# On the course of goal pursuit

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# On the course of goal pursuit: The influence of goal progress on explicit judgments of self-agency

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A B S T R A C T

The experience of causing our own actions and resulting outcomes (i.e., self-agency) is essential for the regulation of our actions during goal pursuit. In two experiments, participants indicated experienced self-agency over presented outcomes, which varied in distance to their goal in an agency-ambiguous task. In Study 1, progress was manipulated at trial level (i.e., stimuli moved randomly or sequentially towards the goal). In Study 2, progress was constant at trial level (sequential), but varied at task level (i.e., goal discrepancy of the outcomes was random or decreased over trials). Study 1 showed that self-agency gradually increased in the progress condition as unsuccessful outcomes were objectively closer to the goal, while self-agency increased exponentially upon full goal attainment in the absence of progress. The gradual pattern for the progress condition was replicated in Study 2. These studies indicate that explicit judgments of self-agency are more flexible when there is goal progress.

## 1. Introduction

Having a sense of agency is a central aspect of our daily life where goal pursuit is ubiquitous. The feeling that one is the cause of one's actions and subsequent outcomes, regardless of whether one actually is, is key to one's self-concept and drives one's future performance and actions (Aarts, Custers, & Marien, 2009; Synofzik, Vosgereau, & Newen, 2008; Wegner, 2002). Previous research suggests that people experience self-agency when they reach their goals, but tend to deny agency over outcomes that are discrepant from their goals, regardless of the size of the discrepancy (van der Weiden, Ruys, & Aarts, 2013). Does this also mean that people would not experience themselves as the cause of goal-discrepant outcomes that occur during goal pursuit (when the goal has not yet been reached)? This seems unlikely, as goal progress (i.e., decreasing goal discrepancy) has been shown to motivate further goal-directed action (Koo & Fishbach, 2014). Such enhanced motivation to perform certain actions does not make sense if people would not believe that the progress is achieved by their own actions. How, then, do people experience self-agency during goal pursuit?

Although goal achievement plays a major role in the experience of self-agency, research indicates that in the absence of goal achievement, experiences of self-agency may be lowered, but still vary as a function of perceptual-motor discrepancy. That is, previous work by Kumar and Srinivsan (2014) investigated the influence of perceptual-motor discrepancy and goal attainment on people's experienced self-agency. In two studies, participants performed a multi-agent game in which they could control one of the presented

agents and were instructed to catch a specific goal. Perceptual-motor discrepancy varied in the extent to which participants' joystick responded smoothly to their movements. At the end of each trial, the goal would either be attained or not, upon which participants indicated their experience of self-agency. Findings revealed that when the goal was not attained, experienced self-agency increased as perceptual-motor discrepancy decreased. This influence of perceptual-motor discrepancy was absent in case of successful goal attainment. These findings have also been replicated using more implicit measures of agency (i.e. intentional binding; Kumar & Srinivasan, 2017).

In the present work, we address the question whether similar variations in experienced self-agency may emerge as a function of goal discrepancy when there are indications of goal progress. Specifically, we investigate whether indications of progress (decreasing goal discrepancy) towards one's goal increase explicit judgments of self-agency over intermediate outcomes during goal pursuit. For this purpose, we will first discuss theoretical models on how self-agency experiences arise, and how goal-directed processes are involved.

### 1.1. The experience of self-agency

Past research has resulted in two main accounts that distinguish between a lower-level *feeling* of agency and a cognitive *judgment* of agency. Both are considered to contribute to an overall 'sense of self-agency' in the remainder of this paper. First, the classical comparator model (Wolpert, Ghahramani, & Jordan, 1995) explains how the feeling of self-agency arises from the sensorimotor system using a feed-forward model to predict the consequences of volitional actions (e.g., that the word 'Hello' will appear on screen when pressing buttons on one's keyboard in a certain way; Wolpert et al., 1995). Whenever such a predictive signal matches the observed outcome (e.g., when one actually sees the word 'Hello' appear on screen), an action will be internally attributed and is accompanied by a feeling of self-agency "*It is I who is doing it*" (Frith & Done, 1989; Moore & Haggard, 2008).

However, since we rarely act within a social vacuum, it is often not that obvious who or what caused something, even though it may match our internal predictions. This uncertainty provides the alternative option of ascribing authorship towards external agents instead of making an internal attribution (e.g., when the person we chat with online has also typed the word 'Hello'; e.g., Custers, Aarts, Oikawa, & Elliot, 2009; Preston, Ritter, & Wegner, 2011). In situations that involve multiple outcomes and in which the cause of these outcomes remains ambiguous, people may turn to cognitive inferences when making causal attributions (Wegner 2002; van der Weiden, Aarts, & Ruys, 2013). These inferences do not exclude the previously discussed motor-predictions, but are complementary to the experience of self-agency.

To explain experiences of self-agency in ambiguous situations, the theory of apparent mental causation (Wegner, 2002; Wegner & Wheatley, 1999) postulates that people infer whether they caused a certain action or outcome based on cognitive outcome representations. When an observed outcome matches an outcome one had in mind before performing an action, people tend to infer self-agency, regardless of whether they actually caused the outcome or not (e.g., Aarts, Custers, & Wegner, 2005; Wegner, 2002; Wegner, Sparrow, & Winerman, 2004). As people typically perform actions with a certain goal in mind (be it implicit or explicit), people typically experience self-agency over outcomes that are in line with their goals (e.g., Aarts et al., 2005, 2009; van der Weiden, Ruys, & Aarts, 2013).

### 1.2. Goals and the experience of self-agency

Accordingly, literature on goal-directed behavior typically considers agency a product of the comparison between a goal (i.e., intended outcome) and the actual action-outcome (Bandura, 1986; Deci & Ryan, 1985; van der Weiden, Aarts, & Ruys, 2013a). As such, processes involved in effective goal attainment have been shown to contribute to the experience of self-agency. For example, the experience of self-agency crucially relies on the active maintenance of a cognitive representation of the goal in mind during goal pursuit (Aarts, 2012; Aarts et al., 2009; Cooper & Shallice, 2006).

Another goal-directed process that modulates the experience of self-agency is the narrowing of attention towards that one specific goal to shield goal pursuit from alternative, conflicting goals (Aarts, 2012; Dijksterhuis & Aarts, 2010; Shah, Friedman, & Kruglanski, 2002). In a study that illustrated the effect of goal shielding on experienced self-agency (van der Weiden, Ruys, & Aarts, 2013), participants performed an adapted version of the Wheel of Fortune task (see Aarts et al., 2005 for the original task). In this computerized task, participants watched two squares (their own and the computer's) moving in random order over a rectangular path of eight tiles. At a certain point in time, a stop cue appeared, and the squares' movements were ostensibly hidden from view. The goal of participants was to stop their own square at a pre-determined location. To make it unclear whether they succeeded in stopping their own square at the intended location, participants were presented with only one of the squares' stop locations. Or so they were told. In actuality, the presented outcome location was determined randomly. Participants were then asked to what extent they felt that they caused their own square to stop at the presented location as a measure of self-agency. Results indicated that people tend to experience self-agency over action-outcomes that completely match their goal representation, but deny agency over action-outcomes that are discrepant from the goal location, no matter how large the discrepancy (van der Weiden, Ruys, & Aarts, 2013).

If people would only make explicit judgments of self-agency once they reach their goal, this would imply that they would not experience themselves as the cause of their own actions *during* goal pursuit (when the goal has not yet been reached). Yet, on the course of goal pursuit, people take multiple actions and may encounter many outcomes that do not (yet) match their final goal. It would make sense if people would also experience self-agency over such intermediate outcomes, as progress towards one's goal can be regarded as a signal of discrepancy reduction (Carver & Scheier, 1998). As such, the experience of achieving progress crucially informs people on how to attain their goal (Locke & Latham, 1990; Reeve, 2014; Schunk & Swartz, 1993).

