

## Sense of Agency as a predictor of risk-taking

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### ABSTRACT

Previous research suggests that people tend to underestimate risks that are under their control. It is however unclear which processes underlie the control-risk relation. The present research investigated the feeling of causal control known as agency as a predictor of risk-perception and risk-taking. In two studies, participants performed a risk-taking task in which their actions either caused immediate or delayed outcomes – a validated manipulation of agency. Results show that when outcomes were shown immediately rather than delayed, and respectively, when agency was high rather than low, participants reported a higher ability to control risks (Study 1). Furthermore, they were also more inclined to take risks (Study 2). The present research, the first to apply principles that emerged from fundamental research on agency into the societally relevant domain of risk-related perception and behavior, therefore showed a clear relation between agency and risk.

### 1. Introduction

Whether the decision is to have unsafe sex, drive faster than allowed, experiment with drugs and alcohol, or going all-in in a game of Poker, risky decisions permeate our lives, sometimes with disastrous consequences. How and why risk taking occurs has important implications, yet many questions remain about which factors underlie risky decision-making. So why and when do we take risks?

People tend to underestimate risks that are under their control. Consider for example how we experience driving compared to our experience of being a passenger on a commercial airline flight: The ability to direct a car's movement makes it feel relatively safe when we are driving, while our inability to influence events as a plane-passenger can make flying relatively scary – even though there are many more accidents with cars than with planes. Furthermore, the very same individual, being present in a car doing the exact same thing, can have drastically different conceptions about ‘what is safe’ depending on whether s/he is the one driving or whether s/he is merely present as a passenger (Horswill & McKenna, 1999).

The relation between perceptions of control on the one hand, and perceptions of risk and actual risk-taking on the other hand have by now been shown in many studies, not only for driving behavior (e.g., DeJoy, 1989; McKenna, 1993), but also for food safety (e.g., Frewer, Shepherd, & Sparks, 1994), health risks (e.g., Weinstein, 1980), sexual behavior (e.g., Klein & Kunda, 1994), and gambling (e.g., Chau & Phillips, 1995). The more one feels in control the lower one's perceptions of risk become - in turn leading to more risk-taking behavior. Although the sheer volume of research on the control-risk relation makes this relation appear as a scientifically well-established one (e.g., Clark, Crooks, Clarke, Aitken, & Dunn, 2012; Dixon, 2000; Durand, 2003; Griffiths, 1994; Higbee, 1972; Houghton, Simon, Aquino, &

Goldberg, 2000; Ladouceur & Mayrand, 1987; Martinez, Le Floch, Gaffié, & Villejoubert, 2011; Simon, Houghton, & Aquino, 2000; Strickland, Lewicki, & Katz, 1966; Wolfgang, Zenker, & Viscusi, 1984; Wortman, 1975), important unresolved issues remain. One such issue noted by Nordgren, Van Der Pligt, and Van Harreveld (2007) is that control is a broad construct and that it is quite unclear which specific processes related to control actually drive risk-taking. Is the control-risk relation driven by willful or forced exposure to risk? Does it rely on the absence or presence of choice over actions or outcomes? Or, can it emerge from the sense of being actively involved?

An insightful paper by Martinez, Bonnefon, and Hoskens (2009) took a first step to address these questions by emphasizing the crucial role for a sense of active involvement in the control-risk relation. Specifically, in a gambling paradigm they presented participants with urns containing balls that would cause participants to either win or lose money. Martinez and colleagues manipulated whether or not participants could choose which urn to play, and whether or not they were actively involved in the mechanistic resolution of their gambles (i.e., physically taking the balls from the urn). Their results showed that whereas choice did not increase risk-taking, motor involvement did, suggesting that motor actions, or alternatively, a sense of active involvement are crucial predictors of risk-taking.

Martinez et al.'s (2009) focus on motor actions and active involvement are intriguing given developments in the domain of cognitive psychology. Specifically, over the past two decades there has been great interest in a construct referred to as the sense of agency, which is often defined as the feeling that we cause and control our actions and through those actions change our environment (Damen, van Baaren, Brass, Aarts, & Dijksterhuis, 2015; Marcel, 2003). This sensation of agency seems to come about in an automatic fashion during a day: We pull a cord to turn on the light in and it feels like we caused the light to occur;

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we raise our hand and see that through *our* action, we can cause a bus to stop; we even feel a sense of achievement when our bluff pays off at a Poker game. Yet, although it seems as if agency comes naturally when we act, there is now a plethora of research showing that agency is not a given. Instead, agency is a changing experience that fluctuates depending on a number of internal psychological processes and external parameters (Moore & Haggard, 2008; Synofzik, Vosgerau, & Voss, 2013). Therefore, despite that it may be logically clear we are the ones performing actions, the sense of personal involvement with our actions and action-consequences may be reduced nevertheless.

