

# The Sense of Agency

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## Action Control by If-Then Planning

*Explicating the Mechanisms of Strategic Automaticity  
in Regard to Objective and Subjective Agency*

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### INTRODUCTION

Over the last decades, evidence from different research areas has accumulated that casts doubt on the very intuitive idea that human actions are caused by conscious intentions (i.e., objective agency; Bargh, Chen, & Burrows, 1996; Haggard & Eimer, 1999; Libet, Gleason, Wright, & Pearl, 1983; Soon, Brass, Heinze, & Haynes, 2008; but see Baumeister, Masicampo, & Vohs, 2011). At the same time, there has been an increased interest in why we have such a pervasive feeling that our intentions cause our actions (i.e., subjective agency; Bayne, 2008; Gallagher, 2000; Haggard & Tsakiris, 2009). In this chapter, we approach the question of objective and subjective agency from a self-regulation perspective. We will focus on how actions can be caused by conscious planning, that is, how future behavior can be intentionally automated by if-then planning (i.e., *implementation intentions*; Gollwitzer, 1993, 1999)—a process we refer to as *strategic automaticity* (Gollwitzer & Schaal, 1998). We will argue that humans can willfully exert automatic action control by an anticipatory process of consciously linking a goal-directed response to an anticipated situation (i.e., if-then planning).

The chapter is divided into two sections concerned with objective agency and a third section concerned with subjective agency. In the first section, we

will broadly introduce the concept of if-then planning and present empirical evidence that action initiation by if-then planning exhibits features of automaticity (e.g., immediacy, efficiency, and redundancy of another in situ conscious intent; Bargh, 1989; Shiffrin & Schneider, 1977). Since the early formulation of a theory of implementation intentions (Gollwitzer, 1993), new developments have been made in areas of action control and language comprehension. We pick up these new developments and explicate possible mechanisms behind the strategic automaticity created by if-then planning in the second section of the chapter. Whereas the first two sections relate to objective agency, that is, how action is controlled (by planning), in the final section we will discuss issues related to subjective agency (i.e., the sense of agency). A self-regulation strategy should not undermine a person's feeling of control, as this feeling provides important information about one's capabilities and influences action-outcome expectancies (Heckhausen, 2008; Rotter, 1966). Therefore, as we argue that self-regulation by if-then planning leads to action initiation that exhibits features of automaticity, in the last section of the chapter, we will discuss how (if at all) these automaticity features affect the sense of agency over the if-then planned actions.

## OVERVIEW OF EXISTING WORK ON IMPLEMENTATION INTENTIONS

### Goal Intentions and Implementation Intentions

Most of the time, we cannot immediately implement the behavior that we want or ought to engage in. For example, a student may sit in class and realize that she has to start working on a class assignment soon or else she will fail the class requirements. Another person, reading an article about health issues, may intend to buy an apple instead of a chocolate muffin at the cafeteria in the afternoon to promote his goal to eat more healthily. These examples illustrate an important characteristic of intentions: intentions can have different levels of specificity. For example, the intention to "eat more healthy food" is a very broad description of what one wants to do, whereas to "buy an apple in the cafeteria" is a more specific intention. This specificity results not only from the obvious reference to a distinct type of healthy food (i.e., goal specificity in the sense of Locke & Latham, 2006), but to the description of *where* and *when* to buy it: at the cafeteria, in the afternoon. This aspect—where and when to perform the intended behavior—is at the heart of an important distinction for intentions proposed by Gollwitzer (1993, 1999). Based on ideas extending back to Narzis Ach (1910) and Kurt Lewin (1926, 1951), Gollwitzer (1993) differentiated between *goal intentions*

and *implementation intentions*. Whereas goal intentions simply specify a desired outcome (“I want to be healthy”) or a desired action (“I want to eat more healthy food”), implementation intentions combine a critical anticipated situation with an intended goal-directed action in the form of “If I stand in front of the cafeteria shelf, then I will grab an apple!” Mentally forming a link between a situational cue and a goal-directed response has been demonstrated to increase the likelihood of actually implementing the intended behavior in numerous studies (meta-analysis by Gollwitzer & Sheeran, 2006). From early on, Gollwitzer (1993) proposed two main mechanisms to explain how implementation intentions achieve these superior outcomes compared to goal intentions. First, the anticipated critical situation becomes highly accessible, and second, a link is created between the critical situation and the intended behavior. These mechanisms underlie the notion of strategic automaticity (Gollwitzer, 1993, 1999; Gollwitzer & Schaal, 1998): an agent intentionally formulates an if (situation)-then (action) plan geared toward achieving a higher order goal (i.e., strategic). The if-then plan results in a perceptual preparedness for the critical situation and a behavioral readiness to engage in the planned behavior (i.e., automaticity). These propositions laid the groundwork for a huge research program successfully testing the heightened accessibility of the critical situation (e.g., Achtziger, Bayer, & Gollwitzer, 2012; Parks-Stamm, Gollwitzer, & Oettingen, 2007; Webb & Sheeran, 2004, Studies 2 and 3; Wieber & Sassenberg, 2006) and the link between situation and action (Aarts, & Dijksterhuis, 2000; Aarts, Dijksterhuis, & Midden, 1999; Adriaanse, Gollwitzer, de Ridder, de Wit, & Kroese, 2011; Bayer, Achtziger, Gollwitzer, & Moskowitz, 2009; Brandstätter, Lengfelder, & Gollwitzer, 2001; Gollwitzer & Brandstätter, 1997, Study 3; Papies, Aarts, & de Vries, 2009; Webb & Sheeran, 2007; Webb, Sheeran, & Luszczynska, 2009). Even more important are the numerous applied studies testing the effectiveness of implementation intentions in helping people to achieve their goals, as reviewed in meta-analyses on eating behavior (Adriaanse et al., 2011) and physical activity (Bélanger-Gravel, Godin, & Amireault, 2013). In the present chapter, we will focus on the second mechanism of if-then planning, that is, the link between the critical situation and the goal-directed behavior resulting in action initiation that features characteristics of automaticity (see Bargh, 1989; Shiffrin & Schneider, 1977): it is fast, efficient, and requires no additional *in situ* conscious intent. In the following section, we will present experimental evidence for this automaticity claim, focusing on evidence pertaining to overt behavior (for other reviews, including outcomes like emotion suppression or self-affirmation via implementation intentions, see Gollwitzer & Oettingen, 2011).

