Does Sense of Agency Make You Take More Risk?

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Abstract

Taking risks constitutes an important part of our daily life. A comprehensive body of research has emphasized that people's perception of control over risks encourages them to underestimate these risks and present much more risk-taking behavior. However, control is a wide and complicated notion so the processes that trigger the association between control and risk are unclear (Damen, 2019). The present study investigated the relationship between the sense of agency, which is defined as a sense of causal control, and risk-taking behavior. In the first phase, predictability of the outcomes of actions was used as manipulation of agency by using a task that included deterministic (fully predictable) action-outcome contingency or random probabilistic (50-50) action-outcome contingency. The amount of sense of agency of the participants at this phase was evaluated with implicit measurement -- intentional binding -- and explicit measurement --ratings of control. At the end of Phase 1, the high or low amount of sense of agency reported by the participants in the explicit measurement question was used as a manipulation check of the agency. In Phase 2, participants performed the Balloon Analog Risk Task to assess risk-taking. Results showed that participants who reported a strong sense of agency tended to take more risks. In addition to the main experiment results, in Phase 1 the finding between implicit and explicit measurements emphasized that these two sense of agency measurement techniques may be related with each other as predictors of the sense of agency. This experiment is the first study that examined the relationship between the sense of agency and risk-taking behavior on the point of the manipulation procedure of agency used -- predictability of the outcomes of actions.

Keywords: Risk-taking, sense of agency, implicit and explicit agency, intentional binding

Many situations that we face in our daily lives require us to make decisions by making choices. However, in some cases, the success/failure or benefit/loss ratio of our decisions are uncertain and unpredictable (Smith, Ebert, & Broman, 2016). In such cases, decisions which are made by using initiative, create the concept of 'risk'. Risky situations, such as driving a vehicle beyond the speed limit, unprotected sex, the impulse to gamble, giving consent for surgery or starting an enterprise project are intertwined with our daily lives, but sometimes these decisions may have unpleasant returns. It is clear the reasons for and causes of risk-taking behavior have considerable implications, but there are still many questions waiting to be answered about which factors trigger decision-making for risky situations (Reyna, & Zayas, 2014; Damen, 2019). Thus, when and under what conditions do people take risks? The present study investigated the relationship between the sense of agency, which is defined as a sense of causal control, and risk-taking behavior.

Let us consider the question of why the idea of traveling by plane is extremely horrible for some individuals. Generally, these people prefer land transport and drive their own cars which are in their control because the take-off of a plane is like an environment which we do not have any effect or control on the incidents that may happen. For this reason, the idea of being a passenger on a plane and giving control to another individual, to a machine or a vehicle can make it scary and unsafe. In fact, when the plane and land vehicles are compared, plane incidents happen less than car crashes and thanks to the technological equipment on the plane, the error margin is at the minimum level (Damen, 2019). Moreover, even the perception of safety that experienced by the driver and passengers in the same vehicle can be different and the risk-taking rates arising from this difference can also vary (Horswill, & McKenna, 1999; Damen, 2019). Thus, our control over the events makes us think that the consequences of these events will be positive, and this leads to more risk-taking.

Previous studies have shown that individuals' perception of a chance to face with the negative events is lower when they compare themselves with the other people and they tend to think, they will be more likely to face with positive events (Weinstein, 1980; Horswill, & McKenna, 1999). In case of more perception of control over a situation exist, this phenomenon named 'unrealistic optimism' or 'optimism bias' is would be felt at a higher level (e.g., Weinstein, 1980). In parallel with this finding, 'unrealistic optimism' is interpreted by some researchers in relation to the concept of 'illusion of control' (Horswill, & McKenna, 1999). Illusion of control can be defined in two ways (Horswill, & McKenna, 1999); according to the first definition, people believe that as a result of the events which are developing under their control, they can be more successful and therefore provide greater positive benefits compared to the events that controlled by others (Horswill, & McKenna, 1999). Even if someone else potentially has the ability to cope better with specific situations, people's perceptions that their own control will have much more positive results are indicative that perceived control may be an illusion (Langer, 1975; Koehler, Gibbs, & Hogarth, 1994; Horswill, & McKenna, 1999).