Accordingly, through subtle contextual manipulations individuals can be led to experience either an increased or decreased sense of agency in otherwise identical situations. For example, individuals are more likely to experience a strong sense of agency when the outcomes of their actions are predictable (Sato, 2009; Wegner, 2004); or, when there are no others present that can also be perceived as likely agents (Dijksterhuis, Preston, Wegner, & Aarts, 2008; Wegner, 2003). Another crucial factor that contributes to the experience of agency is the length of the time intervals between our actions and the action outcomes (Sato & Yasuda, 2005). Often, the longer and more unpredictable those intervals are, the less likely we are to relate those outcomes as being caused by our actions. Instead of being a fixed sensation agency seems to fluctuate, and relatively small changes in the way we perceive information and in the way in which we perform actions – changes that are likely to map upon real-life differences in the devices and interfaces we use – can therefore greatly influence our experiences of control and active involvement. An emerging but important question is therefore whether agency and agency manipulations can modulate risky behavior.

A well-established measurement of risk-taking is the Balloon Analog Risk Task (BART; Lejuez et al., 2002). The BART models real world risk behavior by requiring participants to balance risk with reward. Participants are presented with a virtual balloon and asked to pump it by clicking a pump-button. However, a balloon may explode, and, if the participant did not bank his/her winnings for that round, that money is lost and the participant moves on to a new balloon. Different types of studies supported the validity of BART as an instrument to measure risk-taking, as performance on the BART correlates not only with other measurements of risk-taking, but also with real-world risky behaviors, such as drug and alcohol use, smoking, gambling, aggression, psychopathic tendencies, and unprotected sex (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Bornovalova et al., 2009; Hunt, Hopko, Bare, Lejuez, & Robinson, 2005; Lejuez et al., 2002; Lejuez et al., 2007; MacPherson, Magidson, Reynolds, Kahler, & Lejuez, 2010; Mishra, Lalumière, & Williams, 2010; Skeel, Pilarski, Pytlak, & Neudecker, 2008; Swogger, Walsh, Lejuez, & Kosson, 2010). Unlike many other paradigms, the BART involves sequential risk taking with performance feedback - and is easily manipulated systematically.

To reiterate, the relation between perceptions of control and risk has been firmly established in the literature (e.g., Klein & Kunda, 1994; Strickland et al., 1966; Walker, 1992). Nevertheless which types of control underlie this relation is still unclear (Nordgren et al., 2007). Martinez et al.'s (2009) research on risk-taking showed the importance of involvement and physical actions in our tendencies to take risks. In parallel, the research on agency has shown that the experience of action involvement – agency – is malleable, and depends on a multitude of factors; action-outcome time being one of them. This begs the question whether agency and manipulations of agency can modulate risk-taking.

This research aims to validate the importance of agency in the control-risk relation, and thereby addresses two scientific challenges: First, though informative, most of the research on agency is inherently fundamental and does not provide data relating to societally relevant behavior – the consequences of experiencing weak or strong agency has not been the focus of empirical attention. By applying insights from the agency-domain into the domain of risk-taking, we address this gap in the literature. Second, although there has been much attention for

control as a predictor of risk-perception and risk-taking, agency – a construct related to control – has not been tested within the risk domain. By introducing agency and agency manipulations, the present research therefore investigates novel but relevant predictors of risk-perception and risk-taking.

Two studies were run that involved modified versions of the BART. The present BART featured two types of balloons: one balloon that expanded immediately after a participant's button-press, and one balloon that expanded after a small delay. This manipulation of temporal delay between actions and outcomes is considered as a strong and robust manipulation of the sense of agency (Damen, van Baaren, & Dijksterhuis, 2014; Sato & Yasuda, 2005).