## Empirical Evidence for Strategic Automaticity

Previous overviews of the features of automaticity of if-then planned behavior have structured the research according to the three features of automaticity (immediacy, efficiency, and no additional *in situ* conscious intent; e.g., Gollwitzer & Oettingen, 2011). In line with the general theme of the present edited volume (i.e., human agency), in the following the evidence is organized by potential situational impediments for conscious action control. Some situations may be disadvantageous for conscious, on-line control of behavior because cognitive resources are deployed elsewhere, temptations undermine intended behavior, the required behavior is unpleasant, there are conflicting automatic processes, or critical aspects of the planning-to-action process are not consciously accessible. Finally, we will present evidence from cognitive neuroscience that complements the behavioral evidence that implementation intentions intentionally delegate control to the environment (i.e., strategically automate action control).

### COGNITIVE LOAD: WHEN RESOURCES ARE DEPLOYED ELSEWHERE

Deliberative action control requires cognitive capacity (e.g., Strack & Deutsch, 2004). Thus, the first evidence that if-then planned behavior is automatically initiated comes from research showing that the behavior is efficiently and effortlessly initiated, even when cognitive resources are deployed elsewhere. For example, Brandstätter et al. (2001, Studies 1 & 2) showed that implementation intentions improved the goal striving (i.e., writing a curriculum vitae) of psychiatric patients with low cognitive capacities as a result of acute opiate withdrawal symptoms or acute schizophrenic episodes (Studies 1 & 2). Under more controlled experimental settings (Study 3 & 4), the authors further demonstrated that the performance of university students under cognitive load improved when implementation intentions had been formed. More precisely, participants were asked to work on a dual-task paradigm. The difficulty of the primary task (to follow a target with the mouse cursor) was manipulated to be either difficult or easy. In the secondary task, participants were asked to respond as quickly as possible whenever numbers appeared on the screen, but to withhold their response whenever letters appeared. Half of the participants formed an implementation intention geared at speeding up their response to one critical number. Results showed that forming implementation intentions indeed sped up the responses to the critical cue compared to the non-critical cues (without compromising the responses to non-critical cues). Importantly, for participants with an implementation intention, this effect was independent of the task difficulty of the primary task, thus providing evidence for the prediction that if-then planned action initiation is effortlessness and efficient

in terms of required cognitive resources. As we will return to the notion of effort and if-then planning in regard to the sense of agency, it is important to note that, at this point, “effortlessness” does not necessarily refer to perceived effort. The effortlessness of if-then planned action initiation is deduced from the observation that it can operate successfully even under conditions of low cognitive resources.

### TEMPTATIONS AND THE INITIATION OF UNPLEASANT BEHAVIOR

A particularly difficult situation to exert control involves inhibiting unwanted behaviors that promise an immediate reward (i.e., temptations; Hofmann, Baumeister, Förster, & Vohs, 2012). However, implementation intentions have been shown to increase our ability to behave in line with our goal intentions instead of giving in to temptations. For example, Adriaanse et al. (2010; Study 1) investigated the behavior of women with the goal of reducing their unhealthy snack intake. After thinking about the positive effects of their health goal and reflecting on possible obstacles (i.e., mental contrasting; Oettingen, Pak, & Schnetter, 2001; Oettingen, 2012), they formulated a personally appropriate implementation intention to reduce unhealthy snacking. The results showed that the implementation intention group indeed consumed fewer calories within the following week compared to a control group having the same goal but no related implementation intention. Thus, implementation intentions helped to overcome the temptation of snacking in everyday situations.

Not initiating behaviors that promise an immediate reward is one thing, but what about initiating behaviors that are important but unpleasant? Work by Sheeran and Orbell (2000) showed that forming implementation intentions increased the percentage of women who attended a cervical cancer screening from 69% (control group) to 92% (implementation intention group). Thus, implementation intentions have the potential to initiate actions even against adverse affective states.

### CONFLICTING AUTOMATIC PROCESSES

Another way of demonstrating the automaticity features of if-then planned action initiation is by showing that they can down-regulate other automatic responses. Evidence for this ability comes from research on bottom-up triggered spatial congruency paradigms and research on implicit stereotyping.

#### *Location Congruency Effects*

A particularly impressive demonstration of how if-then planned behavior can influence automatic bottom-up responses is provided by Cohen, Bayer, Jaudas, and Gollwitzer (2006, Study 2). In this study, participants performed

a Simon task (Lu & Proctor, 1995) by responding with a left or right key press to a low or high tone, presented over headphones. The tone, however, was presented either to the left or right ear. This setup results in spatially congruent (tone that requires a left button press presented to the left ear) and incongruent (tone that requires a left button press presented to the right ear) trials. Although the presentation side of the tone is irrelevant to participants' classification responses, there is usually a very robust congruency effect; left responses to a tone presented to the left ear are faster than left responses to a tone presented to the right ear (Lu & Proctor, 1995). In the study by Cohen et al. (2006), participants were given an implementation intention instruction before the task for one of the incongruent situations (e.g., "If I hear a low tone on the right, then I will press the left button!"). For this specific situation and only for this situation, the response times decreased to the level of congruent trials. Thus, the if-then planned behavior was implemented so quickly that the influence of the low-level bottom-up location effect was reduced. In a later, more detailed, investigation on how pre-existing automatic biases and newly formed if-then plans interact, Miles and Proctor (2008) concluded that if-then plans do not necessarily replace pre-existing biases but that they are fast enough to match the automatic biases and thus influence resulting responses in an additive way.