While the first definition represents people's inappropriate expectations of greater success on the consequences of situations where their perception of personal control is appropriate (Horswill & McKenna, 1999), the second definition of the illusion of control emphasize people also have a propensity to feel control over random outcomes that happen by a chance despite they have no effect and no control over the results (Van Elk, Rutjens, & Van Der Pligt, 2015). For instance, while people select their own lottery ticket themselves, rather than trusting some else's lottery ticket selection for them, they tend to feel more control over the lottery ticket and see it more valuable (Langer, 1975). In addition, when the craps players throw the dice themselves rather than other players' throws (Davis, Sundahl, & Lesbo, 2000) or when roulette players throw the roulette ball onto the wheel themselves rather than a croupier's throws for them, they show a tendency to place a higher amount of bets (Ladouceur, & Mayrand, 1987). These examples suggest that people who feel more in control will take more risks.

People's tendency to overestimate their degree of skill or control over outcomes can be effective in increasing their willingness to take risks in some situations (Tobias-Webb et al., 2017). In the literature, many studies conducted in different domains show the relationship between the perceived control over the specific situations by people and their risk-taking tendencies. As summarized in the study by Horswill and McKenna (1999), experiments on driving behavior (e.g., DeJoy, 1989; McKenna, 1993), health risks (e.g., Weinstein, 1980), sexual behavior (e.g., Klein, & Kunda, 1994), food safety (e.g., Frewer, Shepherd, & Sparks, 1994) and gambling (e.g., Chau & Phillips, 1995) have addressed the relation between perceived control and risk-taking tendency. As emphasized by many studies, when people feel in control over a situation, the risks that they take for that situation are underestimated or ignored by them and therefore they exhibit more risk-taking attitudes compared to situations when they feel no control (Damen, 2019).

Despite much research emphasizing the relation between control and risk-taking, control is a wide and complicated notion and point of the which processes that related to control trigger the risk-taking behavior is still unclear (Nordgren, Van Der Pligt, & Van Harreveld, 2007; Damen, 2019). In the study conducted by Martinez, Bonnefon, and Hoskens (2009) to address these unclear processes, participants attended to a gambling task that would allow them to either earn or lose money. During this experiment, motor involvement of the participants in the gambling task (physical involvement to the gambling apparatus (urn) -- take the balls from it) and their freedom to make choices (urn selection to play) were manipulated by the researchers and the findings showed that physical involvement over an event was an efficient trigger in terms of increasing risk-taking behavior but making choices had no effect on risky decisions. These findings emphasize the importance of the sense of active involvement in risk-taking behavior (Damen, 2019).

The sense of active involvement is a subject that arouses curiosity in the field of cognitive psychology and determines the route of many studies. The contribution of the sense of active involvement over events to the creation of the illusion of control is clearly demonstrated with this experiment conducted by Martinez et al. (2009). From this perspective, the concepts of 'illusion of control' and 'sense of agency (SoA)' can be considered as related concepts in terms of their contents (e.g. the feeling of the agency over the uncontrollable outcomes; Henslin, 1967; Tobias-Webb et al., 2017) (Van Elk et al., 2015). In the words of Haggard and Tsakiris (2009), "the experience of agency refers to the experience of being in control both of one's own actions and, through them, of events in the external world." The term 'one's own action' refers to voluntary motor actions (rather than movements that result from brain stimulation, or reflexes) (Haggard, 2017). In fact, we often experience the concept of SoA in our daily lives. For example, when we press the pedestrian crossing button to make the light green for pedestrians, we think that our button-press action caused the green light; or in an elevator, when we press the 'close door' button to close the elevator door earlier we think that the behavior caused the door to close earlier is our button-press, -- although they usually do not work (placebo buttons) (Moore, 2016; McRaney, 2013). These examples reveal, there is a clear relationship between the person's action, that is, motor involvement over events and the appearance of SoA (Damen, 2019).

However, even if the person performs the action, the agency that felt by the person can be changed through manipulations because some external parameters and internal psychological processes have an important function for the change in the amount of SoA (Moore & Haggard, 2008; Synofzik, Vosgerau, & Voss, 2013; Damen, 2019). For example, in the literature, it is emphasized that the length of the time interval between the movement of a person and the outcome of that movement is a factor that plays a crucial role over the manipulation of SoA. As that time interval becomes shorter, the SoA tends to be felt more strongly (Sato & Yasuda, 2005). Another effective determinant for a strong SoA is not to perceive any others as a potential agent -- i.e. supernatural agents such as God (Wegner, 2003; Dijksterhuis, Preston, Wegner, & Aarts, 2008). Thus, individuals experience a stronger agency (active involvement) over the outcome (Damen, 2019). Moreover, to define another factor that affects the amount of SoA, it is an important point that the SoA originates from the causality between voluntary actions and outcomes, therefore it is often associated with the concept of causality. At this point, 'the internal predictive model' (also known as the forward model), which is a crucial account in terms of SoA, can be taken into consideration in relation to the concept of causality (Moore, Dickinson, & Fletcher, 2011). According to the proposition of this model, in the words of Van Elk et al. (2015), "efferent signals from motor-related areas are used to anticipate the sensory consequences of one's movements." In this case, if there is a mismatch between the predicted outcomes and the observed outcomes for individuals, 'prediction error signal' occurs and this error causes individuals to associate the outcomes with an external cause rather than themselves (Van Elk et al., 2015). However, if the outcomes of movements are predictable for individuals, an increase in the amount of SoA happens (e.g., Frith, Blakemore, & Wolpert, 2000; Sato, 2009 Experiment 3). Given that predicting the outcomes of movements accurately is a predictor for successful learning, the contribution of learning is taken into account by this model (Moore et al., 2011; Moore, & Obhi, 2012). The action-outcome contingency procedure which was also used in the present study is based on learning the causality connection between action and outcome (Moore, & Obhi, 2012).