Indeed, a positive influence of goal progress on experiences of self-agency would fit current theorizing on the emergence of self-

agency experiences. That is, as people pursue a goal (e.g., the word 'Hello' on screen), they probably also expect to achieve intermediate, though discrepant, outcomes (e.g., the word 'Hell') before eventually reaching their goal. Hence, such mismatching outcomes may be included within (rather than shielded from) people's goal representations. In line with this notion, goal-shielding (i.e. the inhibition of alternative goals), was found to occur to a lesser extent when the alternative goals were believed to facilitate attainment of the focal goal (Shah, Friedman, & Kruglanski, 2002). If so, based on the predictive and inferential models of self-agency, people should experience self-agency over intermediate outcomes, as they fit prior expectations and facilitate goal attainment. Crucially, because of the random movement of squares in the study by van der Weiden, Ruys, and Aarts (2013), the degree of discrepancy between goals and outcomes did not provide any indication of goal progress; one could simply achieve one's goal, or not. Whether or not goal progress indeed contributes to explicit judgments of self-agency therefore remains an open question.

## 2. The current research

The current research turns towards this proposed influence of progress on explicit judgments of agency within the context of explicit goal pursuit. It was hypothesized that 1) judgments of self-agency would be stronger for outcomes that signal successful goal attainment compared with outcomes that are goal-discrepant, 2) judgments of self-agency would be stronger when people experience progress compared with non-progress, and 3) for people who experience progress, self-agency would increase in a linear fashion as goal-discrepancy decreases, while 4) for people who do not experience progress, self-agency would increase exponentially upon full goal attainment only (all-or-nothing principle). To test these hypotheses, we employed an adapted version of the Wheel of Fortune task (Aarts et al., 2005). In this paradigm, the participant assumes to have control over an object (a moving square) by pressing a key. The goal is to stop this moving square on a displayed goal location. The participant does this while playing against a computer-controlled object (another moving square) in order to induce ambiguity as to whom may be the causal agent for the presented outcomes. Agency experiences were measured over outcomes with varying levels of goal-discrepancy. In two studies, using two different manipulations of progress, we examined the effect of progress on experienced self-agency.

## 3. Study 1

In Study 1, the Wheel of Fortune task was used to compare experienced self-agency (as well as subjectively perceived goal discrepancy) for various outcomes between a progress condition and a non-progress control condition.

### 3.1. Method

#### 3.1.1. Deviations from the original design

Originally, we considered an 8 (Discrepancy: 7 tiles apart, 6 tiles apart, 5 tiles apart, 4 tiles apart, 3 tiles apart, 2 tiles apart, 1 tile, no discrepancy) by 2 (Progress: progress vs. non-progress) by 2 (Self-Criticism: low vs. high) design to assess experienced self-agency. However, we deviated from this planned design for several reasons. At first, we wanted to include the between-subjects factor of self-criticism (Powers, Koestner, Zuroff, Milyavskaya, & Gorin, 2011) using a median-split procedure to compose a high self-criticism group and low self-criticism group. However, based on the considerable amount of criticism on the median split procedure (e.g., McClelland, Lynch, Irwin, Spiller, & Fitzsimons, 2015), we decided in hindsight to drop this factor from the design to maintain enough power to detect the effects of interests. We did perform exploratory analyses including self-criticism as a covariate to the main design analyses.

Second, we decided to include only 5 instead of 8 levels of Discrepancy in line with an un-directional perspective to goal pursuit. Research on motivation often focuses on unidirectional goal pursuit. For example, athletes may have a specific goal to throw a spear for a certain number of meters, but surpassing this goal is not considered a failure. Another example is when there is a clear ending to something, like reading a book. Once all the pages are read, the goal of reading the book is achieved and cannot be surpassed. Other goals, however, are more un-directional, where there is an optimal sweet spot that needs to be reached (see also studies on motor control that similarly view goal progress as unidirectional, e.g., Bilodeau, 1953; Federico, 1970; Jones, 1970). For example, when driving on the highway, either hitting the accelerator pedal too lightly or too heavy both results in failure (as both can lead to unsafe situations). Similarly, when losing weight, a diet can be too strict (resulting in underweight or malnutrition), or too lenient (resulting in overweight) and both can be equally bad. In these cases, goal progress goes in two directions, and as such can be considered un-directional.

In our Wheel of Fortune task, participants are basically trying to hit such a sweet spot, and stopping too soon or too late could both be perceived as equally discrepant from the goal, which would suggest that goal progress in our task would be un-directional in nature. However, based on the notion that goal discrepancy is subjective (e.g., Carver & Scheier, 1990; Koo & Fishbach, 2014), we figured that our paradigm could potentially be subjectively perceived as either unidirectional or as un-directional. That is, if goal progress in our task would be perceived as unidirectional in nature, "passing" the goal would potentially bring participants back to the starting point upon which they would have to travel seven more positions to reach the goal position again. Hence, this starting point should be perceived as having the maximum discrepancy and as further away from the goal as compared to outcomes with a minimum discrepancy "just before" the goal, even though the spatial discrepancy would be identical. As such, we wanted to check whether outcomes immediately following the goal location would be perceived as less close to the goal location compared to outcomes immediately preceding the goal location (e.g., H preceding A in Fig. 3). In the non-progress condition, we did not expect such differences for objectively equally distant locations, due to the random order of movement.

Additional analyses indicated that the perceived distance of outcomes that were objectively equal in distance (but on other sides of the goal location) was similar within as well as between conditions (see Supporting information). In other words, participants' perceived distance between the different outcome locations and the goal location seemed to be similar to the objective (spatial) distance. This may be partially due to the fact that the goal location changed during each trial, making it hard for participants to potentially perceive a concrete starting point along the path of tiles. As a consequence, participants may have prioritized the objective (spatial) distance information instead. Our particular application of the Wheel of Fortune paradigm and the results regarding perceived distance thus seemed to fit better with an un-directional perspective to goal pursuit, where goal progress (i.e., discrepancy reduction) could be perceived from both sides of the goal.

Further analyses were therefore performed with 5 levels of Discrepancy based on the number of objective (spatial) distances. Squares B & H, C & G, and D & F (see Fig. 3) were paired so that there remained only 4 instead of 7 possible outcomes that varied in goal-discrepancy in addition to one possible outcome that signaled successful goal attainment. The alternative analyses using 8 possible levels of Discrepancy are reported in the Supporting Information.

### 3.1.2. Participants and design

In total, 107 students of Utrecht University and Utrecht University of Applied Sciences participated in the first experiment. Students received no financial compensation, but could earn course credit. Due to a programming error,[3] 30 participants did not complete the correct test and were excluded. Three participants were excluded as they reported on misunderstanding the instructions, resulting in invalid responses. The remaining sample included 74 participants (68.9% female) with an average age[4] of 22.35 ($SD$ = 2.11).

The experiment had a final 5 (Discrepancy: 4 tiles apart, 3 tiles apart, 2 tiles apart, 1 tile, no discrepancy) by 2 (Progress: progress vs. non-progress) main design to assess experienced self-agency. Discrepancy was varied within participants, while progress was a between-participants variable.[5] A sensitivity analyses using G*Power for a 5 (Discrepancy: 4 tiles apart, 3 tiles apart, 2 tiles apart, 1 tile, no discrepancy) by 2 (Progress: progress vs. non-progress) mixed ANOVA, alpha = 0.05, power at 80%, nonsphericity correction = 1 (effect size as in SPSS), indicated that we could reliably detect a within-between interaction effect of $f(U)$ = 0.21 ($\eta_{p2}$ = 0.04) or larger based on the included sample size of 74 participants.

