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THESIS

Plan What To Do or How To Do It:

The Influence of Abstract and Concrete Planning on the Sense of Agency

Astrid van der Gun, 3669742

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Supervised by:

Tom Damen

Utrecht University

Second assessor:

Robert Renes

Utrecht University

Abstract

The sense that you are the agent of your actions and the sensory consequences, coined as the sense of agency, has received considerable research attention and has been connected to intentions and goals. However, the influence of planning on agency has not been investigated extensively and the present research is the first to compare the influence of concrete, action focused planning with abstract, outcome focused planning on the sense of agency. In two studies, participants were required to plan in abstract or concrete manners or not plan their actions ahead and subsequently their sense of agency was measured explicitly and implicitly. Mixed results were obtained: in the first study a positive influence of planning on the sense of agency was found, while the second study showed a negative influence of planning on agency for longer time delays. No difference between abstract and concrete planning was found in both studies. It was discussed that this was due to the methodology rather than a lack of conceptual difference between these types of planning. Possible moderators were discussed and the suggestion was made that the first study primed abstract planning on the whole, while the second study primed concrete planning on the whole. Though from the current investigation many questions remained unanswered, it is clear planning influences the sense of agency. The present work may function as a framework for future research on the influence of abstract and concrete planning on the sense of agency.

Plan What To Do or How To Do It:

The Influence of Abstract and Concrete Planning on the Sense of Agency

Imagine you click the 'on' button of the remote control of the television. You probably expect the tv to turn on, as you performed the necessary actions required. If it does turns on, you know it happened because of the action you performed. The sense that you are the agent of your own actions and their sensory consequences, coined as the sense of agency (Haggard and Tsakiris, 2009), is an important aspect of self-consciousness and seems natural and given to most of us. According to Wegner and Sparrow (2004) the sense of agency depends on the integration of agency cues from different sources and as natural as agency seems, it is not always flawless. If your neighbor was outside with a remote control and turned on your tv the moment you pressed the button on your remote control, you may falsely believe you caused the tv to turn on and experience a so called illusion of agency (Dannenberg, Förster, & Jostman, 2012). Likewise, if suddenly the radio turns on the moment you press the button because you accidently used that remote, you may falsely experience no agency over that action. The sense of agency can be influenced by different factors (Wegner, 2003) and one of the factors that has been found to influence agency is planning (Damen, van Baaren, Brass, & Dijksterhuis, 2012). However, different ways of planning exist and research has shown that different types of planning can influence behavior in distinct ways (e.g.: Emmons, 1992; Holland, Aarts, & Langendam, 2006; Gollwitzer, 1999; Koole & Van 't Spijker, 2000; Lally & Gardner, 2013). Thus, this research will be focused on how different ways of planning, abstract and concrete, can influence the sense of agency.

The sense of agency has been explained in two main ways. First, a model was proposed in which agency arises when the actual and predicted sensory outcomes cohere. Wolpert, Gahrahmani and Jordan (1995) found empirical evidence for the existence of what they called an internal forward model of motor control, which predicts the next stage of a natural process

based on the current state and motor command. The sense of agency would arise after a comparison of predicted and actual sensory outcomes has been made (Chambon, Sidarus, & Haggard, 2014). When you are about to open a door, the weight of the door and the amount of effort needed to open it is predicted by your motor system and if this prediction matches the reality a sense of agency will arise. This view has received considerable empirical support (e.g. Balslev, Cole, & Chris Miall, 2007; Blakemore, Wolpert, & Frith, 2002; Frith, Blakemore, & Wolpert, 2000; Sato & Yasuda, 2005).

Later, it was discovered agency could additionally be inferred based on cognitions prior to action (Wegner, 2002). If you decide you want to open the door, a sense of agency will arise if you end up with an opened door. Cognitive representations of outcomes that are available prior to action are compared to the outcome of the action and a match leads to the sense of self-agency. Wegner (2002, 2003) proposed three principles for the sense of agency to be strongest: the principles of exclusivity, priority and consistency. The sense of agency is strongest when the cause of the outcome is exclusive, when prior thoughts about the outcome exist and when these prior thoughts match the actual outcome. Cognitive representations of expected outcomes can be based on intentions and goals one has formed (Blakemore, Wolpert, & Frith, 2002,) but these representations could further arise unconsciously by priming (e.g. Moore, Wegner, & Haggard, 2009; Ruys, & Aarts, 2011; Van der Weiden, Ruys, & Aarts, 2012).