It was hypothesized that when individuals quickly perceived the outcomes of their actions they would experience more agency, compared to situations in which outcomes were presented after a temporal delay. Additionally, it was expected that when individuals quickly perceived the outcomes of their actions they were more likely to perceive an ability to control a situation of risk (Study 1), and, were also more likely to take risks (Study 2), compared to situations in which outcomes were presented after a temporal delay. Finally, if agency indeed influences risk-perception and risk-taking, it is likely that the relation between the action-outcome delay and the measures on risk will be mediated through agency. Shorter action-outcome delays would lead to a stronger sense of agency, and this increased agency subsequently would lead to increased perceptions of risk-control and risk-taking. A significant indirect mediation effect is therefore predicted.

## 2. Study 1

### 2.1. Participants

One hundred-and-fifty participants were recruited (94 females;  $M_{\text{age}} = 38.72$ ) using Prolific.ac, an integrated participant recruitment and compensation system that is both diverse and reliable (Peer, Brandimarte, Samat, & Acquisti, 2017). The experiments were conducted using the online environment of Inquisit 5.0. Sample sizes were based on power analyses using G\*Power (Faul, Erdfelder, Buchner, & Lang, 2009): an estimated small effect size ( $f = 0.10$ ; Cohen, 1988), 1% alpha-level, 80% statistical power, and an expected high correlation among repeated measures ( $r = 0.75$ ). The research was approved by the Utrecht University's faculty review board (FETC18-101 Damen).

### 2.2. Method

#### 2.2.1. General setup

Study 1 featured an adaptation of the Balloon Analogue Risk Taking (BART)-task (Lejuez, Aklin, Zvolensky, & Pedulla, 2003; Lejuez et al., 2002). At the start of each trial, participants were presented with the picture of a balloon and a pump-button. Participants were instructed to inflate the balloon by clicking with the cursor on the pump-button. Each click would produce an inflation sound-effect and a 5% larger picture of the balloon. A trial ended after 8 pumps.

#### 2.2.2. Manipulations and instructions

Participants were presented with two types of balloons: The high-agency no-delay balloon would present the pump-button after 500 ms yet inflate (i.e., show a bigger picture and play a sound effect) immediately when the pump-button was clicked. The low-agency delay balloon would immediately present the pump-button, but inflation only occurred 500 ms after participants clicked on it. The 500 ms delay for the presentation of the pump-button in the high agency condition was introduced to keep trial durations similar (see Fig. 1 for a visualization). The different balloon-types were assigned different colors (blue vs. green; randomized between subjects).

After participants inflated 8 balloons (4 high-agency and 4 low-agency balloons in random order) participants were told that when