### 3.1.3. Materials

#### 3.1.3.1. Agency task.
An adapted version of the Wheel of Fortune paradigm was used (Aarts et al., 2005) and was programmed in E-prime 2.0. In this task, a rectangular path of eight white tiles (size tile: 70 x 70 pixels) was visible. The participant was assigned a dark grey square (70 x 70 pixels) and was told that there would also be a light grey square (70 x 70 pixels), which belonged to the computer. During each trial, these two squares moved over the rectangular path. The squares were displayed one after the other, and each time a square was shown, it jumped to a different location on the rectangular path. Each trial started with a 3 s warning signal, telling the participants to pay attention ("ATTENTION!"). At the same time, a goal location was presented. The goal location was represented by a black square, which was randomly displayed at one of the eight white tiles on the rectangular path. Participants were instructed to try to stop their dark grey square at this goal location. Then a START sign appeared in the middle of the rectangular path. Upon pressing the 's' key, the squares would start moving. Participants were instructed to stop the moving squares during each trial by pressing the 'Enter' key as soon as possible when the STOP sign appeared. From the moment the STOP sign was displayed, the moving squares were no longer visible to the participants. Participants were told that the squares continued moving in the background and that the outcome location depended on the timing of participants pressing the Enter key. In order to discourage participants from waiting several (invisible) laps, we instructed them at the beginning of the experiment to press the STOP key as soon as possible when the STOP sign appeared. The more time elapses, the harder it would be for participants to anticipate the outcome location of their square, and as such to experience self-agency. In reality, however, the outcome location was independent of the timing of their key presses. After 100 ms, the participants pressed the STOP key, the computer randomly turned one of the eight tiles black. This black tile, representing the outcome location of either the computer's or the participant's square, was shown for 1 s. Participants were explicitly told during the instruction that the presented outcome could have been caused either by them or by the computer and that this was randomly determined. At the end of each trial, participants rated the extent to which they felt that they had caused the presented outcome on a 10-point scale from 0 (not at all) to 9 (very much). In other words, the participants were asked to indicate the extent to which they felt to have caused their square to stop at the presented location (instead of the computer moving the computer-controlled square). For a systematic overview of one trial, see Fig. 1.

In each condition, the pattern that the two grey squares followed was different. In the progress condition ($n$ = 38), the squares belonging to the participant and the computer moved along the path of white squares in a sequential order, as in the original and

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commonly used version of the task (e.g., Aarts et al., 2005). The participant's square moved counter clockwise towards the goal location as shown on the left part of Fig. 2 The computer's square moved in the opposite (clockwise) direction. The grey squares were displayed for 50 ms at each position. One lap thus lasted 800 ms (50 ms * 2 squares * 8 positions). The number of laps varied randomly between four or five laps in the progress condition.

The non-progress condition ($n = 36$) was identical to a previously adapted version of the Wheel of Fortune task (van der Weiden, Ruys, & Aarts, 2013). Here, the two grey squares moved along the path in a random order (see right part of Fig. 2). Each location could be followed by any of the other locations. The movement of the participant's and computers' square visually appears to be much faster when the movement is random compared with sequential. A 50 ms display of each square in the random order would make it rather impossible for participants to monitor the squares' movements. To balance this perceptual difference, we increased the display time to 200 ms at each position in the non-progress (random order) condition, for both the participant's as well as the computers' square. One lap thus lasted 2400 ms (200 ms * 2 squares * 8 positions). To make the duration of both conditions as comparable as possible, the number of laps before the appearance of the STOP sign varied randomly between one and two in the non-progress condition.

*3.1.3.2. Perceived distance.* The Wheel of Fortune task was used to investigate participants' subjectively perceived distance between the possible outcome- and goal locations in the agency task. The movement of the squares was identical to the agency task, depending on participants' allocation to the progress or non-progress condition. However, instead of rating their sense of self-agency, participants now rated how close they felt the outcome was to the goal location, on a 10-point scale from 0 (not at all close) to 9 (very close/ identical to the goal).

*3.1.3.3. Self-criticism.* The Levels of Self-Criticism Scale (LOSC: Thompson & Zuroff, 2004) was used to assess levels of overall negative self-evaluation. The scale consists of 22 items that were translated to Dutch (e.g., "Failure is a very painful experience for me"). All items were scored on a 7-point scale ranging from 1 (not at all) to 7 (very much). The mean score ($\alpha = 0.889$) was used as the indicator of self-criticism, with higher scores indicating higher levels of self-reported self-criticism.

*3.1.3.4. Life orientation test.* The Revised Life Orientation Test (LOT-R: Scheier, Carver, & Bridges, 1994) was used to assess dispositional optimism. This scale was added as a potential exploratory measure but has not been analyzed.

*3.1.4. Procedure*

All participants provided written informed consent before study inclusion. Participants individually took part in the experiment in a laboratory room at Utrecht University. The experiment started with the agency task (for full instructions of the task see the Materials of Study 1: https://osf.io/axr96/). The participants first performed several practice trials in which they learned how to start moving their own square (3 trials), to see where their square would stop (3 trials), to see their own and the computer square move and stop with both presented outcomes (3 trials) and to practice the actual task with only one presented outcome (2 trials). In both conditions, the agency task consisted of two blocks of 20 trials. There was a one-minute break between the two blocks. The trials were presented at random. In 8 out of 40 trials, the outcome location signaled successful goal attainment (once for each possible location of the rectangular path). In the remaining 32 trials, the outcome was presented at a one to four tile distance from the goal. When the outcome location was one, two, or three tiles away from the goal, random selection would determine whether the outcome square was presented to the right or left side of the goal (e.g., when square A was the goal location, there would be random selection between square number C and G for a distance of 2 tiles, see Fig. 3).

Next, the participants completed another eight trials of the Wheel of Fortune task to measure perceived distance between the possible outcome- and goal locations. The goal location (tile A, see Fig. 3) remained the same for each of the eight trials. During the first trial, the outcome location was pre-set to appear on tile B (see Fig. 3). For the seven remaining trials the other outcome locations were presented at random.
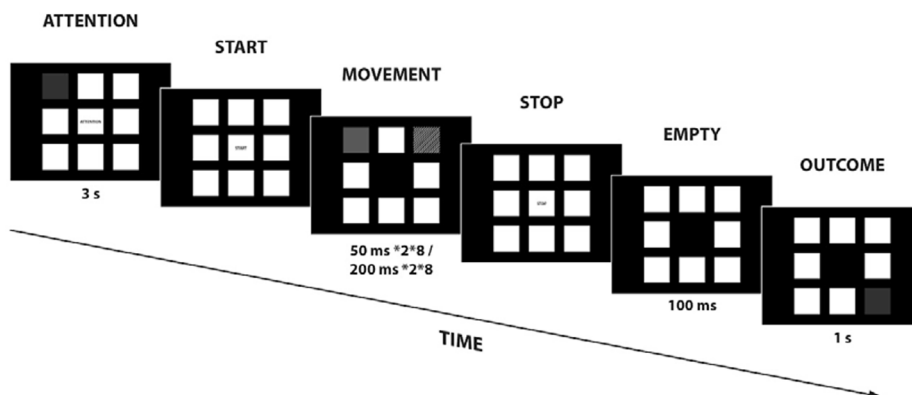