The concept of SoA is considered as a complicated and multifaceted phenomenon due to its content (Kumar, & Srinivasan, 2013). Generally, two crucial aspects of agency --

explicit and implicit aspects -- have been discussed and evaluated in detail at the point of measurement of SoA in laboratory settings. The explicit agency takes into account the reflective attributions (also known as the sense of authorship) of an individual's control over an event, and its measurement is carried out through subjective control ratings --self-report (Tobias-Webb et al., 2017). There are different factors that affect the authorship reports of individuals. For example, in an action-outcome relationship, when the outcome does not match expectation gained from prior learning experiences, temporally delayed, or spatially distorted, people evaluate someone else as an author rather than themselves (Sato, & Yasuda, 2005; Farrer, Bauchereau, Jeannerod, & Franck, 2008; Dewey, & Carr, 2013; Dewey, & Knoblich, 2014).

In addition to explicit measurement, an implicit measurement which is another agency assessment method is highly correlated with the term of intentional binding. With the words of Kumar and Sirinivasan (2013), "intentional binding refers to the finding that participants perceive the self-generated action and its effect to be temporally closer to each other" (Haggard, Clark, & Kalogeras, 2002). In the literature, the existence of a strong link between intentional binding and SoA has been emphasized in point of its relationship with implicit agency measures --causal and sensory feedback, intention and efference (Moore, & Obhi, 2012; Kumar, & Srinivasan, 2013). Therefore, the existence of a stronger intentional binding represents a high amount of SoA (Kumar, & Srinivasan, 2013). Moreover, action-outcome contingency -- learning the causal connection between action and outcome -- (Moore, & Obhi, 2012) and the factors such as action-outcome congruence and the valence of outcomes were evaluated as important determinants for intentional binding (Ebert, & Wegner, 2010; Takahata et al., 2012; Dewey, & Knoblich, 2014). In the Intentional binding studies, two measurement methods are used; Libet Clock and interval estimation task. The purpose of the Libet Clock (Libet et al., 1983) is measuring the perceived time between intention and voluntary action, or between voluntary action and subsequent event by using participants' reports about the position of the spot on the clock-face (Dewey, & Knoblich, 2014). As an alternative, interval estimation method is a more direct measurement than the Libet clock, and it includes the principle of evaluating the perceived time interval between two events by using numerical estimates or verbal judgments (Dewey, & Knoblich, 2014).

Besides the experiments using only one of these SoA measurement methods, some studies have examined the relationship between them. According to the experiment conducted by Ebert and Wegner (2010), the consistency of action-subsequent event was manipulated, and the effect of manipulation was investigated on both SoA measures with two studies. Participants' amount of SoA was measured through explicit measurement by using a question and implicit measurement by using the interval estimation task between action and event. In Study 1, explicit and implicit measurements were applied to the participants after each trial, whereas in Study 2, they were applied in separate blocks. Results indicated that action-event consistency increased both measurement methods in general. However, the fact that the overlap between the two measurement methods only appeared in Study 1 emphasized the implicit and explicit measurements have partially dissociable mechanisms. As a result, it still remains unclear whether the underlying mechanisms of intentional binding and explicit measurement methods are common or separable, and this subject has started to constitute the focal point of the recent studies (Obhi, & Hall, 2011; Moore, & Obhi, 2012).

The results from the SoA studies reveal that the amount of experience of control and active involvement can be altered through experimental manipulations. In our daily life, the small changes we experience while perceiving events and performing actions correspond to these manipulations. It is possible to infer that SoA is fluctuating rather than fixed sense according to these indicators (Damen, 2019). At this point, how the alteration in the amount of agency through manipulations can be reflected in the risk-taking behavior which intertwined with our daily lives emerges as an important research subject.