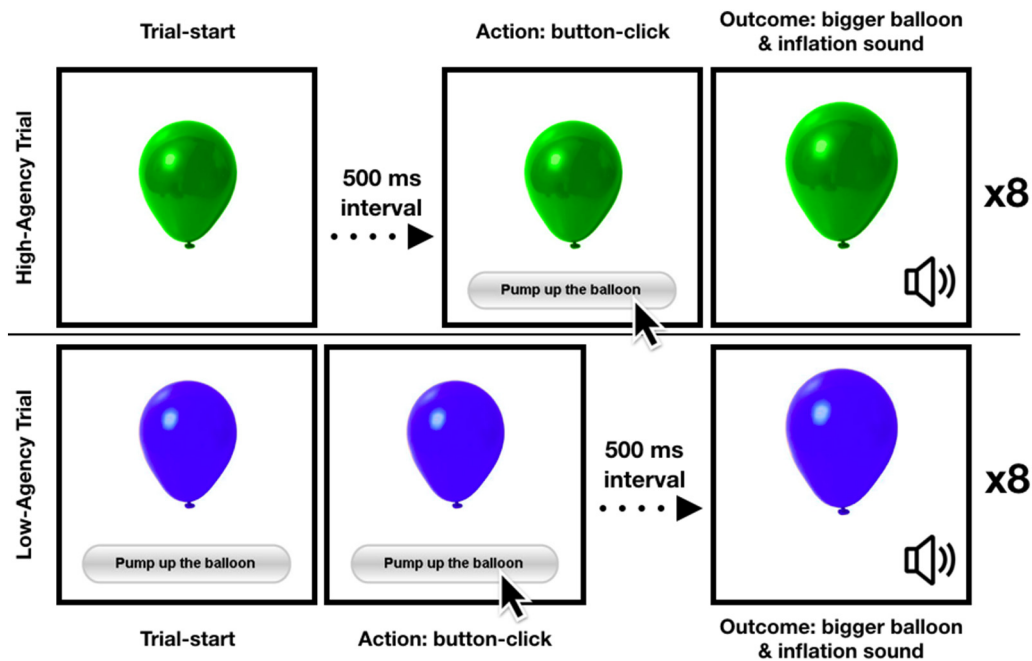


Fig. 1. Visualization of the differences between balloons. The upper half depicts a high-agency trial: outcomes were presented immediately after pumps were given. The lower half depicts a low-agency trial: outcomes were presented 500 ms after pumps were given.

balloons passed a certain threshold of maximum inflation, they would pop. To increase their awareness of this fact, participants were shown a video of a red balloon that was inflated 5 times and then popped (i.e., a picture of a popped balloon and play of a balloon-pop sound-effect). Participants were then told they would inflate the blue and green balloons both one more time. They were also told that if they managed to inflate those balloons 8 times without popping, they would receive a 1ct reward bonus for each pump. However, if the balloon popped, they allegedly received no bonus. In fact, the balloons never popped, and all participants received an additional 16 cts.

### 2.2.3. Dependent variables

After the final inflations, participants were asked 3 questions about each of the balloons: The first question was the main dependent variable, risk-control, which was measured with a Likert-score response to the following question “How confident are in your ability to control the risks associated with this balloon?” (1 = Not at all; 7 = Completely). The second question was a manipulation check (“Did it take a relatively long time for this balloon to expand after clicking?”), and the third featured the proposed mediator agency (“How strongly did it feel as if your mouse-clicks expanded this balloon?”). The task took about 5 min to complete.

## 2.3. Results

### 2.3.1. Manipulation check and hypothesized mediator

A repeated measures Analysis of Variance (ANOVA) showed that participants perceived that immediate-balloons were quicker to inflate after their button-press than the delay-balloons ( $M_{\text{immediate}} = 2.77$ ,  $SD = 1.66$  vs.  $M_{\text{delay}} = 4.14$ ,  $SD = 1.64$ ;  $F(1, 149) = 71.31$ ,  $p < .001$ ,  $\eta_p^2 = 0.32$ ). Furthermore, participants indicated higher agency experiences for the immediate balloons than for the delayed balloons ( $M_{\text{immediate}} = 5.13$ ,  $SD = 1.50$  vs.  $M_{\text{delay}} = 4.60$ ,  $SD = 1.52$ ,  $F(1, 149) = 20.17$ ,  $p < .001$ ,  $\eta_p^2 = 0.12$ ).

### 2.3.2. Perceptions of risk-control

A repeated measures ANOVA showed that participants perceived higher risk-control for the immediate balloons compared to the delayed

balloons ( $M_{\text{immediate}} = 5.23$ ,  $SD = 1.45$  vs.  $M_{\text{delay}} = 4.89$ ,  $SD = 1.51$ ),  $F(1, 149) = 17.33$ ,  $p < .001$ ,  $\eta_p^2 = 0.10$ .

### 2.3.3. Mediation

We tested for mediation using bootstrap-procedures with 5000 random-samples using the MEMORE procedure (Montoya & Hayes, 2017). A lower to upper limit confidence interval wholly below or above the value 0 indicates an effect with a  $p < .05$ . The mediation analysis revealed that agency partially mediated the effects of the balloon-condition on risk-perception, as was indicated by significant direct (LLCI to ULCI:  $-0.43$  to  $-0.18$ ) and indirect effects (LLCI to ULCI:  $-0.14$  to  $-0.01$ ): The immediate balloons led to a stronger sense of agency compared to the delayed balloons, and increased agency in turn was associated with stronger perceptions of risk-control.

## 2.4. Discussion

Study 1's results support the hypotheses: Participants indicated stronger agency for the balloons that quickly inflated after their button-presses compared to the delayed balloons. Furthermore, balloons that quickly inflated were associated with stronger perceptions of risk-control compared to the delayed balloons. Finally, there was both a direct relation between the balloon-types (i.e., the action-outcome delay manipulation) and perceptions of risk-control but there was also an indirect effect via agency. The indirect effect supports the notion that action-outcome delays influence agency, and that agency, in turn, influences perceptions of risk-control. The direct effect of action-outcome delays on perceptions of risk-control is difficult to explain.