**Fig. 1.** Systematic overview of one trial of the agency task.
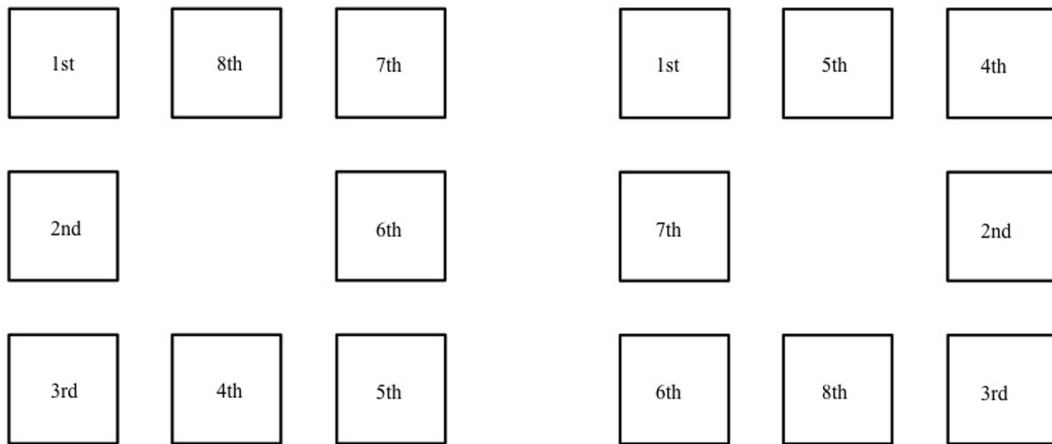
**Fig. 2.** Schematic picture showing the sequential order of movement of the participant's square in the progress condition (left) and an example of the random order of movement in the non-progress condition (right).
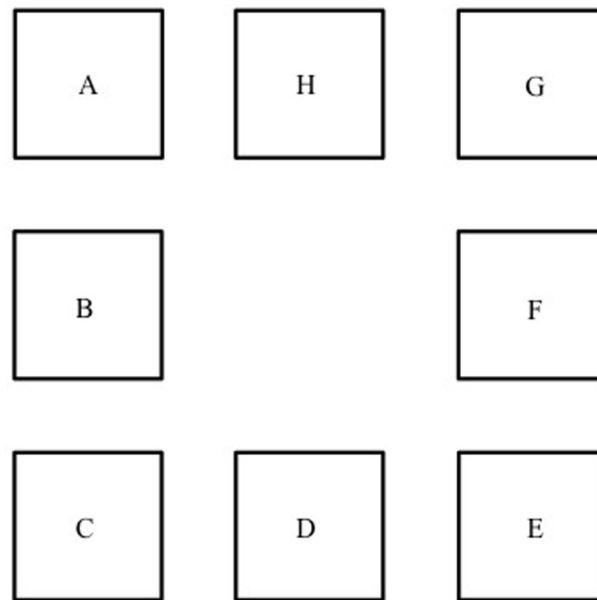


**Fig. 3.** The rectangular path of white squares with various distances as depicted in the task if square A was presented as the goal. Letters are added here for demonstrative purpose and were not shown during the experiment.

Last, the participants indicated their gender and date of birth. All participants were debriefed and further instructed to fill out a brief online survey somewhere within the next three days following the lab experiment. This survey assessed the participants' levels of self-criticism and optimism. All participants received course credit.

### 3.2. Results

#### 3.2.1. Randomization check
An independent *t*-test (two-tailed) and a separate Chi-square test were used to check whether randomization was successful for age and gender. The results did not reveal any significant effects, indicating successful randomization for age $t(67) = 0.44$, $M_{diff} = 0.22$, *SE* $= 0.510$, $p = .665$ and gender $\chi^2$ $(1, N = 74) = 1.15$, $p = .563$, Cramers $V = 0.125$.

#### 3.2.2. Main design analysis
A repeated measures Analysis of Variance (ANOVA) was used to test a 5 (Discrepancy: 4 tiles apart, 3 tiles apart, 2 tiles apart, 1 tile apart, no discrepancy) by 2 (Progress: progress vs. non-progress) design, with discrepancy as a within-participants variable and

progress as a between-participant variable. Fig. 4 presents the means for each cell in the design. See supporting information (Table S2) for all means, associated standard errors and 95% confidence intervals of experienced agency for each discrepancy by condition combination. The reported within-subjects values are Huynh-Feldt corrected.

First, there was a main effect of Discrepancy, $F(2.91, 209.16) = 28.67$, $p < .001$, $\eta_{p2} = 0.285$. This result indicated that the discrepancy between the goal and outcome location influenced the experienced agency of participants. Pairwise comparisons ($p$-values Bonferroni corrected) showed that experienced agency was highest for outcomes that signaled successful goal attainment compared with outcomes that were discrepant with the goal location by 4 tiles ($M_{diff} = 1.70$, $SE = 0.219$, $p < .001$, 95% CI [1.07, 2.33], $d = 0.77$), 3 tiles ($M_{diff} = 1.57$, $SE = 0.251$, $p < .001$, 95% CI [0.84, 2.29], $d = 0.70$), 2 tiles ($M_{diff} = 1.33$, $SE = 0.194$, $p < .001$, 95% CI [0.77, 1.89], $d = 0.58$) or 1 tile ($M_{diff} = 0.66$, $SE = 0.179$, $p = .005$, 95% CI [0.14, 1.18], $d = 0.27$). Second, there was a main effect of Progress, $F(1,72) = 4.51$, $p = .037$, $\eta_{p2} = 0.059$, $M_{diff} = 0.90$, 95% CI [-1.74, −0.06]. Participants in the progress condition experienced higher overall agency ($M = 4.09$, $SD = 1.82$) than those in the non-progress condition ($M = 3.19$, $SD = 1.82$). Last, there was an interaction effect for Discrepancy and Progress, $F(2.91, 209.16) = 4.29$, $p = .006$, $\eta_{p2} = 0.056$, indicating that the effect of discrepancy towards the goal depended on the order of movement of the squares (i.e., random vs. sequential).

### 3.2.3. Exploratory analyses self-criticism

Exploratory analyses including Self-Criticism (mean-centered) as a covariate to the main design revealed fairly similar outcomes ($N = 73$). There was a significant main effect of Discrepancy, $F(2.93, 205.21) = 28.45$, $p < .001$, $\eta_{p2} = 0.289$. Although the main effect of Progress was now non-significant $F(1,70) = 3.81$, $p = .055$, $\eta_{p2} = 0.052$, the interaction effect between discrepancy and progress remained significant $F(2.93, 205.21) = 4.18$, $p = .007$, $\eta_{p2} = 0.056$.

### 3.2.4. Exploratory simple main effects

In order to decompose the interaction effect of the main design, simple main effects were analysed. First, experienced agency for each discrepancy to the goal was compared between both conditions of progress (Bonferroni corrected). There was a significant difference between conditions for outcomes that signaled successful goal attainment ($p = .016$), for outcomes that were 1-tile ($p = .009$) and 2-tiles apart ($p = .029$) from the goal. For these three outcome locations closest to the goal, participants in the progress condition reported higher experienced agency compared to the non-progress condition (Fig. 4). In contrast, there were no significant differences between conditions for outcomes that were 3-tiles apart ($p = .467$), and 4-tiles apart ($p = .431$). For detailed statistics see Table 1.

As previous research typically compared successful goal-attainment to maximum discrepancy (4 tiles away), we also analyzed experienced agency for successful goal attainment compared with outcomes with a maximum discrepancy within each condition (Bonferroni corrected). Experienced agency was higher for outcomes that signaled successful goal attainment compared with outcomes that were 4-tiles apart from the goal location within both the progress condition ($M_{diff} = 2.26$, $SE = 0.305$, $p < .001$, 95% CI [1.37, 3.14], $d = 1.11$), as well as the non-progress condition ($M_{diff} = 1.15$, $SE = 0.313$, $p = .005$, 95% CI [0.24, 2.05], $d = 0.49$). For more detailed information on experienced agency for successful goal attainment compared to all outcomes within each condition, see supporting information (Table S3).

### 3.2.5. Pattern analyses

Several contrast analyses were conducted to explore the patterns of increased agency experiences for the progress and non-progress conditions. It was expected that within the progress condition, effects on experienced self-agency would unfold as a function of the distance of the observed outcome to the goal location. This means that experienced self-agency should gradually increase as the (spatial) discrepancy decreases (reflected by a linear increase pattern).

It was further expected that experienced self-agency in the non-progress condition would show an instant rise for outcomes that signaled successful goal attainment, compared with any of the goal-discrepant outcomes (reflected by an immediate increase pattern). To investigate these hypotheses, we first conducted single pattern contrast analyses to investigate whether the increase in experienced self-agency in the progress and non-progress condition was linear (unstandardized contrast coefficients: −1.41, −0.71, 0.00, 0.71, 1.41), and/or immediate (unstandardized contrast coefficients: −0.5, −0.5, −0.5, −0.5, 2). Second, we conducted multiple pattern contrast analyses to investigate which pattern would be a better fit to the progress and to the non-progress condition.