### *Implicit Stereotypes*

In the person perception domain, stereotypes are assumed to be activated in an automatic fashion. This is important for social interactions, as it implies that conscious control over stereotype activation and application is problematic (e.g., Payne, 2001). However, in line with our argument that if-then planning implements automatic control, research has shown that implementation intentions can be effectively used to prevent stereotyping. Counteracting automatic stereotype activation via implementation intentions has been demonstrated by manipulating the mental representation of target categories (e.g., woman; Gollwitzer & Schaal, 1998). Gollwitzer and Schaal showed that if-then planning to ignore the gender of names resulted in less gender-related stereotype activation. In addition, more recent research has shown that implementation intentions can reduce the generally observed bias against African Americans in the so-called shooter paradigm (e.g., Mendoza, Gollwitzer, & Amodio, 2010; Stewart & Payne, 2008). In this paradigm, participants have to make rapid decisions on whether a target person is holding a weapon or a tool. Participants are supposed to "shoot" individuals with a gun and "not shoot" those with a tool. Research shows that the shooter paradigm leads to more erroneous "shots" of African Americans holding a tool compared to Caucasians holding a tool—presumably because of the stereotypic association

between “African American” and “aggressive.” Stewart and Payne (2008) manipulated the mental representation of the target category (“If I see a Black face, then I will think ‘safe!’”). This manipulation of the concept “African Americans” in the direction of reacting with “safe” rather than the stereotypic “aggressive” led to less erroneous “shots” of African Americans holding a tool. Mendoza et al. (2010) did not manipulate the representation of the target category but instead provided specific goal-directed responses (“If I see a person with a gun, then I will shoot!” and “If I see a person with an object, then I will *not* shoot!”). This second approach also decreased the response bias in that it resulted in less erroneous “shots” of African Americans holding a tool. Note that in general we think that specifying a “do not respond” in the then-part is problematic, as it may heighten the activation of the unintended response (Adriaanse et al., 2011). However, in this particular case, participants had to press one of two buttons labeled “Shoot” and “Don’t Shoot.” Thus, “do not shoot” did not refer to the negation of a response but to the facilitation of pressing the “Don’t Shoot” button.

#### **BYPASSING CONSCIOUS AWARENESS**

Finally, the most compelling demonstrations for the automatic nature of if-then planned action initiation comes from studies in which critical components of the planning-to-action process were not consciously accessible. For example, Sheeran, Webb, and Gollwitzer (2005) indirectly manipulated the superordinate goal for which a plan was created. Specifically, in Study 2, participants formed an implementation intention geared toward speeding up responses in the Matrix Reasoning Subset of the Wechsler Adult Intelligence Scale. In the task, participants are presented with an incomplete abstract picture, which they have to complete by choosing from a number of options. Before the matrix task, the goal to be fast was indirectly activated via a word puzzle task including words related to speed (e.g., “fast,” “haste,” and “rapid”; speed-goal activation condition) or words that were neutral regarding speed (e.g., “tone,” “lavish,” “urban,” “polar”; control condition). The results showed that the speed-related implementation intention was effective only if the speed goal was activated. If the superordinate speed goal was not in place, the implementation intention did not have any effect. As the participants were not explicitly aware of the activation (or non-activation) of the goal, it is unlikely that conscious processes modulated the effectiveness of the implementation intentions. We will return to the issue of why an overarching goal is important for the effectiveness of if-then planned behavior in the second section, when explicating the mechanisms of implementation intentions.

Undoubtedly, a further critical component of if-then planned action initiation is encountering the specified situation. If the action initiation is indeed



automatic (i.e., not requiring another *in situ* conscious intent), then the action should be triggered even when the situation is presented subliminally (i.e., below the threshold of conscious awareness). Bayer et al. (2009) provided evidence for this assumption in two experiments. In one study (Bayer et al., Study 1), the activation of behavior-related concepts through the subliminal presentation of the critical situation was investigated. Participants formed an implementation intention to complain about a rude experimenter. When this experimenter's face was presented subliminally in a word pronunciation task, concepts (e.g., rude, cheeky, conceited) instrumental to the behavior (i.e., complaining) were vocalized faster compared to control words. However, this facilitation was only observed for participants who had formed an implementation intention with the rude experimenter as a critical cue and complaining as the intended response—not for participants who simply held the goal to complain. Thus, this experiment provides evidence that the critical cue directly elicited the activation of concepts related to the intended behavior even outside conscious awareness.

In a second study, Bayer et al. (Study 2) provided more direct evidence that the intended behavior is elicited automatically (as compared to the related concepts activated in Study 1). Participants categorized angular and round forms (i.e., by pressing a left or right key, respectively). One angular form, a triangle, was included in an implementation intention that read: "If I see a triangle, then I will press the left key particularly fast!" In this categorization task, a subliminally presented prime shape preceded the target shape. Response times to the target shapes revealed a speed-up effect for categorizing angular shapes following a triangular prime compared to responses to round shapes and responses to angular shapes made after neutral primes (e.g., shapes not specified in the implementation intention). The authors argued that the subliminal prime activated the intended response, leading to a faster response if the to-be-performed response was congruent (e.g., left for triangles and other angular shapes). The results in both studies were observed only when participants formed an if-then plan prior to the task and not if the plan was formulated as a goal intention (including all critical information but not in an if-then format). Most important, as the critical cues were presented subliminally, the activation of behavior-related concepts (Study 1) and the initiation of the behavior itself (Study 2) could not have been due to conscious control.

#### FIRST NEUROSCIENTIFIC SUPPORT FOR STRATEGIC AUTOMATICITY

We will close this section with one final piece of evidence from cognitive neuroscience that supports the automaticity claim of implementation intention research using brain-imaging techniques. Gilbert, Gollwitzer, Cohen,

Oettingen, and Burgess (2009) compared goal-driven action initiation with implementation intention-driven action initiation. In line with evidence that activity at the lateral Brodmann area 10 (lateral BA 10) is associated with action initiation in a top-down fashion, whereas medial BA 10 activity is associated with more bottom-up driven behavior (reviewed by Burgess et al., 2008; West, 2008), Gilbert and colleagues found heightened activity in the lateral BA 10 for goal-driven behavior but heightened activity in the medial BA 10 for implementation intention-driven behavior. Thus, this evidence from cognitive neuroscience fits with the behavioral evidence and the assumptions underlying implementation intentions that if-then planning delegates a person's action control to situational cues.

## Summary

The presented overview of research highlights the notion of strategic automaticity implemented by if-then planning. Careful if-then planning of what to do in critical situations has been shown to be effective in initiating intended behavior in situations that challenge conscious control. We have provided evidence that implementation intentions are effective in situations in which cognitive resources are deployed elsewhere, temptations facilitate unintended behavior, the behavior to be initiated is unpleasant, there are conflicting automatic processes, and critical aspects of the planning-to-action process are not accessible to conscious awareness.