The Balloon Analogue Risk Task (BART; Lejuez et al., 2002) is a behavioral laboratory measurement technique that focuses on individual differences in risk-taking behavior (Ferrey, & Mishra, 2014). In the development of this computer-based task, some limitations and deficiencies that have arisen as a result of measuring risk-taking behaviors through self-report techniques have played an effective role. Some factors such as memory problems or incorrect introspections appear in the self- report measures as limitations for the assessment of risk-taking behaviors (Benjamin, & Robbins, 2007). According to the principle of BART, participants are presented with an animated virtual balloon and are expected to inflate it by pumping. The explosion point of the balloon is based on a schedule of probability. Each pump-up increases the balloon size and the monetary reward of the participants, but if the balloon explodes, they lose all virtual money that they earned from it. Moreover, participants can decide to stop pumping action at any time and transfer the virtual money that they earned from that balloon to the permanent bank. This task depends on the attitude of participants to decide between earning more monetary reward by risk-taking or taking a certain, lower reward by ending the trial. Many studies that emphasized the validity of BART have shown that there is a strong consistency between the risks taken in the BART and in the real world (Ferrey, & Mishra, 2014). For example, people who tend to take risks in terms of alcohol, smoking, illicit drug use (Lejuez et al., 2003a; Fernie, Cole, Goudie, & Field, 2010), aggression, gambling, and unprotected sex (Lejuez, Aklin, Zvolensky, & Pedulla, 2003b, Lejuez et al., 2004) show greater risk-taking behavior in the BART (Ferrey, & Mishra, 2014 for detailed review).

To summarize, the relationship between risk-taking and control perception have been investigated by different studies (e.g., Strickland et al., 1966; DeJoy, 1989; McKenna, 1993;

Klein, & Kunda, 1994; Frewer et al., 1994). The findings draw attention to the existence of the relationship between these two fields. Control is a complex and broad area. Therefore, the processes that trigger the relationship between perceived control and risk-taking behavior are unclear (Nordgren et al., 2007; Damen, 2019). However, the effect of motor involvement on the risk-taking behavior found by Martinez et al. (2009) brings to mind that the SoA – the experience of active involvement --, which is the starting point of the present experiment, may be related to the risk-taking behavior. The SoA specifically requires motor actions/involvement (Haggard, 2017) over events as a first condition and then the amount of SoA can be altered by various manipulations. The predictability of the outcomes of individuals' actions is one of these factors (e.g., Frith et al., 2000; Sato, 2009). The studies conducted so far have focused on the change in the amount of SoA by using different manipulations and the results have been interpreted from a cognitive perspective, but they often have not been investigated in point of their relationships with socially important behaviors. In the present study, the relation between SoA and risk-taking, which traditionally has been studied at the cognitive perspective and at the social perspective separately, was investigated.

In the literature, there is only one study that focuses on the relationship between SoA and risk-taking (Damen, 2019). In order to manipulate SoA, a temporal delay between the action and the outcome was used and it was assumed immediate outcomes after the action would increase the SoA, while delayed outcomes would reduce it. As a result of the study by using BART for measuring risk-taking behavior, it was determined, participants with a high amount of SoA which was measured using the explicit SoA question had more control over risks and were more prone to risk-taking. Although the idea of the study of Damen (2019) shows similarities with the present study in terms of the focused subject, it differs in terms of manipulation procedure used for the SoA. The present study is the first study that focuses on the relationship between SoA and risk-taking in terms of SoA manipulation procedure used – matching between predicted and observed outcomes -- and this study also contributes to the gap in the literature. Moreover, considering that the relationship between the two measurement techniques of SoA, namely the explicit and implicit measurements, is unclear (Haggard, 2017), this research also investigated whether there is a relationship between two measures of SoA.

Within the scope of the present study, an experiment consisting of two phases was carried out. In Phase 1, implicit and explicit measurements of SoA were collected by using simple action-outcome contingency task. The match between the predicted and observed outcomes was considered as a trigger for the increase of SoA (e.g., Frith et al., 2000; Sato, 2009). Therefore, deterministic action-outcome (100% deterministic key- color contingency, fully predictable) and random action-outcome (50% - 50% key-color contingency) contingencies manipulated between groups of participants. At the end of Phase 1, the reported amount of SoA by participants in the explicit measurement question was used as a manipulation check of the agency. In Phase 2, the risk-taking behaviors of the participants who divided into two groups according to whether they experience the SoA were measured by using a version of the BART. For the results, it was expected that in the implicit measurement task, participants who experienced the deterministic action-outcome contingency – participants who reported a high amount of SoA in the explicit measurement -- would have shorter interval estimations compared to participants who experienced the random action-outcome contingency due to increased SoA. In addition, as the main hypothesis, it was expected that participants in the Deterministic Action-Outcome Group would tend to take more risks by inflating the balloon a greater number of times.