#### 3.2.5.1. Single pattern analyses.
The linear contrast analysis revealed a linear increase in experienced self-agency in the progress condition $t(37) = 7.01$, $p < .001$, $M_{diff} = 4.21$, $SD = 3.70$, 95% CI [2.99, 5.43], $d = 1.14$ as well as in the non-progress condition $t(35) = 3.42$, $p = .002$, $M_{diff} = 1.88$, $SD = 3.29$, 95% CI [0.76, 2.99], $d = 0.57$. This linear trend was stronger for the progress condition than for the non-progress condition, $t(72) = -2.86$, $p = .006$, $M_{diff} = 2.33$, 95% CI [3.96, 0.71], $d = 0.67$. Second, we investigated a pattern of immediate increase in which goal attainment is contrasted against all goal-discrepant outcomes together for both the progress as well as the non-progress condition. These analyses revealed an immediate increase in experienced self-agency in both the progress condition $t(37) = 7.38$, $p < .001$, $M_{diff} = 3.31$, $SD = 2.77$, 95% CI [2.40, 4.22], $d = 1.19$, and the non-progress condition $t(35) = 3.27$, $p = .002$, $M_{diff} = 1.95$, $SD = 3.57$, 95% CI [0.74, 3.16], $d = 0.55$. There was no significant difference between conditions for the immediate pattern, $t(72) = -1.84$, $p = .070$, $M_{diff} = -1.36$, 95% CI [−2.83, 0.12], $d = 0.43$.

These results indicated that both linear and immediate increase patterns are significant for the progress and non-progress condition. This seems plausible, as in both conditions experienced self-agency was highest for goal attainment compared to all levels of goal-discrepancy. In addition, the contrast of the linear trend is stronger for the progress condition compared to the non-progress
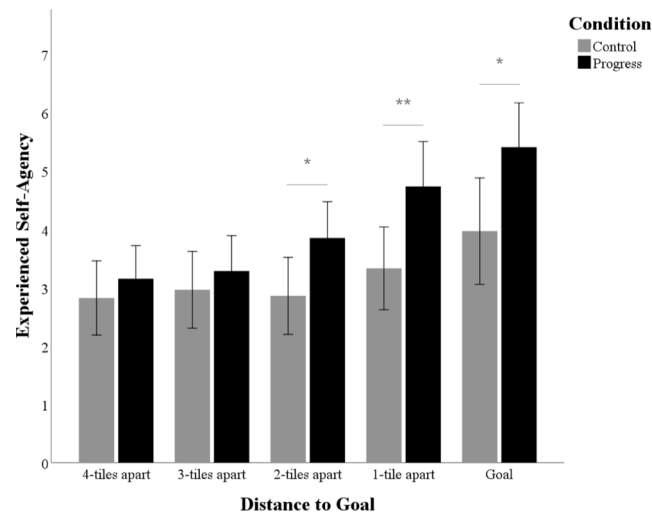
**Fig. 4.** Experienced self-agency over decreasingly goal-discrepant outcomes for the progress and non-progress condition (Error bars: 95% Confidence Intervals). Experienced self-agency was significantly different between conditions for outcomes that signaled successful goal attainment, were 1-tiles apart, and 2-tiles apart, * $p < .05$, ** $p < .01$.

**Table 1**
Exploratory simple main effects experienced agency for outcomes at each discrepancy compared between the progress (n = 38), versus the non-progress (n = 36) condition Study 1. Mean differences between the progress minus non-progress condition, standard errors, p-values and 95% confidence intervals and effect sizes.

| Discrepancy | $M_{diff}$ | SE | $p$ [a] | 95% CI | $d$ |
|---|---|---|---|---|---|
| 4-tiles apart | 0.33 | 0.418 | 0.431 | [−0.50, 1.17] | 0.18 |
| 3-tiles apart | 0.32 | 0.441 | 0.467 | [−0.56, 1.20] | 0.17 |
| 2-tiles apart | 0.99 | 0.446 | 0.029* | [0.10, 1.88] | 0.52 |
| 1-tile apart | 1.40 | 0.519 | 0.009** | [0.37, 2.44] | 0.63 |
| Goal location | 1.44 | 0.583 | 0.016* | [0.28, 2.60] | 0.57 |

* p < .05, ** p < .01.
[a] Adjusted for multiple comparisons (Bonferroni).

condition, meaning there is a larger total amount of increase in the progress condition. Based on our hypothesis, in the progress condition we further expect the linear pattern of increase to fit better than the immediate pattern of increase. This difference was not expected for the non-progress condition. To investigate this expectation, we performed multiple pattern contrast analyses.

*3.2.5.2. Multiple pattern analyses.* In line with previous research by van der Weiden, Ruys, and Aarts (2013), we followed the functional analysis procedure by Furr and Rosenthal (2003). For each participant, we multiplied the mean agency scores for each level of distance with the standardized contrast coefficients that were associated with these levels of distance for both a linear, and an immediate increase pattern. We then calculated the sum of the products for each pattern and conducted t-tests to examine whether the sums of the two patterns differ for the progress and non-progress condition.

For the progress condition, the linear increase pattern ($M_{sum} = 4.21$, $SD = 3.70$) appeared to be a better fit compared to the immediate increase pattern ($M_{sum} = 3.31$, $SD = 2.77$), $t(37) = 2.79$, $p = .008$, $M_{diff} = 0.90$, 95% CI [0.25, 1.56], $d = 0.28$. For the non-progress condition, the fit of the linear increase pattern ($M_{sum} = 1.88$, $SD = 3.29$) did not significantly differ from the fit of the immediate increase pattern ($M_{sum} = 1.95$, $SD = 3.57$), $t(35) = −0.30$, $p = .766$, $M_{diff} = −0.07$, 95% CI [−0.56, 0.42], $d = 0.02$. This indicated that neither a linear nor immediate pattern is a better fit for the increase of experienced self-agency in the non-progress condition.

### 3.3. Discussion

In Study 1, progress was manipulated and self-agency experiences were measured over outcomes with varying discrepancies to the goal. Consistent with previous research, we replicated the finding that experienced agency over outcomes that signal goal attainment is enhanced compared with other outcomes (e.g., Aarts et al., 2005; van der Weiden, Ruys, & Aarts, 2013). Newly adding to the idea that agency over goal-directed behaviors arises according to an all-or-nothing principle (van der Weiden, Ruys, and Aarts, 2013), the current findings indicate that experiences of self-agency over goal-discrepant outcomes may be enhanced as well. Specifically, when participants were provided the opportunity to experience progress during goal pursuit, the experience of self-agency seemed to unfold

more gradually as outcomes appeared spatially closer to the goal. To increase our level of evidence, a second experiment was conducted including a stronger manipulation of progress.

## 4. Study 2

In Study 2, we aimed to replicate the previously found effect of distance between the goal and outcome location on the experienced agency of participants, and to further investigate the influence of progress. Study 2 therefore again employed the same progress condition as in Study 1, in which the participants' square moves sequentially towards participants' goal to suggest progress. Yet, in this condition, the degree of goal discrepancy of outcomes was randomly selected on each trial. We compared this 'random' outcome progress condition to a condition in which the opportunity to experience progress was further induced by decreasing goal discrepancy over trials during the task (i.e., incremental outcome progress). We had no prior expectations about experiences of self-agency in the new incremental outcome condition. On the one hand, additional cues of progress could result in a steeper slope in the progress condition. Conversely, one could also argue for a steeper slope in the random condition, where outcomes that are 4 tiles apart from the goal location (perhaps especially as the task progresses) could have a stronger negative impact on experienced agency than in the progress condition, (where bad performance at the start may even be anticipated). Alternatively, one could also merely expect a main effect, where the additional progress cue enhances experienced self-agency across the board.

### 4.1. Method

#### 4.1.1. Participants and design

In total, 41 students of Utrecht University and Utrecht University of Applied Sciences participated in the second experiment in return for course credit. Due to a procedural error, data of one participant were overwritten and could not be recovered. One participant was excluded from analyses because this person conducted agency research as a study project. Two more participants were excluded from analyses because they reported to be aware that the action-outcomes were pre-programmed. The remaining sample included 37 participants (64.9% female) with an average age[6] of 21.92 ($SD = 1.36$).