Currently, most researchers agree the sense of agency is based on a combination of sensorimotor cues and cognitive cues (e.g. Aarts, 2007; Barlas & Obhi, 2013; Desantis, Roussel, & Waszak, 2011; Knoblich & Repp, 2009; Moore et al., 2009; Synofzik, Vosgerau, & Voss, 2013; Van der Weiden, Aarts, & Ruys, 2013; Wenke, Fleming, & Haggard, 2010) and both the cognitive and the motor control approach emphasize the role of predictions, intentions and goals in determining the sense of agency. Thus, many researchers have focused

on the importance of intentions and goals for the sense of agency to arise (e.g. Blakemore et al., 2002; Brass & Haggard, 2008; Gallagher, 2012; Haggard, 2005; Van der Weiden, Ruys, & Aarts, 2012; Wegner, 2002). A number of other factors were found to influence the sense of agency as well. Greater working memory load has been found to negatively affect agency ratings (Hon, Poh, & Soon, 2013), while primed knowledge of success was found to positively affect the sense of agency in the absence of outcome information (Aarts, 2007) and a greater amount of action alternatives to choose from has also been linked to a higher sense of agency (Barlas & Obhi, 2013).

Little research has been dedicated to investigate the influence of planning on the sense of agency. This is interesting considering the well reported influence of outcome compatible intentions and goals on agency. As the inferential cognitive approach states that prior thoughts about actions heightens the sense of agency (Wegner, 2002) and empirical evidence shows agency increases when expected and actual outcomes are compatible and goals are achieved (e.g. Blakemore et al., 2002; Sato & Yasuda, 2005; Van der Weiden et al., 2012), one might expect the sense of agency to increase when an action was planned ahead. However, Damen et al. (in press) found the opposite effect in their line of studies. When participants were asked to plan ahead which key they wanted to press to produce a tone, their sense of agency for that tone was lowered compared to when they did not plan ahead their action. According to the authors, this surprising effect might be due to the temporal separation of the planning and the action. Conscious deliberation on the action was already done during planning and thus may no longer be present at the time of the actual action, explaining why a lowered sense of agency could arise when the action was planned ahead. The sense of agency might have been connected to the moment of planning and thus the acting upon the plan may be more automatic, leading to a lower sense of agency.

Nevertheless, different types of planning may influence the sense of agency in different ways. In the research by Damen et al. (2012) participants were asked to plan in a concrete, action focused manner. They were asked to plan ahead which button they were going to press. A distinction between behaviors represented on a higher, outcome focused level of abstraction and behaviors represented on a lower, action focused level of abstraction has been reported by several researchers (e.g. Freitas, Gollwitzer, & Trope, 2004; Koole & Van ‘t Spijker, 2000; Trope & Liberman, 2003; Vallacher & Wegner, 1987).

Implementation intentions are an example of concrete, action focused planning as they link action plans to specific situations. Implementation intentions are known to predict actual behavior more consistently than normal action plans (e.g. Holland, Aarts, & Langendam, 2006; Gollwitzer, 1999; Koole & Van ‘t Spijker, 2000; Lally & Gardner, 2013) and to make the execution of behavior effortless and automatic (Aarts & Dijksterhuis, 2000; Koole & Van ‘t Spijker, 2000). Van der Weiden, Aarts, and Ruys (2010) discuss that concrete, action focused behavioral representations may lead to the under-attribution of agency and Dannenberg, Förster and Jostmann (2012) found that people are less prone to the illusionary experience of agency when they hold concrete goals and are focused on *how* to attain a goal. All together, concrete planning might lead to a lower sense of agency.

However, abstract, effect focused plans have shown to affect behavior differently. For example, compared to implementation intentions, action plans make behavior less automatic and more effortful (Aarts & Dijksterhuis, 2000; Holland, Aarts, & Langendam, 2006). The effect of abstract planning on the sense of agency might also be different from concrete planning. Van der Weiden, Aarts, and Ruys (2010) state that abstract, outcome focused representations are linked to a heightened sense of agency and Dannenberg, Förster and Jostman (2012) found that people are more likely to experience an illusion of agency when goals are more abstract and people are thus more focused on goal outcome.

Taken together, these studies suggest that thinking about outcomes before an action might lead to a higher sense of agency (Dannenberg et al., 2012; Van der Weiden et al., 2010), while prior thoughts about the action itself might lead to a lower sense of agency (Damen et al., 2012). However, this difference has never been investigated in one research paradigm before and thus, it remains unclear if these effects are due to some conceptual difference between concrete and abstract planning or to the difference in research paradigm. In the current work, the influence of abstract and concrete planning on the explicit (study 1) and implicit sense of agency (study 2) will be investigated. It is hypothesized that abstract planning will increase the reported sense of agency for participants, while concrete planning will decrease the sense of agency compared to not planning ahead the action at all.