Method

Participants

A total of 63 University of Kent students were recruited in this study. The data of 13 participants were excluded from the total sample; 8 participants for inappropriate authorship evaluation on the explicit SoA measurement, 3 participants for failure on learning key-color association, 2 participants for technical problems caused by the software. After data exclusion, 50 eligible participants aged between 18 and 34 (M = 20.88, SD = 3.20) remained (41 females; 9 males).

All participants were informed with an information sheet (Appendix C) and informed consent (Appendix D) was obtained before their participation. At the end of the experiment, each participant was informed about the content of the research through the debriefing form (Appendix E). In addition, all participants were told that they could get information about the findings of the research and that they could ask any questions they wanted. The study was approved by the University of Kent Psychology research ethics committee (Appendix B). It was carried out in accordance with the World Medical Association's Declaration of Helsinki. Participants who were recruited via the university's online research participation scheme (RPS) were awarded 2 RPS course credits at the end of the experiment. Furthermore, after the participant recruitment process of the experiment was completed, the top two scorers of the BART were awarded with £10 valued Amazon voucher. The purpose of the award was to observe the risk-taking behaviors by increasing the motivation of the participants to make the most money in the BART.

Research Design

Between subject design was used in the research and the participants were randomly divided into two groups namely Deterministic Action-Outcome(A-O) Group ($N = 25$) and Random A-O Group ($N = 25$). In the experiment, the independent variable of the experiment was obtaining either a deterministic action-outcome training or random action-outcome training. The intention was to produce a stronger SoA in the Deterministic A-O Group, compared with the Random A-O Group. We used the explicit SoA ratings to check whether our intended manipulation was successful, and excluded any participants for whom the manipulation did not work. The dependent variable was risk-taking behavior measured by the number of balloon pumps in the BART in terms of Deterministic A-O Group and Random A-O Group.

Furthermore, for the interval estimation measure, the dependent variable was participants' estimations of the length of the interval in the intentional binding question in terms of their groups.

Procedure

The experiment was programmed in PsychoPy3. Each participant was tested individually in the School of Psychology Research Lab of the University of Kent for approximately 30 minutes. The present study consisted of two computer-based phases. In Phase 1 which was the manipulation phase for the main experiment, participants were presented with two different outcomes that were fully predictable or random probabilistic according to the participant's actions. In addition to the explicit SoA measurement that applied for manipulation check at the end of the task, the implicit SoA measurement was performed during the task and additional findings which were independent of the main experiment (SoA and risk-taking) were obtained. In Phase 2, participants completed BART where the risk-taking behavior was measured.

Before passing to the computer-based phases, all participants completed the Barratt Impulsiveness Scale (BIS-11; Patton, Stanford, & Barratt, 1995) which evaluates the personality and behavioral structure of impulsiveness (Appendix A). BIS-11 is one of the most used self-report impulsiveness measurements in the literature and involves 30 items. It includes three subscales called cognitive impulsiveness, motor impulsiveness and non-planning impulsiveness (Patton et al.,1995; Vasconcelos, Malloy-Diniz, & Correa, 2012). In the current study, BIS-11 scores were used to check the similarity of the participants' impulsivity levels at baseline to ensure one group was not more impulsive than the other, on average, before the experiment began.

Phase 1 – Interval Estimation Task

In this phase, participants were asked to estimate the time interval between their actions and produced outcomes as an implicit measurement of SoA and they were also asked to answer the question of the sense of authorship at the end of the phase as an explicit measurement of SoA (**Fig. 1**). The instructions which were given to the participants told, the first phase of the experiment consisted of two parts: the practice part and the main part. Before the practice part, it was stated that they have to make time interval estimation after each trial. Moreover, they were also informed by examples about the meaning of the concept 'millisecond' – 1000 millisecond is 1 second and an eye blink takes approximately 200 milliseconds (see Ebert, & Wegner, 2010 for details of the instruction).