Overall, the second experiment provided a 5 (Discrepancy: 4 tiles apart, 3 tiles apart, 2 tiles apart, 1 tile apart, no discrepancy) by 2 (Progress: random outcome vs. incremental outcome) design. A sensitivity analyses using G*Power for a 5 (Discrepancy: 4 tiles apart, 3 tiles apart, 2 tiles apart, 1 tile, no discrepancy) by 2 (Progress: progress vs. non-progress) mixed ANOVA, alpha = .05, power at 80%, nonsphericity correction = 1 (effect size as in SPSS), indicated that we could reliably detect a within-between interaction effect of $f(U) = 0.30$ ($\eta_{p2} = 0.08$) or larger based on the included sample size of 37 participants.

#### 4.1.2. Materials

##### 4.1.2.1. Agency task.
The participants performed the progress version of the agency task as described in Study 1, but this time half of the participants were presented with additional cues of progress. In the random outcome progress condition ($n = 19$), the goal discrepancy of the presented action-outcomes was randomly determined across the 40 trials. This condition was thus identical to the progress condition of Study 1. Within the new incremental outcome progress condition ($n = 18$), action-outcomes were incrementally presented closer to the goal as the task progressed.

##### 4.1.2.2. Perceived ability.
For exploratory purposes, we added two items concerning participants' perceived ability to perform the task without formulating any a-priori expectations. *The items were:* "*To what degree did you feel that you were able to stop the moving square on the target location?*" and "*To what degree did you feel that you were better able to stop the moving square on the target location over the course of the task?*" on a 10-point scale ranging from 0 (not at all) to 9 (entirely).

#### 4.1.3. Procedure

All participants provided written informed consent before study inclusion. The participants then continued with several practice trials and the agency task. Similar to Study 1, the agency task again consisted of two blocks of 20 trials. In both conditions, outcomes that signaled goal attainment were presented in 8 out of 40 trials (once for each possible location of the rectangular path). In the remaining 32 trials, the outcome was presented 1 to 4 tiles apart from the goal location. When the outcome location was 1, 2, or 3 tiles apart from the goal, random selection determined whether the outcome square was presented to the right or left side of the goal (see Fig. 3). The 40 trials were randomly presented for the random outcome progress condition. In contrast, in the incremental outcome progress condition (unbeknownst to the participants) the 40 trials were programmed in 5 sets of 8 trials in which action-outcomes were presented semi-randomly according to the following rules: set 1(outcomes: 75% 4 tiles apart, 25% 3 tiles apart), set 2 (25% 4 tiles apart, 75% 3 tiles apart), set 3 (100% 2 tiles apart), set 4 (75% 1 tile apart, 25% no discrepancy) and set 5 (25% 1 tile apart, 75% no discrepancy). In both conditions, participants performed 20 trials before and 20 trials after a one-minute break. Due to the nature of the manipulation, discrepancy is more reflective of presentation order for the incremental outcome condition than the random progress condition. This means that for the incremental outcome condition, outcomes that were 4-tiles and 3-tiles apart were presented

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[6] Age missing ($n = 1$).

relatively at the beginning of the experiment, while outcomes that were 2-tiles, 1-tile and a match to the goal location were presented during the middle and towards the end of the experiment respectively. In contrast, for the random progress condition, outcomes with all discrepancies to the goal location could be presented at any time during the experiment (i.e. at random).

After answering the perceived ability items and providing demographic information regarding their age and gender, the participants were debriefed and received course credit.

### 4.2. Results

#### 4.2.1. Randomization check

An independent $t$-test (two-tailed) and a separate Chi-square test were used to check whether randomization was successful for age and gender. The results did not reveal any significant differences between conditions for age $t(34) = 1.39$, $M_{diff} = 0.62$, $SE = 0.448$, $p = .174$ and gender $\chi^2 (1, N = 37) = 0.05$, $p = .823$, Cramers $V = 0.037$.

#### 4.2.2. Main design analysis

A repeated measures Analysis of Variance (ANOVA) was used to test the 5 (Discrepancy: 4 tiles apart, 3 tiles apart, 2 tiles apart, 1 tile apart, match) × 2 (Progress: random outcome vs. incremental outcome) design with Discrepancy as a within-participants variable and type of Progress as a between-participants variable. Fig. 5 presents the means for each cell in the design.

The reported within-subjects values are Huyn-Feldt corrected. Results indicated that there was a significant main effect of Discrepancy $F(3.09, 108.00) = 60.30$, $p < .001$, $\eta_{p2} = 0.633$. In line with Study 1, the distance between the goal and outcome location influenced the experienced agency of participants. Pairwise comparisons ($p$-values Bonferonni corrected) indicated that experienced agency was significantly higher for outcomes that signaled successful goal attainment compared with goal-discrepant outcomes that were 4 tiles apart ($M_{diff} = 3.22$, $SE = 0.348$, $p < .001$, 95% CI [2.18, 4.26], $d = 2.15$), 3 tiles apart ($M_{diff} = 2.98$, $SE = 0.256$, $p < .001$, 95% CI [2.22, 3.75], $d = 2.05$), or 2 tiles apart ($M_{diff} = 1.58$, $SE = 0.228$, $p < .001$, 95% CI [0.90, 2.26], $d = 1.09$), though not compared with outcomes that were just 1 tile apart from the goal location ($M_{diff} = 0.66$, $SE = 0.233$, $p = .072$, 95% CI [-0.03, 1.36], $d = 0.41$). Second, there was a significant main effect of Progress condition $F(1, 35) = 4.73$, $p = .037$, $M_{diff} = 0.76$, 95% CI[0.05, 1.47], $d = 0.72$, such that experienced agency was higher for participants in the incremental outcome condition ($M = 5.34$, $SD = 1.06$) compared with the random outcome condition ($M = 4.58$, $SD = 1.06$). Last, there was no significant interaction effect for Discrepancy and Progress condition, $F(3.09, 108.00) = 0.71$, $p = .550$, $\eta_{p2} = 0.020$. Follow-up analyses were conducted to explore the patterns of (increasing) self-agency for both conditions of progress.

#### 4.2.3. Pattern analyses random outcome progress

In line with the original progress condition in Study 1, we expected that the effects on experienced self-agency in the random outcome condition would gradually increase as the (spatial) discrepancy decreases, reflected by a linear increase pattern. We first conducted single pattern contrast analyses to test whether the increase in experienced self-agency in the random outcome condition was linear and/or immediate. Similar to the progress condition in Study 1, both the linear contrast ($t(18) = 6.28$, $p < .001$, $M_{diff} = 5.66$, $SD = 3.93$, 95% CI [3.77, 7.56], $d = 1.44$) and the immediate contrast ($t(18) = 6.01$, $p < .001$, $M = 3.91$, $SD = 2.80$, 95% CI [2.55, 5.26], $d = 1.40$) were significant. Moreover, the multiple pattern contrast analyses revealed that the linear increase pattern ($M_{sum} =$
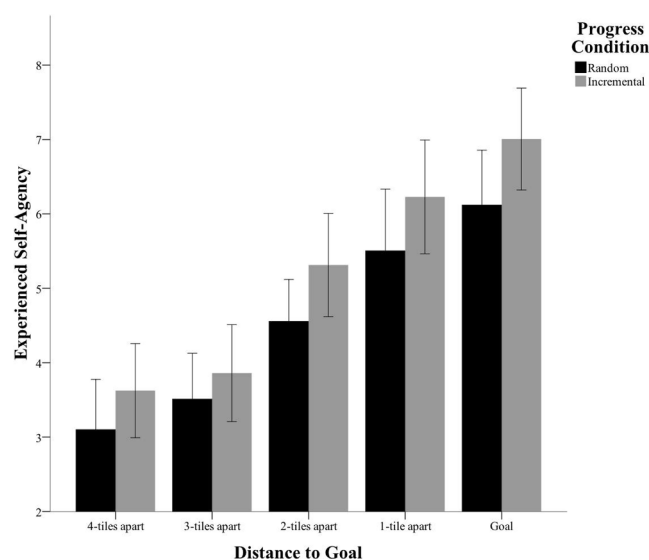


**Fig. 5.** Experienced self-agency over decreasingly goal-discrepant outcomes for the random outcome progress condition (identical to the progress condition in Study 1) and incremental outcome progress condition (Error bars: 95% Confidence Intervals).