Study 1

Study 1 was designed to investigate whether making people either plan in a more abstract, outcome focused form or in a more concrete, action focused form would influence their reported sense of agency in a way that differs from when they do not plan their actions ahead. Participants were required to either plan their action (pressing a specific key to score a goal) in a concrete way (pressing a key) or plan in an abstract way (scoring a goal) in trials of the experiment and every participant also made decisions without planning ahead of time. Subsequently, their sense of agency was measured. Earlier research showed a negative influence of concrete planning on the sense of agency (Damen, et al., 2012). However, as research also shows there is a large difference between concrete and abstract planning (Emmons, 1992; Freitas, Gollwitzer, & Trope, 2004), it is worthy to investigate whether the influence of concrete and abstract planning on the feeling of agency also works in different manners.

For this study, it was expected that there would be a difference in the sense of agency for participants who planned ahead their action in concrete or abstract ways in comparison to

participants who did not plan ahead their action. Specifically, it was expected that participants would report a lower feeling of agency when they planned ahead their action in a more concrete, process focused fashion than in a control condition (in accordance with Damen et al., 2012). However, following the study of Dannenberg, Förster and Jorstman (2012), it was hypothesized that participants would report a higher feeling of agency when they were asked to plan their action in a more abstract, outcome focused manner. It was also expected that participants would report a higher feeling of agency in trials wherein the time delay was shorter than in trials wherein the time delay was longer, because of the well reported effect of time delay on the feeling of agency (e.g.: Damen et al,. 2012; Farrer, Valentin, & Hupé, 2013; Knoblich, & Sebanz, 2005).

Methods

Participants. A total of 67 participants took part in the first study on the Utrecht University campus in exchange for course credit or a candy bar. The mean age of the participants was 21.95 years (*SD* = 3.53). 13 males and 47 females took part. 7 of the participants did not make their gender known.

Materials.

Explicit Agency Task. An explicit agency task was designed specifically for this study. The task was a computer-task wherein participants were shown three goals underneath each other on the left side of the screen and a pivot animator with a ball on the right side of the screen. The goals had different colors and in the goals there was written: Q, A or Z. To the left of the goals the words “team blue”, “team red” and “team green” were displayed, which corresponded to the color of the goals (see figure 1). Pressing one of three keys (Q, A or Z) on the keyboard would lead to the ball being kicked in one of the three goals on

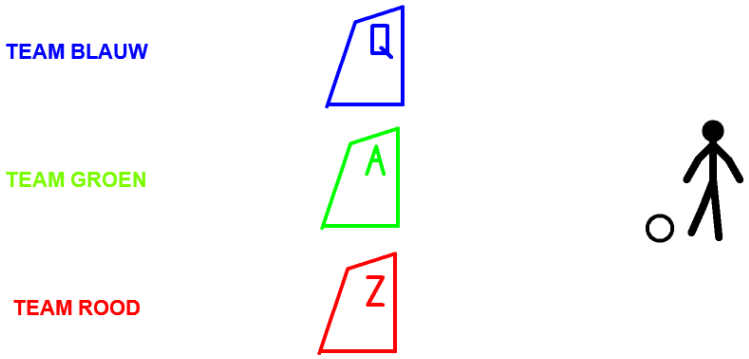

Figure 1. Still screen of the explicit agency task.

the computer screen in each experimental trial. Alongside 60 experimental trials, 10m filler trials were built into the design to increase agency ambiguity (Damen et al., 2012). In these trials, the ball would never move into the goal that corresponded with the key the participant had pressed.

Participants performed several practice trials before they could progress to the main task. In half of all trials, participants had to plan ahead their action and in the other half they were asked to only decide right before the action. Half of the participants were randomly assigned to the concrete condition and the other half to the abstract condition. Participants in the concrete condition were asked to decide (ahead or not) which key they wanted to press: Q, A, or Z. In the abstract condition, participants were told every goal was matched to a team and that team would receive points for scoring in their goal (different than in soccer). They were then asked to decide (ahead or not) in which goal they wanted to score. All participants were told that the movement of the ball could be either caused by themselves or by the computer and in all conditions participants were able to press the chosen key only after a timer counted from three to zero. When participants had to plan ahead their action, the instructions to make their decision ahead of time was presented 5000 ms before the timer. This was their planning time. When participants did not have to plan ahead their action, this instruction was omitted.