At the beginning of each trial, participants pressed either the 'D' key or the 'L' key, according to their choice. The visual stimulus presentation according to participants' keypress was different for Random A-O Group and Deterministic A-O Group. 100% deterministic action (keypress) and outcome (balloon color) association were presented to Deterministic A-O Group participants. For example, when they pressed the key 'D', the blue balloon always appeared on the screen and when they pressed the key 'L', the yellow balloon always appeared on the screen. The balloon colors associated with each key were counterbalanced between the Deterministic A-O Group participants. However, the association between action and outcome was completely random for the Random A-O Group participants. Regardless of whether the participant pressed the key ‘D’ or the key ‘L’, blue balloon or yellow balloon was presented randomly. At the beginning of Phase 1 (prior to the practice part), all participants were asked to press both keys (‘D’ or ‘L’) an approximately equal number of times in order to ensure that they learned which key caused which visual stimulus.

The practice part consisted of 10 trials. The key-color association used for the Random A-O Group and for the Deterministic A-O Group was the same in the practice part as well. At the beginning of each trial, a fixation cross was presented which indicated that participants can press the key whenever they want to initiate the trial. Following their keypress, a blue balloon or yellow balloon appeared on the screen after a randomly selected interval (30 ms, 170 ms, 210 ms, 340 ms, 400 ms, 590 ms, 680 ms, 720 ms, 860 ms, 950 ms) and participants continued to see the fixation cross throughout the delay. At the end of each trial, by using a scale which ranged from 0 ms to 1000 ms, participants were asked to answer the question: 'How much time passed between your keypress and the balloon (in msec)?’. In addition, after the time interval estimation of the participants at the end of each trial, the feedback was given about the actual delay. The practice part played key roles for the main part. Firstly, the participants both recognized the content of task and improved their ability to estimate time interval and assess it. Secondly, it allowed participants to believe that the time intervals were also varied during the main part and that it included those 10 intervals.

The main part consisted of 60 trials. In this part, participants were presented with the same key-color associations as the practice part. Presented key-color associations differed according to the manipulation content of the groups in which the participants were involved. In the same way as the practice part, at the main part of Phase 1, the participants saw a fixation cross which was indicating that they can press the key whenever they want on the screen. The fixation cross remained on the black screen throughout the delay time after pressing the key. However, there were fundamental changes separating the main part from the practice part. Firstly, three different delays - 100 ms, 400 ms, 700 ms - were used between the participants' keypress and the appearance of the visual stimulus (Ebert, & Wegner, 2010). Each of these delays was randomly presented in 20 of the 60 trials, regardless of which keys the participants pressed and the key-color association. At the end of each trial, participants answered the question: 'How much time passed between your keypress and appearance of the balloon (in msec)?’ and reported their interval estimations on a scale which ranged from 0 ms to 1000 ms. However, unlike the practice part, no feedback was given about their interval estimation and actual delay in the main part. At the end of Phase 1 which consisted of 60 trials, all participants reported their sense of authorship with the question: ‘In the interval estimation task, to what extent do you feel the color of the balloons was caused by the keys you selected?’ on a scale which ranged from 0% to 100% as an explicit measurement of SoA. Afterward, two more questions were asked to the participants which were: 'What color of balloon did you get when you pressed 'D' key?' and 'What color of balloon did you get when you pressed 'L' key?' to check whether they have learned the key-color association according to group which they were in.

At the end of Phase 1, the question of the explicit SoA measurement was accepted as the manipulation check question for Phase 2. In this question, the data of the Random A-O Group participants who reported less than 50% sense of authorship and the Deterministic A-O Group participants who reported above 50% sense of authorship were involved to analysis at the end of the experiment. Furthermore, participants' answers to the question of key-color association learning according to their groups were used as exclusion criteria for data analysis. While Deterministic A-O Group participants learned the key-color association, Random A-O Group participants were expected not to report a key-color association.