Study 1 was designed such that participants experienced the different types of balloons and at the end of study responded on a measure of risk-control. There was therefore a single subjective measure based on previous experiences. The important question is whether similar findings emerge when actual risk-taking is measured, and therefore, whether agency is a relevant predictor of risky behavior. To address this question participants in Study 2 were presented with a traditional version of the BART-task in which balloons could actually pop and participants were therefore required to repeatedly decide whether to continue inflating the balloons or whether to stop. It was expected that

participants would feel more agency and take more risks when balloons inflated immediately compared to balloons that inflated after a small delay, and that agency mediated the relation between action-outcome delay and risk-taking.

### 3. Study 2

#### 3.1. Participants

Study 2 featured more repeated measurements compared to Study 1 (30 vs. 2) in all likelihood also reducing response variance and thus minimum sample size. Seventy participants were recruited (46 females;  $M_{\text{age}} = 33.54$ ) using Prolific.ac using the online environment of Inquisit 5.0.

#### 3.2. Method

##### 3.2.1. Description

This study more closely resembled the classical version of the BART (Lejuez et al., 2002; Lejuez et al., 2003). The crucial differences between Study 1 and 2's paradigms were the following: all pumps were worth 1 ct each; participants could repeatedly decide whether to provide an additional pump or whether to collect the money already earned on that trial; in Study 2 the balloons could actually pop; and the main dependent variable was actual risk-taking behavior (i.e., number of pumps as well as number of popped balloons).

At the start of the BART, a computer screen would display the picture of a small balloon, a pump-button, a reset button labeled "Collect \$\$\$," and a display indicating the money earned on this balloon. With each pump, money was accumulated in a temporary bank. When a balloon exploded, all money in the temporary bank was lost, and the next uninflated balloon appeared on the screen. The participant could stop pumping the balloon at any time and click the "Collect \$\$\$" button. A new balloon appeared after each balloon explosion or money collection until a total of 30 trials were completed. The probability that a balloon would pop was 1/30 for the first pump, 1/29 for the second, and so on until the 30th pump at which point the probability was 1/1. Participants were given no precise information about the probability of the popping of the balloons.

##### 3.2.2. Manipulation

The manipulation was identical to Study 1: The high-agency no-delay balloon presented the pump-button after 500 ms and inflations occurred immediately after clicks on the pump-button. The low-agency delay balloon immediately presented the pump-button, but inflations only occurred 500 ms after participants clicked the pump-button.

##### 3.2.3. Dependent variables

Risk-taking behavior was measured by analyzing the number of pumps on balloons that did not pop, and by comparing the number of popped balloons (see Lejuez et al., 2002; Lejuez et al., 2003). The same items as in Study 1 were used to provide a manipulation check and measure the mediator agency. The task took about 10 min. The overall procedure is visualized in Fig. 2.

### 3.3. Results

#### 3.3.1. Manipulation check and hypothesized mediator

A repeated measures Analysis of Variance (ANOVA) showed that participants perceived that immediate-balloons were quicker to inflate after their button-presses than the delay-balloons ( $M_{\text{immediate}} = 2.65$ ,  $SD = 1.64$  vs.  $M_{\text{delay}} = 4.87$ ,  $SD = 2.24$ ;  $F(1, 70) = 55.64$ ,  $p < .001$ ,  $\eta_p^2 = 0.44$ ). Furthermore, participants indicated higher agency experiences for the immediate than for the delay balloons ( $M_{\text{immediate}} = 7.46$ ,  $SD = 1.77$  vs.  $M_{\text{delay}} = 6.51$ ,  $SD = 1.98$ ;  $F(1, 70) = 21.42$ ,  $p < .001$ ,  $\eta_p^2 = 0.23$ ).

#### 3.3.2. Risk-taking

Participants took more risks with immediate-balloons than with delay-balloons. This was reflected both in the ANOVA on the average number of pumps on balloons that did not pop ( $M_{\text{immediate}} = 9.40$ ,  $SD = 3.47$  vs.  $M_{\text{delay}} = 8.78$ ,  $SD = 3.21$ ;  $F(1, 70) = 7.52$ ,  $p = .008$ ,  $\eta_p^2 = 0.10$ ), as well as for the number of popped balloons ( $M_{\text{immediate}} = 4.47$ ,  $SD = 2.08$  vs.  $M_{\text{delay}} = 3.80$ ,  $SD = 2.25$ ;  $F(1, 70) = 6.23$ ,  $p = .015$ ,  $\eta_p^2 = 0.08$ ).