Participants who failed to give a response after the timer reached zero were shown an error message and instructed to press the key when the timer reaches zero next time. After each trial participants had to indicate on a slider scale of 1 to 100 to what extent they felt they (and not the computer) had kicked the ball into the goal. Three participants were removed from analyses, because their scores on this measure deviated abnormally and consistently from the mean. Because of the known effect of time delay on the feeling of agency, the time interval between the pressing of the key and the movement of the ball was varied over trials to make the situation ambiguous (100 ms vs. 500 ms vs. 900 ms evenly divided over trials; see Sato & Yasuda, 2005).

Questionnaires. Following the explicit agency task, participants were asked to fill out the Behavior Identification Form from Vallacher and Wegner (1989). This form was used to measure individual differences in the degree to which individuals represent their actions on a concrete or abstract level and consisted of 25 dilemma's wherein participants were asked to choose between 2 options to describe a certain action (e.g.: *Reading: A. Following lines of print* (= more concrete) *vs. B. Gaining knowledge* (= more abstract)). Analyzing participants' responses on this scale, the Cronbach's alfa was mediocre, α = .68, M = 12.36, SD = 4.01.

After completing this form, participants were lastly asked to complete the Rotter Internal-External Locus of Control Scale (1966) to control for broad individual differences in the degree to which individuals believe they can or cannot control events happening to them, as this may influence agency. This scale consisted of 29 forced choice paradigms wherein participants had to choose between a more external or a more internal interpretation (e.g.: *A. Many of the unhappy things in people's lives are partly due to bad luck* (= external locus of control) *vs. B.People's misfortunes result from the mistakes they make* (= internal locus of control)). Cronbach's alfa for this scale indicated that a single dimension was being measured, α = .72, M = 14.55, SD = 4.31.

Procedure. Testing took place in the laboratories of the Utrecht University. Participants were led to a lab room where they were seated in front of a computer. They were told that the subject of the study was the feeling of control and were informed about the option of withdrawal from participation at any point during the study. No reference was made to the hypothesized influence of planning. They were then given computerized instructions about what the task would look like and they received instructions that the aim of the task was to score in one of the goals on the computer screen. After this instruction, participants could start the explicit agency task.

Lastly, participants were asked to fill out the Behavior Indentification Form (Vallacher & Wegner, 1989) and the Rotter Internal-External Locus of Control Scale (1966). The Behavior Identification Form was used to control for possible individual differences in the feeling of agency and the Rotter Internal-External Locus of Control Scale (1966) to control for broad individual differences in locus of control that may influence the feeling of agency.

Results

Main analysis. A 2 (planning type: abstract vs. concrete) x 3 (time delay: 100 ms vs. 500 ms vs. 900 ms) x 2 (plan presence: plan vs. no plan) repeated measures ANOVA was used to test the difference in agency scores among the different conditions.

Histograms and Shapiro-Wilk statistics indicated that the assumption of normality was violated and Mauchly's test of Sphericity showed that for time delay the assumption of sphericity was violated as well, $W = .64$, $p < .001$. The Huyn-Feldt Epsilon will accordingly be used when reading the analysis for time delay. F_{max} demonstrated that the homogeneity of variance assumption had not been violated.[1]

[1] In an attempt to correct for the non-normality of the data set, transformations and non-parametic tests were carried out. Despite transformations, the distribution of data did not change signifantly. Moreover, non-parametic tests did not change the results significantly. Hence, results of a normal ANOVA test are reported.

The ANOVA results showed a significant main effect for planning presence, F (1, 65) = 5.66, p = .02, partial η^2 = .08. When people had to plan their decision ahead, they reported a higher sense of agency (M = 81.99, SD = 1.82) than when they did not plan ahead their decision (M = 80.31, SD = 1.82). Additionally, a main effect for time delay occurred, F (1.52, 98.88) = 15.25, p < .001, partial η^2 = .19. As expected, agency ratings were higher on trials with a short time interval between clicking and the movement of the ball than on trials with a longer time interval (M_{100ms} = 83.30, SD = 1.64; M_{500ms} = 81.56, SD = 1.74; M_{900ms} = 78.59, SD = 1.98). Contrary to expectations, no main effect of planning type was found (F (1, 65) = 0.13, p = .720) and no significant interactions were found, F's < 1, n.s.