5.66, $SD = 3.93$) was a better fit compared to the immediate increase pattern ($M_{sum} = 3.91$, $SD = 2.80$), $t(18) = 3.70$, $p = .002$, $M_{diff} = 1.75$, 95% CI [0.76, 2.75], $d = 0.51$.

### 4.2.4. Exploratory analyses.

*4.2.4.1. Pattern analyses incremental outcome progress.* Although we had no prior expectations on the pattern in the incremental outcome condition (see also footnote 7), we conducted exploratory single pattern contrast analyses to see whether the increase in experienced self-agency in the incremental outcome condition was linear and/or immediate. Similar to the progress condition in Study 1 and the random outcome condition in Study 2, both the linear contrast $t(17) = 9.48$, $p < .001$, $M_{diff} = 6.70$, $SD = 3.00$, 95% CI [5.21, 8.19], $d = 2.23$) and the immediate contrast ($t(17) = 7.26$, $p < .001$, $M_{diff} = 4.53$, $SD = 2.65$, 95% CI [3.22, 5.85], $d = 1.71$) were significant. In addition, the multiple pattern contrast analyses revealed that the linear increase pattern ($M_{sum} = 6.70$, $SD = 3.00$) was a better fit compared to the immediate increase pattern ($M_{sum} = 4.53$, $SD = 2.65$), $t(17) = 5.36$, $p < .001$, $M_{diff} = 2.17$, 95% CI [1.32, 3.02], $d = 0.77$.

*4.2.4.2. Perceived ability.* Two independent samples t-tests were performed to compare the perceived ability to perform the task between participants in the random and incremental outcome conditions. There was no significant difference between participants in the random ($M = 4.11$, $SD = 1.63$) and incremental outcome condition of progress ($M = 4.56$, $SD = 1.76$) in their scores on overall ability to perform the action of having to stop their moving square on the target location, $t(35) = -0.81$, $p = .424$, $M_{diff} = -0.45$, 95% CI [−1.58, 0.68], $d = 0.27$. There was, however, a significant difference between participants' perceived increased ability to stop the moving square on the target location over the course of the task, $t(35) = −3.58$, $p = .001$, $M_{diff} = −2.17$, 95% CI [−3.41, −0.94], $d = 1.18$. Specifically, participants in the incremental outcome condition scored higher on this item ($M = 7.28$, $SD = 1.87$) compared with participants in the random outcome condition ($M = 5.11$, $SD = 1.82$).

### 4.3. Discussion

In Study 2, we aimed to replicate the effect of discrepancy between the goal and outcome location on experienced agency under conditions of progress during each trial, and to further investigate influences of progress by incrementally decreasing goal discrepancy over the course of the task. The results again revealed that experiences of self-agency were not only enhanced for successful goal outcomes, but also for somewhat unsuccessful (discrepant) outcomes. Like Study 1, Study 2 showed that when participants' square progressed towards their goal during each trial while the goal discrepancy of action-outcomes was randomly determined, the experience of self-agency seemed to unfold gradually as outcomes were objectively closer to the goal. The results of Study 2 suggest that experiences of self-agency could be even further enhanced when participants could also experience progress based on subsequent outcomes that were presented incrementally closer to the goal throughout the task. However, although the effect size of this main effect was quite strong, the *p*-value was less convincing, and the effect should therefore be interpreted with caution.

## 5. General discussion

Experiences of agency are essential to the way we perceive ourselves and feel in control over our future behavior (Eitam, Kennedy, & Higgins, 2013; Jeannerod, 2003). The purpose of the current research was to gain insight in the effects of goal progress on explicit judgments of self-agency. Previous research suggested that in the absence of goal achievement, the experience of self-agency varies as a function of perceptual-motor control (e.g. Kumar & Srinivasan, 2014, 2017), but not as a function of goal discrepancy (van der Weiden, Ruys, & Aarts, 2013). However, this research did not directly investigate how goal progress might function as a cognitive cue that enables agency inferences over intermediate outcomes on the course of goal pursuit. In prior research, goal discrepancy has mostly been neglected, or intentionally ruled out (van der Weiden, Ruys, & Aarts, 2013). We aimed to broaden the view on experienced self-agency during goal pursuit, by investigating whether progress influences explicit judgments of self-agency.

In two studies, we found support for the notion that indicators of goal progress can enhance experiences of agency during goal pursuit. Study 1 revealed that self-agency gradually increased as outcomes were objectively closer to the goal in the progress condition. This pattern for the progress condition was replicated in Study 2, which additionally hinted that self-agency could be even further enhanced as a result of goal progress at task level. Consistent with previous agency research, we replicated the finding that experienced self-agency over goal attainment is enhanced compared to goal-discrepant outcomes (e.g., Aarts et al., 2005; van der Weiden, Ruys, & Aarts, 2013). However, participants also experienced enhanced self-agency over goal-discrepant outcomes under conditions of progress. These findings suggest that self-agency over goal-directed behaviors does not always arise according to an all-or-nothing principle, but can be a rather flexible concept when combined with a sense of progress.

Progress enables people to not only detect goal-discrepant outcomes, but to gain insight in the course of action needed to attain their goal (Harkin et al., 2016). As such, goal-discrepant outcomes can be regarded as stepping-stones towards a certain goal and may be anticipated before action performance, explaining why agency experiences increase gradually during goal pursuit, rather than according to an all-or-nothing principle. This gradual unfolding of agency experiences might be very meaningful in the face of goal-striving. For example, findings by Steinhauser and Kiesel (2011) suggest that in order to successfully regulate one's behavior, previous failed attempts at goal attainment have to be recognised as being caused by oneself. Hence, if people experience self-agency over outcomes that do not (yet) match their goal – as our results suggest -, this may mean that they are better able to regulate future actions

in order to attain their goal.

The present research showed that participants who are provided with a sense of progress experience higher overall levels of agency compared to those who do not. One possible alternative explanation for this could be an illusion of predictability. The sequential order of movement might have given people the feeling that they were better able to predict where the moving square would stop. Indeed, people have been shown to infer more agency over (seemingly) predictable events (e.g., Sato & Yasuda, 2005; van der Weiden, Aarts, & Ruys, 2011). Illusions of predictability could then explain why participants in the progress condition showed higher levels of experienced agency. However, not only did a sense of progress lead to higher overall experienced agency than non-progress (Study 1), these experiences also increased gradually as goal discrepancy decreased (Study 1–2). It seems unlikely that predictability would (fully) account for this in Study 1, as the sequential movement would make all outcomes seem equally more predictable and not favour any outcome specifically. However, it is possible that predictability played a role in Study 2 where participants seemed to indicate a higher overall sense of agency when goal discrepancy decreased incrementally over the course of the task.

Possibly, the effects of progress might rely on cognitive associations between a goal and its intermediate outcomes (cf. van der Weiden, Ruys, and Aarts, 2013). These associations could be either visual or psychological in nature. In the first scenario, several outcomes might become visually associated to the goal, simply because they are next to the goal or spatially close to it (proximity) and look similar (similarity; Reisberg, 2013). However, this would not explain the difference in experienced agency between the progress and non-progress condition in Study 1, for outcomes that are identical in visual spatial proximity. Alternatively, the association could be more psychological in nature. In that case, outcomes could be, to some extent, part of one's expectation. A match between one's expectation and outcome consequently leads one to infer agency (Aarts et al., 2005; Wegner, 2002; Wegner & Wheatley, 1999; van der Weiden, Aarts, & Ruys, 2013). As a result, people may also experience a sense of achievement when attaining these associated outcomes. To further investigate this possibility, future research could have participants in a progress versus non-progress condition rate how pleasant they experienced outcomes of varying levels of discrepancy to be, as was also done in research on gambling and illusions of control (e.g., Clark, Crooks, Clarke, Aitken, & Dunn, 2012).