#### 3.3.3. Mediation

The MEMORE mediation procedure on the average number of pumps revealed a direct effect of the balloon-condition on the number of pumps (LLCI to ULCI: 0.06 to 1.08), but no indirect effect (LLCI to ULCI:  $-0.19$  to  $0.32$ ), and therefore no mediation occurred. However, the mediation analysis on the average number of popped balloons revealed that agency fully mediated the effects of balloon-condition on the number of popped balloons (LLCI to ULCI: 0.01 to 0.66), annulling any direct effects (LLCI to ULCI:  $-0.23$  to  $0.97$ ): The immediate balloons led to a stronger sense of agency compared to the delayed balloons, and increased agency in turn was associated with increased risk-taking.

### 3.4. Discussion

Study 2's results show the same pattern as was observed in Study 1: Participants indicated stronger agency for the balloons that quickly inflated after their button-presses compared to the delayed balloons. Furthermore, balloons that quickly inflated were associated with more pumps and more pops, indicating more risk-taking compared to the delayed balloons. Finally, although no mediation through agency was observed in the analysis on the number of pumps, full mediation through agency was observed in the relation between the balloon-types (i.e., the action-outcome delay manipulation) and the number of popped balloons.

## 4. General discussion

The present research investigated whether individual's experiences of agency could predict perceptions of risk-control as well as actual risk-taking. Two studies indeed showed such a relation: First, agency was successfully manipulated by varying the time between actions and action outcomes. Subsequently, it was shown that on trials on which individuals experienced a strong sense of agency, they were more confident in their ability to control risks (Study 1) and were also more likely to engage in actual risk-taking behavior (Study 2). The present findings thereby add to the literature that showed a relation between perceptions of control and risk: First, they replicate the core idea that cognitions about control are related to perceptions of risk and risk-taking (Dixon, 2000; Horswill & McKenna, 1999; Strickland et al., 1966). Second, they suggest the state-based experience of control known as agency (Marcel, 2003) constitutes an important player in the control-risk relation.

Studies 1 and 2 differed in their methodology. In Study 1, participants first became acquainted with the differences between balloons; were informed balloons could pop but did not experience the popping; and were asked to report their subjective perception of risk-control for the two balloon-types. Study 2 was quite different as participants were immediately confronted with situations in which balloons actually did pop, and repeatedly had to decide whether or not to continue thereby providing an indication of actual risk-taking. Despite being methodologically different, the subjective and objective measures aligned to support a model in which action-outcome delays influenced measurements of risk through agency. This is a novel finding in the risk literature.

The relevant mediation analyses testing the full model showed significant mediation two out of three times: In Study 1 with a