Reaction times. A 2 (planning type: abstract vs. concrete) x 3 (time delay: 100 ms vs. 500 ms vs. 900 ms) x 2 (plan presence: plan vs. no plan) repeated measures ANOVA on reaction times showed a significant main effect of planning presence, F(1,65) = 152.51, p < .001, partial η^2 = .70. Participants performed the action faster when they planned it ahead (M = 358.44, SD = 12.32) than when they did not plan ahead the action (M = 640.33, SD = 26.17).

Exploratory Covariates. To check the assumption that locus of control as measured by the Locus of Control of Behavior Scale and behavior identification as measured by the Behavior Identification Form would not have a significant influence on the feeling of agency, they were added as covariates in the design. As no significant influence of these factors was found, results were reported leaving out these covariates.

Discussion

The findings of the first study raise questions about the exact influence of planning on the sense of agency. No difference between concrete planning and abstract planning in the explicit agency task was found, but participants reported a higher sense of agency when they formed a prior plan compared to when they did not plan. No predictions were made about the

influence of planning as opposed to not planning. However, as Damen et al. (2012) found that concrete planning influences the sense of agency negatively, the current results are nonetheless quite surprising. The unexpected results could have been caused by the methodological differences between the current study and the study of Damen et al. (2012). In this study a new, more elaborate task was used to make differentiating between concrete planning and abstract planning possible. At the same time, the design of this explicit agency task had not been tested before and might have confounded the results in several ways.

First, the lack of significant effects for the difference between abstract and concrete planning and the surprising effect of planning on the sense of agency could be ascribed to the fact that the abstract goal was even visible for participants in the concrete condition in this design. Specifically, the team names where visible to these participants as well and could have primed them to think in a more abstract manner. It might be that even in the concrete condition, people were inclined to plan in an abstract manner. If this is the case, then results are in fact in accordance with what was hypothesized based on findings from Dannenberg et al. (2012). Although all information was made visible to all participants to make sure conditions did not differ in ways other than the instructions given, this particular aspect of the methodology in this study potentially confounded results.

A second characteristic of the first study that might have confounded results is the fact that participants did not have to indicate their plan ahead of time. This was omitted as indicating the plan would be an additional action on top of mere planning, but this also made it possible that participants did not plan ahead in the planning condition at all. Third, as participants were asked to report their sense of agency explicitly, their knowledge and expectations might have confounded results.

However, the unexpected influence of planning on the sense of agency and the lack of difference between the influence of the type of planning on the sense of agency could

certainly reflect some conceptual effect as well. Possibly, the actual influence of planning on the sense of agency is more similar to what is commonly thought, but somewhat contrary to what was found by Damen et al. (2012) and no difference in influence on the sense of agency exists between concrete and abstract planning. Nevertheless, it remains unlikely that concrete planning has a positive influence on the sense of agency considering the fact that the investigation by Damen et al. (2012) consisted of 5 separate studies which all had similar results: when planning ahead an action (in a concrete manner), the sense of agency over that action decreases. Another reason it seems unlikely planning heightens the sense of agency is that participants in the first study acted faster when they planned their action than when the action was unplanned. This was in accordance with what was found by Damen et al. (2012). They suggested that concrete planning leads to more automatic behavior and as the action can be performed faster and with less effort, the sense of agency reduces. Thus, it appears likely that the current results are due to chance or methodological issues and that planning does not positively influences the sense of agency.

In summary, from this study it remains unclear what the influence of planning on the feeling of agency is and in study 2 this ambiguous influence will be further investigated utilizing an implicit as opposed to explicit measurement of agency.

Study 2

The aim of the second study was to address some potential confounding aspects of the methodology in study 1 and to gain further insight into the mechanisms behind the influence of planning on the feeling of agency. In order to solve some of the issues discussed above a simpler and more straightforward methodology was utilized in study 2, comparable to the task from Damen et al. (2012). Moreover, the task opted for in this study was an implicit instead of explicit agency task, meaning participants had to indicate how long they felt the time delay between their action and the effect was. Time delay as an implicit measure of agency was

based on the fact that people experience the time delay between their action and the sensory consequences to be shorter when agency is high than when agency is low. This effect has been coined the 'intentional binding effect' by Haggard, Clark, and Kalogeras (2002) and has proven to reflect the sense of agency in numerous studies (e.g. Damen et al., 2012; Engbert, Wohlschläger, & Haggard, 2008; Moore & Obhi, 2012). This implicit way of measuring agency decreases the chance that people act differently due to their expectations and knowledge about the concept of agency. Another adaptation made in study 2 was that participants had to indicate their plan to ensure they would act accordingly.