## FURTHER EXPLICATION OF IMPLEMENTATION INTENTION MECHANISMS

As shown in the empirical review above, implementation intentions are very simple plans with surprisingly strong effects. The principles proposed by Gollwitzer (1993, 1999), increased cue accessibility and automatic action initiation, provided a theory that instigated a lot of research testing both these process assumptions (summary by Gollwitzer & Oettingen, 2001), and the effectiveness of implementation intentions in various applied settings (reviewed by Adriaanse et al., 2011; Bélanger-Gravel et al., 2013; Gollwitzer & Sheeran, 2006). However, further analysis of the psychological mechanisms underlying the situation-behavior link seems warranted. How exactly is the verbal if-then plan translated into real action? What is the nature of the mental representation of the situation and the action created by if-then planning? And does the nature of the representation provide insights into why if-then planning is so effective? In this section, we will propose answers to these questions and further explicate mechanisms of if-then planned action initiation.

To set the stage, we will compare action control by implementation intentions to habitual action control. Both share certain characteristics: as with implementation intentions, habitual behavior is immediate, efficient, and can occur outside awareness (Aarts & Dijksterhuis, 2000; Verplanken & Aarts, 1999; Wood & Neal, 2007). However, habits are created differently from implementation intentions (e.g., Sheeran, Webb, & Gollwitzer, 2005). Habitual associations between situations and behaviors are created by the repeated co-occurrence of certain situations and executing certain responses. How can the similarities (in terms of action execution) between implementation intentions and habitual behavior be explained, when forming an implementation intention involves neither the actual perception of the situational cue, nor the execution of the real—repeatedly performed—action? Let us take a closer look at the following example of an implementation intention: “If I stand in front of the cafeteria shelf, then I will grab an apple!” Formulated under the umbrella of a corresponding superordinate goal (e.g., to eat more healthy food), this plan increases the likelihood of actually grabbing an apple when standing in front of the cafeteria shelf, compared to a mere goal intention (e.g., “I want to eat more apples!”). Basically, the two components of the plan, the if-part and the then-part, are only verbal descriptions of a situation (“cafeteria shelf”) and an action (“grab an apple”). Thus, the question that must be addressed is how verbal self-instructions can achieve what in habit formation is done through repeated co-occurrence of a real situation and a real action. Our answer is based on what we refer to as the *pattern-overlap principle*. We propose that planning effects (i.e., successful action initiation upon perception of the critical cue) are successful to the degree that the activation patterns at the time of planning and the necessary activity pattern to initiate the action upon encountering the critical cue overlap. This overlap includes similarity between the activation patterns in form (i.e., similarity between what one is thinking [i.e., simulating] and what one is encountering and intending to act) and location (i.e., what brain resources the mental representations draw on). We assume a specific planning event can be mapped to a certain point in a continuum of no overlap at all to a perfect overlap with the necessary activity to initiate the action. We expect that the formation of implementation intentions is an ideal form of planning that results in a comparatively high overlap because the specific form of the implementation intention activates important aspects (e.g., situation *and* action, respecting the causal order) that are not activated in more mundane plans. The components described in the next sub-section contribute to the activation pattern at the time of planning and action initiation.

## Five Components of (If-Then) Planned Action Execution

We propose four components that, when activated simultaneously, lead to the automatic initiation of the if-then planned behavior, and a fifth component overseeing the execution of the behavior. The first component (A) is the superordinate goal, which provides the context for the stimulus-response association. The second component (B) is the representation of the critical situation, which is the link and the trigger for the following two components: the direct priming of motor components (C) and the activation of the anticipated behavioral outcome (D), which together initiate the intended action either directly (motor priming) or by action-effect principles (anticipated outcome). The last component (E) includes processes that guide and adjust the behavior according to the current environment (e.g., location of target objects). We will address each component separately and outline how they may fulfill their function in the execution of (if-then) planned behavior.

### GOAL STATE

If-then plans are formed in the service of a superordinate goal. The goal provides the internal environment, or context, in which the action planning and execution take place. The active goal is one important feature contributing to the activity pattern that is necessary for the action initiation when the critical situation is encountered. If-then planned action initiation is thus conditional, that is, it depends on the unique context provided by the active goal (e.g., Sheeran et al., 2005). This unique context is shaped by different aspects, including goal commitment, as well as the desirability and feasibility of reaching the goal.

The conditional automaticity associated with if-then planning has analogies in other areas of psychology. For example, there is increasing evidence for conditional automaticity in attitude activation. Implicit attitude measures (assumed to measure automatic attitude activation) show that an African-American person in the context (i.e., environment) of a church automatically activates a different attitude than an African-American person in the context of a street corner (Dasgupta & Greenwald, 2001; Wittenbrink, Judd, & Park, 2001). As the environmental context (church vs. street corner) determines the automatic link between African-American faces and attitudes, we assume that a superordinate goal can similarly provide the (internal) environment for the automatic initiation of if-then planned behavior, creating context (i.e., goal-) dependent automaticity (Bargh, 1989). Thus, for implementation intentions to influence behavior (i.e., automatic action initiation), the same goal must be active when the critical situation is encountered as when the plan was formed. The active

goal contributes to the general state (internal environment) that leads to the automatic action initiation.

As detailed previously, implementation intention effects are seen only when a respective goal (i.e., speed) is activated and in line with the plan (Sheeran et al., 2005). This provides evidence for our assumption that implementation intentions offer a kind of goal-dependent automaticity, as well as support for the pattern-overlap principle as decreased similarity (presence vs. absence of goal) between the mental state at the time of planning and the time of cue perception eliminated implementation intention effects.

### PERCEPTUAL SIMULATION OF THE CRITICAL SITUATION (IF-PART)

With the superordinate goal active, the first step in forming an implementation intention is to anticipate an adequate situation and formulate this situation in the if-part of the plan. For example, with the goal of “eating more healthy food,” one could anticipate that a good opportunity to eat something healthy is the reoccurring confrontation with the cafeteria shelf in one’s university or company. Thus, one may specify: “If I stand in front of the cafeteria shelf . . .” The complexity of specifying an adequate situation is explained elsewhere (Gollwitzer, Wieber, Myers, & McCrea, 2010). Here we will concentrate on how a verbal formulation of a situation (e.g., in front of the cafeteria shelf) may be sufficient to provide a mental representation that is likely to be reactivated upon contact with the real situation, thereby triggering the processes that set the action in motion. To bridge the gap between language and perception (and subsequent action), recent theories of language comprehension (reviewed by Barsalou, 2003; Glenberg, 2007; Zwaan, 2004) provide intriguing insights that may advance our understanding of how a mental act can link a behavioral response to a situation.