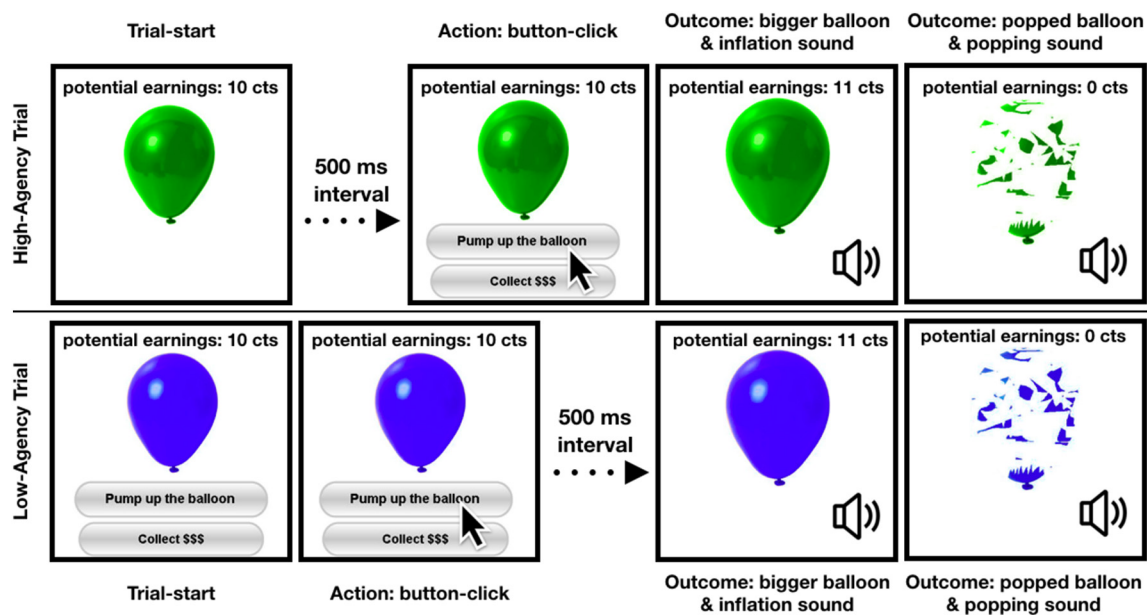


Fig. 2. Visualization of Study 2's procedure. Participants could choose either to bank their potential earnings, or increase those earnings by 1 ct by adding another pump to the balloon. Pumps caused balloons to either become bigger or to pop. The upper half of the figure depicts a high-agency trial: outcomes were presented immediately after pumps were given. The lower half depicts a low-agency trial: outcomes were presented 500 ms after pumps were given.

measurement relating to the perception of risk-control; and in Study 2 on a measurement relating to the amount of popped balloons. There was however no evidence for mediation on the other measurement of risk in Study 2 - that is on the average number of pumps on balloons that did not pop. Although the suggested model would be more convincing if it would show mediation a third time, this measurement was constrained (pumps on popped balloons should not count as argued by Lejuez et al., 2003; Lejuez et al., 2002) limiting the number of trials, decreasing the sensitivity of this measurement. Nevertheless, the fact that the hypothesized mediation was observed twice strongly suggests that perception of risk-control and risky behavior was influenced by action-outcome intervals through agency.

The discovery that agency can predict perceptions of risk-control and risk-taking is important given the malleability of agency (Synofzik et al., 2013). A 500 ms delay manipulation was sufficient to create a change in agency. And there are many factors reported in the literature considered to underlie or influence the sense of agency - time is only one of them. For example, the predictability of outcomes (Blakemore, Frith, & Wolpert, 1999; Moore & Haggard, 2008), response fluency (Chambon & Haggard, 2012; Wenke, Fleming, & Haggard, 2010), and prior planning (Damen et al., 2015) have all been shown to modulate agency experiences. Thus, a picture emerges in which agency can strongly fluctuate depending on subtle situational differences across otherwise very similar situations, subsequently promoting or inhibiting risk-perception and risk-taking.

There is another reason why it is important for future research to investigate the relation between agency and risk using manipulations other than action-outcome delays. Specifically, the literature on risk uncertainty and delay discounting suggests that delayed outcomes may be associated with increased uncertainty (Arai, 1997; Johnson & Busemeyer, 2010) and outcome devaluation (Critchfield & Kollins, 2001), thereby suggesting that delays may reduce risk-taking behavior for reasons unrelated to agency. However, given the profound methodological differences it is impossible to know whether these processes operate in paradigms as presented in the present paper (e.g., in delay discounting studies the hedonic value of immediate rewards is typically compared to that of rewards received days/years/months from now). But more importantly, the mediation analyses clearly indicate that agency is of importance in the relation between temporal delay and

risk-perception and risk-taking. Nevertheless, though the link between agency and risk seems promising, other studies and manipulations would help to more strongly establish this relation.

The present studies addressed a challenge with regards to research on the sense of agency: While informative, the fundamental research in the agency domain has often missed a societally relevant dimension, thereby limiting its impact. Scientists mostly investigated neutral actions, neutral action-effects, and individuals' perceptions of immediate control. Studies that investigate how agency shapes thinking and behavior are rare. The present studies applied insights and manipulations from the fundamental agency domain in a more meaningful context and shows how agency (manipulations) influence behavior in a relevant way.

Do operators take more risk when the machines they work with respond quickly rather than delayed? Are investors more likely to take risks when the interfaces they work with are quicker to show their gains or losses? The present research suggests this may indeed be the case. It revealed that one's immediate experience of performing actions and controlling outcomes, the sense of agency, is predicted by the temporal delay between action and effects. Such delays in turn appear to influence and predict perceptions of risk-control and risk-taking.

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