In this study participants again completed both trials wherein they had to plan and trials wherein they did not plan their action (clicking a button to hear a specific sound). Half of the participants were asked to plan in abstract manners and half of the participants were asked to plan a concrete manner. After each trial participants estimated the time delay between their mouse-click and the presentation of the sound. It was expected that participants would underestimate the time delay, indicating a higher sense of agency, more for shorter time intervals than for longer time intervals and more for abstract planning than for concrete planning.

Method

Participants. A total of 69 participants at the Utrecht University campus participated in exchange for course credit or a candy bar. 27 males and 42 females took part in the study and the mean age of participants was 22.49 years old (*SD* = 1.88).

Materials and procedure. The procedure for study 2 was similar to the procedure for study 1, but the actual task differed. After participants were led into the lab room, they were told the study was about the perception of time and they were able to start the task. In the task participants could click on one of three buttons on the screen and this generated (after 100 ms, 500 ms or 900 ms) one of three different sounds. Participants were led to believe that the

sound could be produced by themselves, but also by the computer. After each trial, participants were asked to estimate the time interval between their mouse-click and the sound. Two participants were removed from analysis due to extreme and consistently high scores on this measure[2].

In half of the trials, the participants were asked to plan ahead their action and to indicate that plan by clicking one of three options before each trial. Half of all participants were in the abstract, effect focused planning condition and half of the participants were in the concrete, action focused condition. Participants in the abstract condition were asked to decide which sound – a knock, cling or whistle – they wanted to hear, while participants in the concrete condition were asked to decide which button – 1, 2 or 3 – they wanted to click on. One participant was deleted from analysis because he/she consistently did not stick to the plan.

Before the main task, which consisted of 60 trials, participants completed 18 practice trials to learn which sound belonged to which button and to familiarize them with the task at hand.

Results

Main analysis. A 2 (planning presence: plan vs. no plan, within) x 3 (time delay: 100 ms vs. 500 ms vs. 900 ms, within) x 2 (planning type: abstract vs. concrete) repeated measures ANOVA was performed. In this study, estimation of time was used as an implicit measurement of the feeling of agency. Histograms and Shapiro-Wilk statistics indicated that the assumption of normality was not violated, but the assumption of sphericity was violated for time delay, $W = .238$, $p < .001$. The Huyn-Feldt Epsilon will accordingly be used when reporting the analysis for time delay. F_{max} indicated that the homogeneity of variance assumption had not been violated.

[2] The removal of participants did not amplify significance in reported analysis compared to original analysis.

For planning presence no main effect was found, F (1, 64) = 2.47, p = .121, n^2_p = .037. No main effect for planning type was found either, F (1, 64) = 0.27, p = .604, n^2_p = .004. This was in contrast to what was hypothesized. However, a significant main effect was again found for time delay, F (1.16, 74.25) = 10.37, p = .001, n^2_p = .139. Contrary to expectations, pairwise comparisons revealed that people estimated the time delay for a 100 ms (M = 237.47, SD = 27.63) significantly more inaccurate than for 500 ms (M = 505.29, SD = 32.44, p < .001), and 900ms (M = 901.77, SD = 50.46, p = .005), but no significant differences were found between the estimates for 500 ms and 900 ms, p = .899. Of the interaction effects, only time delay x planning presence was marginally significant, F (2, 128) = 2.40, p = .095, n^2_p = .036. While differences in estimates between the plan (M = 238.96, SD = 28.74) and no plan (M = 235.97, SD = 27.87) conditions were small for a time delay of 100 ms and for a time delay of 500 ms as well (M_{plan} = 505.63, SD_{plan} = 32.07; M_{noplan} = 504.95, SD_{noplan} = 34.43), people overestimated the time delay when it was 900 ms in the plan condition (M = 923.20, SD = 51.71) compared to in the no plan condition (M = 880.33, SD = 51.12). This difference was significant, F (1,65) = 5.22, p = .026, n^2_p = .074.

Reaction times. Performing the 2 (planning presence: plan vs. no plan, within) x 3 (time delay: 100 ms vs. 500 ms vs. 900 ms, within) x 2 (planning type: abstract vs. concrete) repeated measures ANOVA on reaction times revealed a significant effect of planning presence, F (1, 65) = 387.25, p < .001, n^2_p = .856. Participants clicked faster when they did not plan their action (M = 492.51, SD = 49.02) than when they did plan ahead their action (M = 1433.34, SD = 41.43).