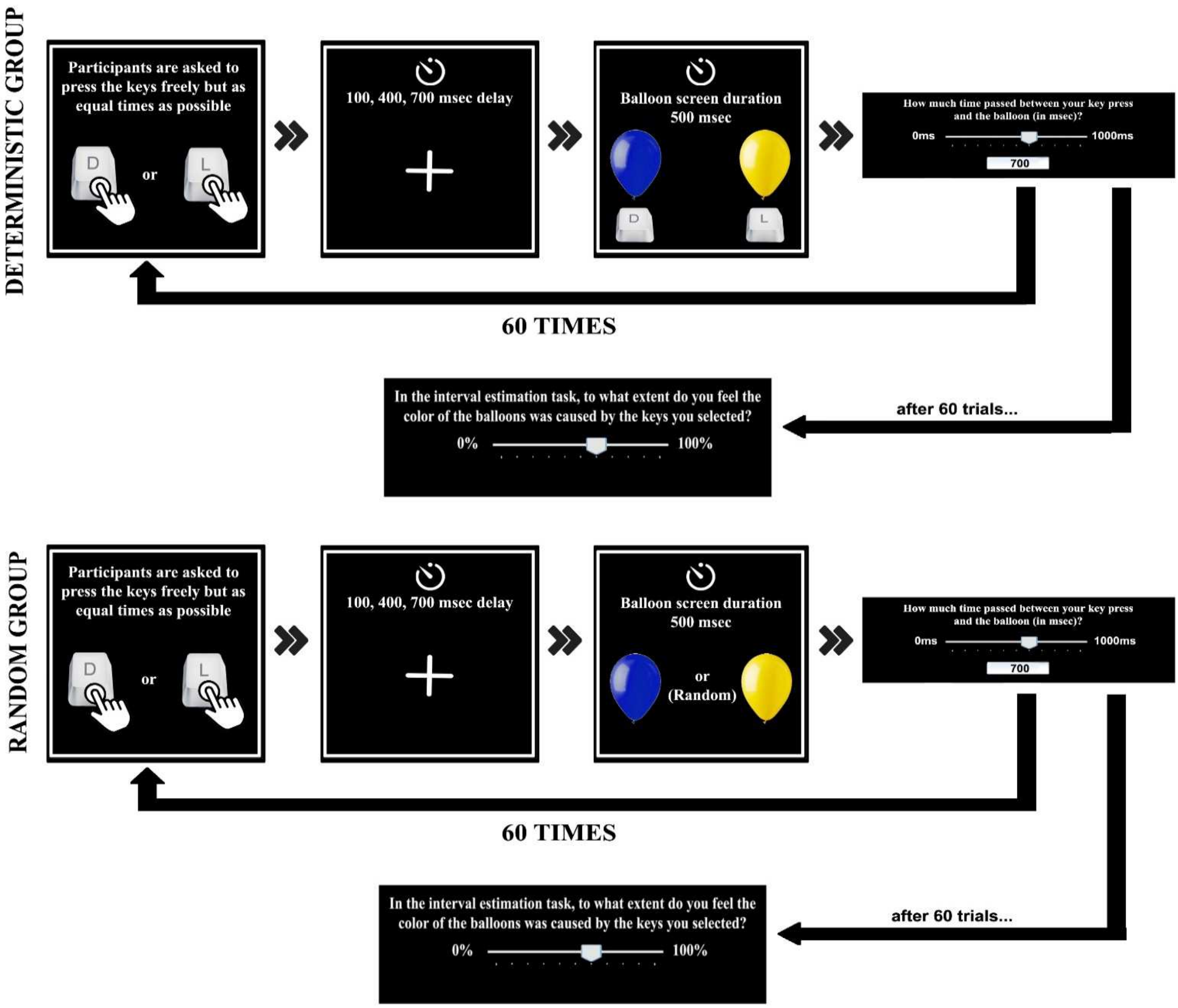


Fig. 1. Overview of the content of the Interval Estimation Task.

Phase 2 – The Balloon Analogue Risk Task

In Phase 2, the effect of SoA that was manipulated in Phase 1 on risk-taking behavior was evaluated by using a version of the BART. Before starting Phase 2, participants were asked to try to earn as much virtual money as possible in the BART and they were informed that the two top scorers of the BART will receive a voucher at the end of the data collection process from all participants. The reward system was implemented to increase the motivation of the participants on the task. In accordance with the content of the BART, at the beginning of each trial, the computer screen consisted of a small simulated balloon and a permanent money box that labeled as 'Total Earned'. Participants earned £0.05 from each pump that inflates the balloon. While each pump increased the size of the balloon, it also increased the likelihood of an explosion of the balloon. At any time, participants could stop pumping and they could collect the money which they earned from the balloon, but when the balloon exploded, all the money which they earned from that balloon was lost (**Fig. 2**). All the balloons presented in the experiment had the same probability of an explosion. The probability of each balloon explosion was 1/100 on the first pump, 1/99 on the second pump, 1/98 on the third pump, etc. and it was 1/1 on 100th pump which was the maximum number of pumping.

Phase 2 consisted of two parts; main part and practice part. In the practice part, there were 5 trials and participants were presented with a white balloon on each trial. They used the 'ENTER' key to pump the balloon and the 'SPACE' key to collect earned money. The aim of the practice part was to familiarize the participants with the content of the BART and prepare them for the main part. The money earned from the white balloons in the practice part was not added to the total money score of the participants at the end of the BART.