In line with general simulation theories of cognition (Barsalou, 1999, 2008; Kiefer & Pulvermüller, 2012), recent theories of language comprehension assume that comprehending verbal content relies on the re-enactment of analog sensorimotor experiences (i.e., simulations; e.g., Glenberg & Kaschak, 2002; Glenberg & Robertson, 1999; Kaschak & Glenberg, 2000; Stanfield & Zwaan, 2001; Zwaan, Stanfield, & Yaxley, 2002). In contrast to traditional theories of mental representations as abstract symbols representing feature lists, semantic networks, and frames, simulation theories assume that a mental representation of an object is a re-enactment of sensorimotor experiences associated with the real object (Barsalou, 2003). Thus, reading verbal material activates simulations of the read content in both perceptual and motor areas. For example, reading about an “eagle in the sky” has been shown to activate a mental representation of an eagle with

outstretched wings, whereas reading about an “eagle in the nest” does not. Pure analyses based on syntax and semantics do not necessarily predict this differentiation—however, a model that includes re-enactments of prior perceptual experiences with these two situations certainly would (Stanfield & Zwaan, 2001; Zwaan et al., 2002). That these simulations indeed recruit perceptual brain areas is supported by neuroscientific research showing, for example, that reading words that refer to a smell (e.g., cinnamon) activate primary olfactory areas (González et al., 2006) and seeing food activates gustatory processing areas (Simmons, Martin, & Barsalou, 2005; see also the sub-section below on motor simulations).

What does this mean for the formation of the if-part of an implementation intention? The above-described research suggests that although a real situation and a verbal description of the same situation may intuitively seem different, what is going on in our brain may not be so different at all. The critical situation serves as a link and trigger for the action initiation. If reading about (or thinking about) the critical situation activates a perceptual simulation of the situation, this perceptual simulation should overlap with the perceptual activity triggered on contact with the real situation. Thus, instead of the need to assume questionable translation processes that map perceptual states to abstract mental representations and re-map these abstract representations to perceptual states (i.e., transduction and symbol grounding problem; Barsalou, 1999; Searle, 1980), the perceptual state of the critical situation itself becomes the link and trigger for the action initiation. This perspective can explain why no additional *in situ* conscious intent is necessary for the if-then planned action initiation (i.e., why conscious recognition of the situation is not necessary; Bayer et al., 2009). The efficiency of this account becomes evident when considering the various translation processes required by an explanation based on more traditional accounts of mental representations (e.g., one translation from verbal content to abstract representation during plan formation, another translation from perception to abstract representation on encountering the cue, and additional translation processes in the action component of the if-then plan).

### MOTOR SIMULATION (THEN-PART 1)

But how are actions cognitively represented in the then-part of implementation intentions? We propose two components that become linked to the critical situation that hand in hand lead to the initiation of the intended behavior: the priming of motor components (motor simulations) and the simulation of the anticipated behavioral outcome. As with the if-part, the then-part of an implementation intention is a verbal description, this time

of a behavior (e.g., “grab an apple”). Simulation theories of cognition are not limited to sensory perceptual simulations. Motor simulations also play an important role in understanding verbal descriptions of behavior (e.g., Glenberg & Kaschak, 2002; Zwaan & Taylor, 2006; cf. Jeannerod, 2001). William James (1890, vol. II, p. 526) nicely stated this idea: “Every representation of a movement awakens in some degree the actual movement which is its object.” Forming a verbal description of an action (as is the case in the then-part of an implementation intention) would thus to some degree activate the actual movement. This old idea finds empirical support in modern research. For example, participants in a study by Glenberg and Kaschak (2002) read sentences that included certain arm movements and reported whether the sentence made sense or not by button presses that required moving their arm away or toward their body. Response times were faster for button presses that matched the movement included in the respective sentence (e.g., a sentence about “closing a drawer” was associated with faster responses to buttons that required them to extend their arm away from the body). This supports the assumption that processing verbal material about a motor movement includes the enactment of analog motor simulations that overlap with the activity patterns associated with actually performing the movement. This view is also supported by neuroscience studies. For example, event-related fMRI measurements of brain activity in frontocentral motor regions showed partially overlapping activation patterns (according to the somatotopic organization of the area) when participants performed specific movements and passively read corresponding words (e.g., moving their foot and reading the word “kick”; Hauk, Johnsrude, & Pulvermüller, 2004; Pulvermüller, Hauk, Nikulin, & Ilmoniemi, 2005).

Similar to the arguments made above for the mental representation of the critical situation, the presented research suggests that processing verbal descriptions of a behavior activates analog simulations in brain areas also involved in actually performing the behavior. Thus, when forming an implementation intention, a perceptual simulation of the critical situation is activated and specific motor simulations (covert actions) that reflect specific components of the intended behavior may thus be linked to the perceptual if-part simulation. With the above plan to “grab an apple,” these components could include simulations of arm extension and adjustments of handgrip size to an ordinary apple. Thus, encountering the critical situation will pre-activate specific motor components and thereby directly prime the intended behavior. We propose that this motor priming constitutes another important component that leads eventually to the effective and effortless action initiation of implementation intentions.

### **SIMULATION OF ANTICIPATED BEHAVIORAL OUTCOME (THEN-PART 2)**

The motor component explained above may constitute an important function for very concretely formulated then-parts such as “then I will press the right button!” or “then I will grab an apple!” However, implementation intentions sometimes spell out rather abstract behaviors (e.g., Achtziger, Gollwitzer, & Sheeran, 2008, Study 2). Even in the case of “then I will grab an apple!” it is unlikely that the primed motor components sufficiently reflect the complexity of the behavior in varying situations. We propose that another component is important, namely the anticipation of the behavior outcome. Regardless of how abstractly the then-part of an implementation intention is formulated, it always implies a certain behavioral outcome, for example, holding an apple in one’s hand. (Note that by anticipated behavioral outcome, we mean the immediate behavioral outcome of the action specified in the then-part of the plan [e.g., holding the apple in one’s hand] and not the superordinate goal [“eat healthy”; but see Wieber, Sezer, & Gollwitzer, 2014, for implementation intentions including the superordinate goal attached to the then-component].) Do we represent these behavioral outcomes when forming the then-part of an implementation intention? If so, this anticipated outcome should also become associated with the critical situation. Simulation accounts of cognition (e.g., Barsalou, 1999) are dynamic, meaning that they also include temporal aspects (e.g., Decety, Jeannerod, & Prablanc, 1989; Frak, Paulignan, & Jeannerod, 2001) and outcomes of simulated actions (i.e., the anticipation assumption, Hesslow, 2002). Thus, processing the verbal description of “grabbing an apple” may not only be represented as a static concept (i.e., “grabbing” and “apple”) but also as the movement toward the apple, the adjustment of the handgrip (see the following sub-section), and also the outcome: the apple in one’s hand. Some research in the area of language comprehension indeed suggests that outcomes of actions are activated when processing verbal descriptions of behaviors (Horton & Rapp, 2003). From this evidence we deduce that when forming the then-part of an implementation intention, in addition to any implied low-level motor simulations, the mental representation includes a simulation of the anticipated behavioral outcome as well. This outcome simulation, by simple Hebbian mechanisms, is then also associated with the critical situation and may become re-enacted on encountering the situation.