Discussion

No influence of planning on the sense of agency as measured by people's time estimations was found in an implicit agency task. However, planning did influence the sense of agency for a time delay of 900 ms. People overestimated this delay when they planned

ahead their action, but underestimated it when they did not plan ahead their action, suggesting people might experience a lower sense of agency when they plan their action and the time delay between action and effect is as long as 900 ms. Not finding a difference between the planning and not planning condition for shorter time delays is not surprising considering what was found by Damen et al. (2012). They reported a significant difference between the influence of (concrete) planning and not planning on the sense of agency for delays of 900 ms and 1300 ms, but not for a delay of 100 ms when measured implicitly by time estimations. Possibly, delays of 100 ms and 500 ms are too small for people to accurately estimate, explaining the consistent overestimation for these time delays. Time estimation might thus not be an appropriate implicit measure of agency for time delays shorter than 900 ms.

No indication of an influence of planning type on the feeling of agency was found, which was in line with what was found in study 1, but contrary to what was hypothesized based on the studies by Dannenberg et al. (2012), Van der Weiden et al. (2010) and Damen et al. (2012). It was argued before that the first study might have measured abstract planning on the whole. In the same manner, this study possibly measured concrete planning on the whole, as no higher goal was served by the mouse click than to hear a single sound. This could explain for the lack of significant difference between abstract and concrete planning: all participants might have been more inclined to plan in a concrete manner. The possibility that there is in fact no difference between the influence of abstract and concrete planning on the sense of agency should however not be dismissed. In that case, both abstract and concrete planning may influence the sense of agency negatively.

An influence of time delay on the feeling of agency was found. People overestimated the time delay when the actual delay was 100 ms more than for 500 ms and for 900 ms, but no differences in accuracy of time estimation existed between the delays of 500 ms and 900 ms. As it was discussed before that 100 ms and 500 ms might not be appropriate time delays to

measure the sense of agency, it seems unlikely this is linked to a conceptual difference in sense of agency between these time delays. It is again suggested that people have a hard time estimating a time delay of 100 ms.

General discussion

The central question of the current research was what the influence of abstract and concrete planning is on the sense of agency. Earlier empirical evidence shows agency increases when expected and actual outcomes are compatible (e.g. Blakemore et al., 2002; Sato & Yasuda, 2005; Van der Weiden et al., 2012) and thus, one might expect agency to be higher when an outcome was planned ahead. However, research by Damen et al. (2012) showed the opposite effect for concrete planning: the sense of agency was reduced for participants who planned ahead an outcome in a concrete, action focused manner. The present investigation is the first to compare the influence of concrete, action focused planning and abstract, outcome focused planning on the sense of agency. Findings indicate that, contrary to what was expected, there might be no difference between abstract and concrete planning for the influence on agency.

Planning influences the sense of agency

From this investigation, the influence of planning on the sense of agency remains unclear. Different results were obtained in the two studies. In the first study, it was found that participants experienced a higher sense of agency over the action when planning it ahead, independent of whether the planning was action focused or outcome focused. Although no hypothesis was made about the effect of planning in general on the feeling of agency, this result was surprising considering the results of Damen et al. (2012) in their extensive line of research about the influence of action focused planning on the sense of agency. As they found a negative effect of concrete planning on agency, the effect of both abstract and concrete planning together would logically more likely be either negative or zero than the positive

effect that was found in this study. However, these results appear to be a consequence of the methodology of the first study rather than a conceptual effect of planning on the sense of agency. One important aspect of the methodology was that it might have triggered abstract planning on the whole, as the abstract goal (scoring for a team) was even visible to participants in the concrete condition.

In the second study methodological issues of the first study were addressed in an implicit agency task. This study complicated the picture further, as no influence was found of either concrete, abstract planning or planning in general on the sense of agency when measured by time estimations. On first glance this result did not correspond to results obtained by Damen et al. (2012) and neither to results from the first study. However, for an actual time delay of 900 ms between action and effect results for planning as opposed to not planning were more compatible to what was found by Damen et al. (2012) for concrete planning. When participants planned ahead their action their time estimates suggested a lower sense of agency than when they did not plan ahead their action.

Both studies failed to show a difference in the sense of agency between concrete and abstract planning. Considering the abundance of research about the difference between abstract and concrete planning (Emmons, 1992; Freitas, Gollwitzer, & Trope, 2004) and the different influences of thinking about outcomes (Dannenberg et al., 2012; Van der Weiden et al., 2010) and thinking about actions (Damen et al., 2012; Van der Weiden et al., 2010) on the sense of agency, this is a highly surprising result. It is possible there is indeed no conceptual difference between these types of planning when it comes to their influence to planning. All of the above mentioned surprising results could however also have been caused by several possible moderators between abstract and concrete planning and the sense of agency.

