multiple implementation intentions targeting unhealthy snacking habits. *European Journal of Social Psychology*, *43*, 344–354. http://dx.doi.org/10.1002/ejsp.1963.

Verplanken, B., Aarts, H., van Knippenberg, A., & van Knippenberg, C. (1994). Attitude versus general habit: Antecedents of travel mode choice. *Journal of Applied Social Psychology*, *24*, 285–300. http://dx.doi.org/10.1111/j.1559-1816.1994.tb00583.x.

Vinkers, C. D., Adriaanse, M. A., Kroese, F. M., & De Ridder, D. T. D. (2015). Better sorry than safe: Making a Plan B reduces effectiveness of implementation intentions in healthy eating goals. *Psychology and Health*, *30*, 821–838. http://dx.doi.org/10.1080/08870446.2014.997730.

Webb, T. L., & Sheeran, P. (2007). How do implementation intentions promote goal attainment? A test of component processes. *Journal of Experimental Social Psychology*, *43*, 295–302. http://dx.doi.org/10.1016/j.jesp.2006.02.001.

Webb, T. L., & Sheeran, P. (2008). Mechanisms of implementation intention effects: The role of goal intentions, self-efficacy, and accessibility of plan components. *The British Journal of Social Psychology*, *47*, 373–395. http://dx.doi.org/10.1348/014466607X267010.

Wegner, D. M. (1994). Ironic processes of mental control. *Psychological Review*, *101*, 34–52. http://dx.doi.org/10.1037/0033-295X.101.1.34.

Wickham, H. (2009). *ggplot2: Elegant graphics for data analysis*. New York: Springer.

Wieber, F., & Sassenberg, K. (2006). I can't take my eyes off of it - attention attraction effects of implementation intentions. *Social Cognition*, *24*, 723–752. http://dx.doi.org/10.1521/soco.2006.24.6.723.

Wieber, F., Odenthal, G., & Gollwitzer, P. M. (2010). Self-efficacy feelings moderate implementation intention effects. *Self and Identity*, *9*, 177–194. http://dx.doi.org/10.1080/15298860902860333.

Wieber, F., Sezer, L. A., & Gollwitzer, P. M. (2014). Asking "why" helps action control by goals but not plans. *Motivation and Emotion*, *38*, 65–78. http://dx.doi.org/10.1007/s11031-013-9364-3.

Wilcox, R. R. (1987). New designs in analysis of variance. *Annual Review of Psychology*, *38*, 29–60. http://dx.doi.org/10.1146/annurev.ps.38.020187.000333.

Wood, W., Tam, L., & Witt, M. G. (2005). Changing circumstances, disrupting habits. *Journal of Personality and Social Psychology*, *88*, 918–933. http://dx.doi.org/10.1037/0022-3514.88.6.918.

Zhang, Y., Fishbach, A., & Kruglanski, A. W. (2007). The dilution model: How additional goals undermine the perceived instrumentality of a shared path. *Journal of Personality and Social Psychology*, *92*, 389–401. http://dx.doi.org/10.1037/0022-3514.92.3.38.