But how does the anticipated behavior outcome contribute to the initiation of the intended action? Historical and recent theories of action control in fact state that actions are represented by their outcomes (Lotze, 1852; *ideo-motor principle*, James, 1890; *action-effect principle*, e.g., Hommel, 1993; Elsner & Hommel, 2001; Shin, Proctor, & Capaldi, 2010). After the contingency is learned that a certain action will result in a certain outcome, the activation of the outcome can initiate the respective action. Experimental evidence supports



these assumptions (reviewed by Prinz, 1997; see also Hommel, Chapter 14 of this volume). This action-effect principle may contribute to the effortless action initiation observed for implementation intentions. If the critical situation is encountered and the anticipated outcome representation is triggered, the activation of the outcome may trigger necessary actions to achieve the outcome. Thus, the action-effect principle provides an explanation of how even rather abstract then-parts of an implementation intention (which cannot be adequately represented by low-level motor simulations at the time of planning) are still able to automatically initiate the intended behavior. We assume that both the low-level motor simulations and the activation of the anticipated behavioral outcome complement each other in activating the intended action.

### ON-LINE GUIDANCE

The final of our five components of if-then planned action control is not directly concerned with the planning itself; however, it still must be considered. One cannot always anticipate each aspect of the critical situation. For instance, the location of the apples in the cafeteria shelf in relation to one's body will never be the same and cannot be perfectly anticipated during the planning phase. Fortunately, this is not necessary. The only requirement is that the critical situation is reasonably similar (i.e., there will be apples available). If the previously discussed components (motor simulations and anticipation of the behavioral outcome) successfully *initiate* the response, other processes achieve the guidance of the behavior to its completion. Action-perception comparisons seem to adjust action control to current environmental circumstances (e.g., Frith, Blakemore, & Wolpert, 2000). It has been shown that location changes of target objects are immediately corrected for, even if participants are unaware of the change (Castiello, Paulignan, & Jeannerod, 1991). Other research on so-called affordances (Grezes, Tucker, Armony, Ellis, & Passingham, 2003; Tucker & Ellis, 1998; reviewed by Ellis, 2009) demonstrates that the perception of objects leads to automatic adjustment of low-level motor aspects such as trajectory of hand movements, handgrip size, and hand orientation (Ellis & Tucker, 2000; Goodale, Pelisson, & Prablanc, 1986). Together, this research shows that planned behavior only needs to be initiated; the on-line control of the details are taken care of by our perceptual-motor system with its years of experience in guiding our body in the environment to produce intended outcomes.

### Summary

Plans are made to achieve a respective goal. Thus, while forming an implementation intention, the superordinate goal is activated. In the planning

phase, low-level motor simulations and the simulation of the intended outcome (then-part) are co-activated with (and thus linked to) the perceptual simulation of the critical situation (if-part). At the time of action initiation, the perceptual activity instigated on contact with the critical situation will reactivate the low-level motor simulations and the intended outcome and thereby prime the intended action. Thus, even the verbal formulation of an if-then plan co-activates and wires (Hebb, 1949) the necessary perceptual and motor circuits in the brain for an environmentally controlled action initiation. The proposed mechanisms provide starting points for further research. For example, the pattern-overlap principle can be used to predict the effectiveness of if-then planning (and planning efficiency in general) as it indicates how the critical situation and the intended action must be specified in line with variables such as the individual's experience level (in regard to the relevant action domain) or familiarity with the to-be-encountered environment.

## THE SENSE OF AGENCY IN IF-THEN PLANNED BEHAVIOR

The first two sections of this chapter were concerned with our perspective on objective agency, that is, how an agent is able to control his or her actions. Our answer is that one way of consciously controlling actions is by planning them in an if-then format. Now we will turn to the subjective aspect of agency. Feelings or judgments of being in control of one's behavior and certain aspects of the environment have motivational consequences by informing the agent about what he or she is capable of doing and influencing contingency judgments about what actions will bring about which outcomes (Heckhausen, 1989; Rotter, 1966). A self-regulation strategy should not undermine this feeling of control. Thus, in this last section of the chapter, we will discuss processes that may be important in creating a feeling and judgment of agency in regard to the strategic automaticity of if-then planned actions.

### Self-Efficacy versus Sense of Agency

Before discussing the sense of agency, we need to distinguish it from a prominent concept in the realm of motivation psychology: self-efficacy (Bandura, 1982; Schunk & Pajares, 2009). Before one executes an action and has a sense of having caused the action (i.e., sense of agency), people have a belief about how well they are able to execute certain actions to deal with upcoming challenges. These self-efficacy beliefs have been shown to affect choices of activities, effort expended, persistence, interest, and achievement (Bandura, 1977; Bandura & Schunk, 1981; Pajares, 1996, 1997; Schunk, 1995).

Planning the necessary actions to achieve a certain goal (i.e., if-then planning) could increase self-efficacy and thus goal attainment by the mere confidence gained through the specification of the necessary steps. However, we expect that the cognitive processes described in the previous section of this chapter are responsible for if-then planning effects, rather than factors that influence motivation such as self-efficacy. The results of a meta-analysis (Webb & Sheeran, 2008, Study 1) are in line with this argument concerning self-efficacy. Self-efficacy alone could not explain the effects of if-then planning on goal attainment, and the analyses indicated that if-then planning effects are mostly *not* driven by factors that influence motivation (e.g., self-efficacy). However, it may very well be that successful goal attainment (as a consequence of if-then planning) does increase self-efficacy beliefs. This, however, concerns the effects of successful goal striving (with or without implementation intentions) on subsequent goal striving and is a separate question from whether self-efficacy is responsible for planning effects.