Possible moderators in the studies

Level of abstraction of studies. It remains interesting that the influence of planning on the sense of agency was different in the first study than in the second study. One possible reason for this is the difference in level of abstraction between the two studies. As was discussed above, it is possible the first study primed abstract planning on the whole as the abstract information (the team names that belonged to the goals) was even visible to participants in the concrete condition. At the same time, participants in the second study might have planned in more concrete terms, as no higher goal was served by clicking a button than to hear a single tone. In that case, the planning that lead to a heightened sense of agency in the first study may have been abstract planning, which is in accordance with what was expected. Moreover, the negative influence of planning for a time delay of 900 ms in the second study may have pointed to the expected negative influence of concrete planning only.

Complexity of the task. Another possible moderator in the current work may be the complexity of the task in the studies. It is known that actions that are well practiced become represented on a more abstract, outcome focused level (Aarts & Dijksterhuis, 2000; Vallacher & Wegner, 1987). When a behavior is well practiced, it is performed more automatic and there is a lesser need to focus on the concrete actions needed to achieve the goal (Aarts & Dijksterhuis, 2000), while less practiced behavior is represented at a more concrete level (Vallacher & Wegner, 1987). In the same manner, complex and difficult behaviors are represented on a more concrete level, while easier, habitual behaviors have an abstract representation (Vallacher & Wegner, 1987; Van der Weiden et al., 2010).

While the task in study 1 was straightforward and not complicated, the task in study 2 might have been more difficult for some participants. Specifically, the task was possibly more difficult for participants in the abstract planning condition than for participants in the concrete planning condition. Participants in the abstract condition not only had to remember their plan, but also which key belonged to which sound. This may as well explains the fact that

participants reacted slower when they made a plan than when they did not make a plan. Possibly, the planning itself made the task harder, as they had to act according to the plan. In contrast, in the first study participants were remembered of which key belonged to which goal by making this visible on the screen. Thus, the first study could be seen as an overall easier task, which might stimulate abstract thinking. The second task might have overall inclined people to plan in more concrete terms, as the abstract condition was considerably more difficult than the concrete condition.

Agency ambiguity. A last important possible moderator between concrete and abstract planning and the sense of agency in this research is the difference in ambiguity of the situation in the two studies. As study 1 contained a visual agent in the form of a pivot animator, this could have made the ambiguity of agency higher for participants, as it could be seen as another visible agent. In ambiguous situations the influence of planning might be different than in situations that are not ambiguous. Planning, irrelevant of the type of planning, might be a cue of agency when everything else is uncertain. In study 2 this uncertainty was reduced, as there was no other visible agent. Although it was explained to participants that the computer or they themselves could have caused the sound, it is possible that people were under the impression that they themselves were in reality the only agents.

Future research options

As the current study was the first to investigate abstract and concrete planning in the same agency paradigm, further research is needed to shed more light on their distinct influences on the sense of agency and to address some of the current limitations. In the future, the focus should be on designing a research paradigm that reliably distinguishes concrete from abstract planning and can be used to measure the sense of agency both implicitly (through time estimations for delays longer than 900 ms) and explicitly. In this way,

moderating influences between planning and the explicit and implicit measure of agency can be reduced.

Apart from new fundamental laboratory research, applied and field research can be a valuable additions to the existing literature. Laboratory research is needed to control for possible confounding influences, but additional field research could heighten the ecological validity of results (Goodwin, 2010). Moreover, in real life abstract planning are often made up of several concrete steps and may be considerably more long-term than in the current investigation. To address these issues, future applied research could use real life scenario's to heighten the ecological validity and make sure abstract plans are more comparable to the action plans people make in real life.

A last valuable adaptation to the current research would be to let people make plans as they normally would do instead of assigning them to plan in a concrete or abstract way. After people made their plans they could be rated as to their level of abstraction.

Conclusion

Although the current investigation did not result in a clear picture of the influence of abstract and concrete planning on the sense of agency, it is clear making plans can influence the sense of agency in different ways. Making plans to act appears to make the action itself faster and it seems likely that at least making concrete plans leads to a lowered sense of agency. More research is needed to shed light on the influence of abstract planning on the sense of agency, as, in spite of the lack of results in the current research, this type of planning might possibly influence agency in opposite ways. However it may be, it is important to realize that the plans you make every day might influence your conscious and unconscious realization of being in charge and responsible for your actions.

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