In Study 2, we explored participants' perceived ability at performing the Wheel of Fortune task. While participants experienced moderate ability to determine the outcome of their actions overall, they felt that they were getting better at it throughout the course of the task, especially when goal discrepancy decreased progressively. As such, our progress manipulation may have raised feelings of self-efficacy. Although feelings of self-efficacy and self-agency have been suggested to be closely related, they are distinct in terms of temporal focus. Whereas the sense of agency concerns causal attribution in the moment (i.e., as *"It is I who is doing it";* van der Weiden, Aarts, & Ruys, 2013), self-efficacy concerns prior beliefs about one's capability to perform intended behavior (Bandura, 1977; Haggard & Eitam, 2015). It is not surprising that our progress manipulation may have promoted such feelings of self-efficacy, as discrepancy reduction implies successful action performance and allows for an interpretation of competence (Bandura, 1986; Schunk & Swartz, 1993). Self-efficacy may therefore be a potential working mechanism underlying the influence of progress on experiences of self-agency worth investigating in future studies.

Temporal focus may not only play a role in whether people experience self-agency and/or self-efficacy. In addition, temporal focus may determine the extent to which people represent discrepant outcomes as a (intermediate) goal in itself (see also Gozli & Dolcini, 2018; Gozli, 2019; Liberman & Trope, 2003; Pacherie, 2008; Vallacher & Wegner, 1987, Wegner & Vallacher, 1986; van der Weiden, Aarts, & Ruys, 2010). For example, for a person who wants to lose 10 lb (goal) the loss of each pound may be perceived as a (intermediate) goal as well. To the extent to which people represent discrepant outcomes as a goal in itself, experienced self-agency over the attainment of these outcomes should be enhanced. It would be interesting for future research to examine whether temporal focus could indeed further boost experiences of self-agency under conditions of goal progress.

In addition, it would be interesting to investigate whether experiences of self-agency increase as a function of actual progress and/ or as a function of the psychological experience of progress. This could be distinguished in research on illusionary goal progress. For example, in a field study, Kivetz, Urminksy and Zheng (2006) manipulated the perception of (rather than actual) progress, using stamp cards to investigate goal motivation. Specifically, in one condition, people got a card for ten stamps. In the other condition, people also required ten stamps but were given a card for twelve that already had two 'free' stamps on it. The objective goal discrepancy was thus equal in both conditions (i.e., 10), while the latter group had a psychological "head start" (Kivetz et al., 2006).

Future research could similarly create different conditions of subjective progress, e.g., by creating Wheel of Fortune tasks with 5 vs. 10 tiles. In both conditions, participants could then start out with attaining outcomes that are objectively discrepant with their goal by 5 tiles, and incrementally achieve outcomes closer to their goals. However, participants in the condition with the increased number of tiles may perceive their progress to go slower. That is, a change in discrepancy from 5 to 4 tiles is relatively smaller in the task with 10 tiles (i.e., 10% discrepancy reduction) compared with the task version with 5 tiles (i.e., 20% discrepancy reduction). If increasing the number of possible action-outcomes would decrease the effect of discrepancy reduction on experienced self-agency, this would indicate a crucial role for the subjective experience of progress.

It is important to underscore that following the findings on perceived distance, and by collapsing experienced agency for objectively same distance tiles, we considered goal pursuit to be un-directional. As a consequence, goal progress represented the reduction of the objective distance between outcomes and the goal, and this reduction could be perceived from either the left (moving towards) or from the right side of the goal (moving away). Although our task is rather abstract in nature, our findings may only relate to un-directional types of goal pursuit (e.g., when trying to drive neither too slow not too fast, or when trying to sedate a dangerous animal by shooting a dart neither to the left nor the right of the animal).

Our work cannot provide evidence for the influence of progress on experienced agency in case of unidirectional goal pursuit (e.g., when trying to inflate a balloon without letting it burst and having to start all over again, or when trying to get a good grade on an assignment). Future studies could examine whether a similar linear increase of experienced agency in case of unidirectional goal

pursuit as well. For example, this could be investigated using a task in which the tiles of the path are aligned horizontally and in which the participants' square always starts from the first tile on the left (7-tiles apart) and moves towards the last tile on the right (goal). In the context of unidirectional goal pursuit, experienced agency would be expected to increase, and subjectively perceived distance would be expected to decrease in a linear fashion as a function of discrepancy when there is progress.

In addition, it remains an open question whether experiences of agency would arise in a similar pattern across goal-discrepant outcomes in situations in which "passing" a certain goal could still signal a desired outcome instead of failure. This would mean that, despite being discrepant, an outcome that exceeds a goal would still include successful goal attainment (i.e., "the more the better", e.g., when obtaining a higher grade or faster track record than you aimed for). This may be particularly relevant to goal pursuit in the context of sports or performances.

Several limitations have to be considered when reviewing our research and the present findings. First, in Study 2, no control group was used. None of the participants were offered zero progress cues. This only enabled us to relatively compare the progress cues at trial level to those at task level, and not to those without progress cues. In Study 1 there was a control group without any progress cues. In future research it would be ideal to also directly compare the conditions in our second study to a control group and to increase the sample sizes. Moreover, in the incremental outcome condition of Study 2, progress was manipulated both by reducing goal discrepancy during each trial (i.e., in terms of the square's sequential movement) and by reducing goal discrepancy of the outcomes over the course of the task. Although the results suggest that task-level progress enhanced experienced agency over and above the effects from progress at trial level, it would be interesting to further disentangle the effects using larger samples sizes (e.g., to see whether task-level progress is less or similarly effective in the absence of trial-level progress).

A final point of discussion pertains to the generalizability of our findings. Although our experimental studies provide valuable information on the causal relations between goal progress and experienced self-agency, it may prove difficult to ultimately translate our findings beyond the artificial context of goal pursuit that is inherent to the Wheel of Fortune paradigm. That is, outcomes of having to stop a square on a given target location seems far removed from a daily-life setting in which people's actions and subsequent outcomes progress towards their own personal goals over a period of time. An alternative approach to provide real-life evidence for the assumed influence of goal progress and goal discrepancy on the sense of self-agency might be the use of ecological momentary assessment (EMA). For example, following EMA research within the domain of eating behavior (e.g. Boh et al., 2016), a future study may consider intermediate outcomes in terms of weight loss and measure self-agency over people's weekly weight status while they strive towards a desired weight to explore the ecological validity and potential societal impact of our current findings.

## 6. Conclusion

The current research provides first evidence that explicit judgments of self-agency vary as a function of goal discrepancy when there are indications of goal progress. We replicated the typical finding that agency experiences are enhanced over outcomes that signalled successful goal attainment. We also extended these prior findings by showing that explicit judgments of self-agency gradually increased as outcomes were closer to the goal and people experience progress prior to action performance (at trial level). The current research thereby suggests that inferences of self-agency can be rather flexible, in the case of goal-striving, combined with cues of progress. Future knowledge on how- and when progress specifically relates to a sense of agency during goal pursuit can provide a better understanding of how people regulate their actions over time and may successfully achieve their goals in various domains of life. In the future, progress may not only be used to positively predict the sense of agency, but might also be applied deliberately to support successful goal achievement through a sense of authorship over unsuccessful outcomes along the way.

**Data availability and Supporting Information**

The data, syntax, materials, and supporting information for this research project are available online at: https://osf.io/axr96/

**Ethics statement**

Both studies were approved by the Ethics Committee of the Faculty of Social and Behavioral Sciences at Utrecht University [FETC017-031].

## CRediT authorship contribution statement

**Anneloes Kip:** Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Data curation, Project administration. **Demi Blom:** Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing. **Anouk van der Weiden:** Supervision, Conceptualization, Methodology, Resources, Writing – review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.concog.2021.103222.

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