In contrast to the anticipatory belief that one is able to execute certain actions to deal with a future situation (self-efficacy), the sense of agency has been defined as “the sense that I am the one who is causing or generating an action” (Gallagher, 2000). Something that complicates the analysis of agency experience is that we seldom have an intense feeling of being the agent of an action, but we certainly feel or become aware of failures of agency (cf. Chambon & Haggard, 2013). This aspect is interesting from a self-regulation perspective. When knowledge (e.g., chocolate muffins contain many unhealthy ingredients) in combination with a specific behavior (e.g., *I am eating a chocolate muffin every afternoon*) is in conflict with certain goals (e.g., eating healthy food), we are likely to become aware of this action and our potential role in this behavior. This may get us started with attempts to self-regulate our behavior. The result of this self-regulation effort (i.e., reflecting about what I will buy in the cafeteria the next time) is probably also under heightened scrutiny. Thus, self-regulation processes may highlight certain aspects of the sense of agency, and if self-regulation is effortful, this feeling of effort may itself increase to the sense of agency for behaviors related to the self-regulation process (Demanet, Muhle-Karbe, Lynn, Blotenberg, & Brass, 2013). Provided that the underlying goals for a plan do not change, self-regulation (by if-then planning) can have two outcomes: either the planned (intended) behavior is successfully initiated, or the planned behavior is not initiated and some other, unintended behavior is executed. We will now discuss if-then planning and the sense of agency with the following two questions in mind. First, are there reasons to believe that the strategic automaticity implemented by if-then planning undermines the sense of agency for the planned behaviors? Second, what might the differences be between

intended actions (successful self-regulation) and unintended actions (failed self-regulation) concerning the sense of agency?

### Anticipation-Outcome Comparisons

There are multiple processes contributing to the phenomenological experience of being the agent of one's actions (Gallagher, 2012). The major source of agency information seems to be derived from comparison processes between anticipated behavioral outcomes and sensory feedback from actual behavioral outcomes. In general, mismatches (beyond a certain tolerance) between anticipation and actual outcome decrease the sense of agency (for a critical review, see Synofzik, Vosgerau, & Newen, 2008; see also Synofzik, Chapter 13 of this volume). The anticipation component of this comparison can have different sources that we will discuss in the following.

#### LOW-LEVEL FORWARD SIMULATIONS

Motor signals from the brain are assumed to feed into a simulation mechanism that allows predictions of the signal's consequences (and thus corrections) even before actual perceptual feedback is available (Frith et al., 2000). This means that when we initiate an action, signals from the brain are not only sent to the involved muscles, but a simulation mechanism is triggered that simulates the consequences of these motor signals and helps us to constantly monitor the success of our movement. Experiments with self versus externally induced movements indicate that these motor signals and presumably the forward simulation are an important contributor to the sense of agency (Engbert, Wohlschlaeger, & Haggard, 2008; Moore, Wegner, & Haggard, 2009; Sato, 2009). As both successful and unsuccessful if-then planned behaviors are initiated by the organism (and not an external force), they are of course also based on motor signals from the brain. The information that contributes to one's sense of agency should be present, just as it is present for non-planned voluntary actions. Thus, regarding this specific component, there is no reason to assume that the sense of agency is impaired or otherwise affected for successfully implemented if-then planned actions.

#### MENTAL REPRESENTATION OF ACTION CONSEQUENCES

Voluntary action is usually preceded by an intention that includes information about the action outcome. This (conscious or subconscious) mental representation of the outcome prior to the action is assumed to be a second contributor to the sense of agency. Experiments demonstrated that both supraliminal and subliminal priming of such representations prior to an action increase explicit judgments of agency (Aarts, Custers, & Wegner, 2005), as well as

implicit measures of the sense of agency (e.g., Haggard, Clark, & Kalogeras, 2002; Moore, Wegner, & Haggard, 2009).

We proposed that at least two processes are directly involved in the initiation of if-then planned behaviors (see sub-section above): direct motor priming (i.e., action initiation by direct cue-behavior associations) and priming of the intended behavioral outcome (i.e., action initiation by action-effect principles). We thus assume that both processes will contribute to the action initiation, and the complexity of the intended behavior will influence which process contributes more. The greater the contribution of cue-initiated motor components, the less may the action initiation dependent on the action-effect principle (cue-initiated activation of the intended outcome). Thus, as there is not necessarily the need for another *in situ* conscious intention, regarding this specific component, a decrease in the sense of agency may be expected. This decrease could probably be moderated by the degree to which the action is indeed initiated without another *in situ* conscious intention. Note that the argument that implementation intention-initiated actions do not *need* another *in situ* conscious intention does not mean that this conscious intention is *necessarily* always absent.

For unintended behaviors—where “unintended” refers to the undesired behavior that started the self-regulation process (in our example, eating chocolate muffins)—the case is more complicated. We will focus on two reasons that the if-then planned behavior may have failed. If the unintended behavior was executed with “no thought,” that is, purely habitually, there may not have been a mental representation of the action outcome prior to the action (see Wood & Neal, 2007, for a purely cue-motor response account of habits; but see Aarts & Dijksterhuis, 2000, for a habit view that involves goals and thus representations of behavioral outcomes). Thus, this component may not contribute to a sense of agency for failed self-regulation behaviors, behaviors that failed because of pure habit: the person who just grabbed the chocolate muffin out of pure habit (i.e., without an explicit conscious intention) and in light of having explicitly planned to grab an apple may be left with the feeling that this action was not initiated by the self.

However, the sense of agency regarding the action of grabbing the chocolate muffin may be different if the initially unintended action was not habitually initiated, but was undertaken because one could not resist the temptation. An all-too-vivid representation of the behavioral consequences (e.g., the delicious taste of the chocolate muffin) may override the initial intention to grab the apple and make one reach out for the chocolate muffin. Thus, in this case, a mental representation of the behavioral outcome is present and could make the initially unintended behavior seem intended, as the actor is aware of the desire for the chocolate muffin. This brings us directly to the final aspect, a reconstruction of agency after the action is executed.

## HINDSIGHT RECONSTRUCTION AND INTEGRATION INTO HIGHER ORDER GOALS

The construction of a sense of agency in hindsight (e.g., Wegner & Wheatley, 1999; reflective judgment of agency; Synofzik et al., 2008; higher-order sense of agency; Gallagher, 2012) is an attributional process that interprets the perceived action and its consequences in light of one's beliefs and goals. The very nature of if-then planning is to find responses that are not only in line with one's current goals but that explicitly facilitate these goals. Thus, after executing the planned action, one is usually very aware of the planning episode in which he or she explicitly planned to do the action in the specified situation because of its anticipated positive effect on a currently important goal. In this sense, there is no reason to believe that if-then planning should impair this attributional process—if anything, the explicit planning may increase the likelihood that the successfully implemented action is attributed to the self.

In the case of undesired behaviors, one actually did not initiate the planned behavior (e.g., grab an apple) that was supposed to facilitate one's goal (e.g., eat healthily). This apparent mismatch may decrease the sense of agency and, importantly, could be a signal for the agent that one's goal achievement is threatened. It may thus emphasize the need to put more thought into a more effective new plan (e.g., to buy an apple on the way to work to avoid the troublesome situation of the cafeteria). However, that may be an overly optimistic assumption. Unfortunately (in this case), humans' ability for attributions is very flexible. There are many attributions possible that allow one to avoid admitting to failure, from thinking that today was a special day to totally questioning one's health goals because of the observation of one's own behavior (cf. Bem, 1972). This highlights an important aspect of the process of behavioral change. Action plans in the form of if-then plans are one important part of behavior regulation. However, dealing with possible failures may be another important aspect that should not be neglected. Maybe effective behavioral change needs at least one action plan (to initiate the intended behavior) and one backup plan that specifies how to deal with a possible failure (e.g., prioritizing one's goals or not making self-serving attributions).

## Summary

Positive comparisons between anticipated behavioral outcomes and sensory feedback from actual behavioral outcomes seem to provide us with a sense of agency. The sources of the anticipated outcome can vary from very low-level forward simulations of motor signals to conscious or subconscious mental representations of the intended outcome to very high-level attributions of action outcomes based on one's general belief system. On the lowest level, namely the

forward simulations of motor signals, we do not expect differences between non-planned and if-then planning-initiated actions for the sense of agency, as the same low-level mechanisms are at work in both cases. At the medium level, conscious or subconscious mental representations of action outcomes, non-planned and if-then planned actions may indeed vary in their sense of agency. As if-then planned action initiation is expected to rely to a significant degree on direct motor priming—reducing the need for an explicit mental representation of the action outcome—we expect the sense of agency to be reduced compared to non-planned voluntary actions that rely on the mental representation of the action outcome. On the highest level, however, this may switch, and if-then planned actions may lead to a stronger sense of agency. As planning is usually a conscious process with attention devoted to one's goals and actions to achieve the goal, having performed such a planned action will very likely result in self-serving attributions of being in control. Thus a higher sense of agency will emerge compared to a non-planned voluntary action that had no planning history.

Given these differences in medium- and high-level factors that contribute to the sense of agency, the interesting question arises of whether the differences may be captured by different measures of the sense of agency. Whereas more low-level measures (i.e., implicit measures) may capture a decrease in the sense of agency for if-then planned actions, higher-level measures (e.g., explicit judgments) may not differ, or we may even find a stronger sense of agency for if-then planned actions.

Finally, perceived effort has been shown to contribute to the sense of agency (Demanet et al., 2013). If-then planned action initiation has been shown to be effortless (i.e., in the sense of operating even with cognitive load). Thus, aside from the predictions made from the comparative models discussed earlier, if-then planned actions should lead to a lower sense of agency compared to non-planned voluntary actions. An interesting question would then be how the feeling of effort interacts with the information from the comparative models and on what level (implicit or explicit) the effort information influences the implicit or explicit judgment.

## CONCLUSION

In the present chapter, we have discussed the question of objective and subjective agency from a self-regulation perspective. We have outlined that implementation intentions have been a fruitful area of research, as they provide a strategy for humans to regulate their behavior according to their own goals. In the first section of our chapter, we provided an overview of empirical research supporting the idea that by using implementation intentions one

can strategically automate one's future actions. We provided evidence that the actual action initiation is fast, efficient, and does not require another *in situ* conscious intent. This conscious, intentional planning and the subsequent automatic action initiation are what we refer to as strategic automaticity.

In the second section of the chapter, we focused on the processes that may underlie if-then planned action initiation by integrating new developments in research on action control and language comprehension into implementation intention theory. We proposed five components relevant to the translation of verbal self-instructions into action. The superordinate goal provides the context in which the link between the critical situation and action is active. Furthermore, we proposed that this link is represented by sensorimotor simulation processes, connecting perceptual simulations of the if-part to motor simulations and simulations of the anticipated behavioral outcome of the then-part. Finally, automatic processes of on-line guidance oversee the execution of the initiated intended action. The theoretical explication of these processes provides a rich basis for future research on planning and action control in general, and on how to maximize the effectiveness of if-then planning in particular.

In the third section we evaluated what the consequences of our notion of strategic automaticity might be for the sense of agency regarding if-then planned actions. Our preliminary conclusion is that if-then planning does not in general impair the sense of agency. However, different factors contributing to the sense of agency may be affected differently with the consequence that different measures of the sense of agency are affected differently. These propositions are empirically unexplored, but their investigation seems necessary to arrive at a full understanding of self-regulation by if-then planning.

To conclude, even after roughly 20 years of research on if-then planning, there are important grounds still to be explored. In the current chapter we focused on objective agency by further explicating the mechanisms of action control by if-then planning and its relation to one's subjective sense of agency. The scope of research to be investigated in regard to self-regulation via if-then planning is enormous in our eyes because if-then plans may not simply be one self-regulation strategy, but (verbal) thinking in if-then formats about future situations and actions may be a fundamental mechanism of human action control (i.e., not solely as they are used strategically but as they occur in our natural thinking about the future). In that sense, we have focused on implementation intentions as an ideal type of planning. The delineated mechanisms may not only become fruitful in the ultimate endeavor of psychological research—the prediction of behavior—but the notion of strategic automaticity may also provide insights into the more



basic philosophical questions of how it is possible that immaterial thoughts can propel our physical bodies.

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