After completing the practice part, participants passed to the main part. In the task, there were 30 trials which included 3 different balloon colors; blue balloon, yellow balloon, and grey balloon. Each balloon color was presented 10 times to the participants in random order during the BART. While participants used the 'D' key to pump the blue balloons, the 'L' key to pump the yellow balloons, and the 'H' key to pump the grey balloons, they used 'SPACE' key to collect money before the explosion of the balloon.

In Phase 2, Deterministic A-O Group participants used the keys which caused a specific balloon color in Phase 1 to inflate the balloon which has the same color. For example, participants who saw a blue balloon when they pressed the ‘D’ key in Phase 1 were instructed to inflate the blue balloon by pressing the ‘D’ key in Phase 2. However, the balloon colors and the keys which were used to inflate these balloons were meaningless for the Random A-O Group participants because they exposed to a random key-color contingency in Phase 1. Furthermore, the grey balloon which was presented additionally to blue and yellow balloons was a completely new balloon color for the participants that they had not encountered. The grey balloon was included in the experiment as a neutral balloon color to determine whether the effect of SoA generalizes beyond the particular key-color associations formed.

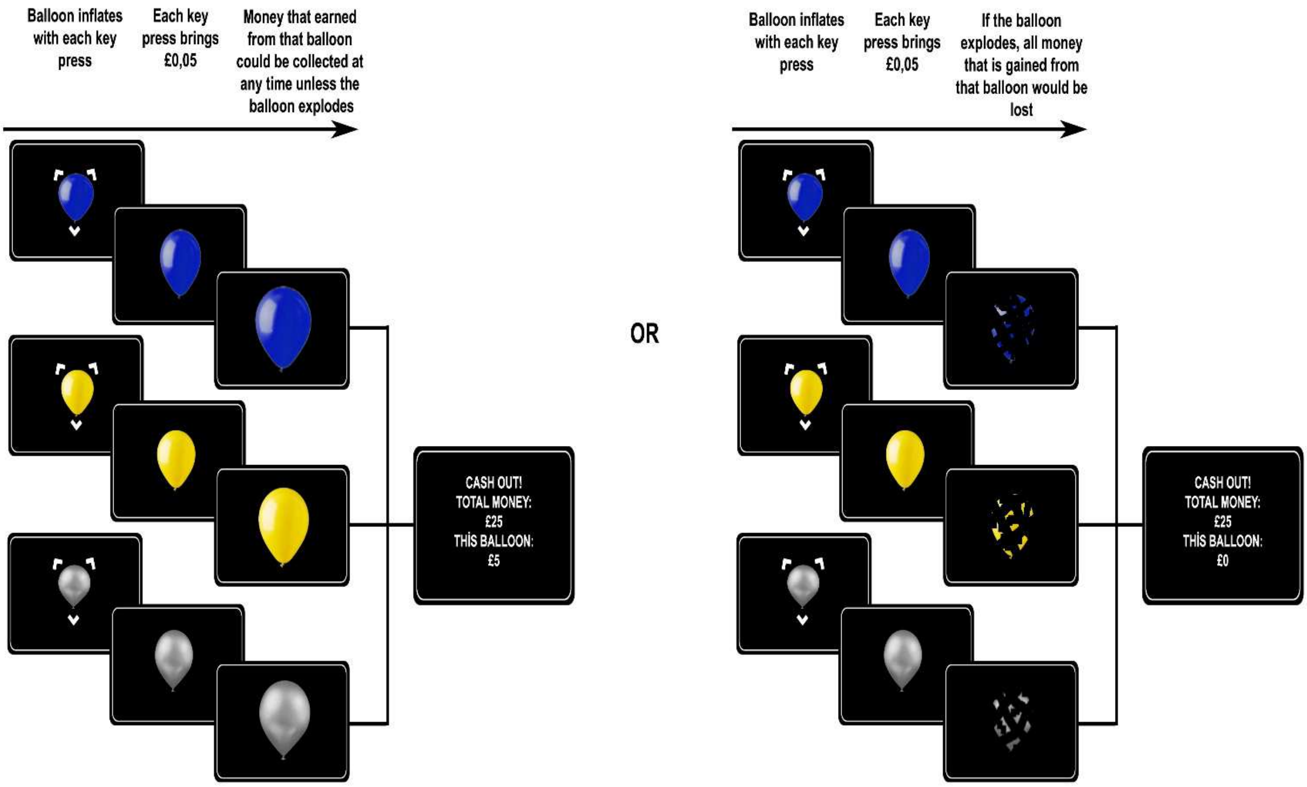


Fig. 2. Overview of the content of BART. There are 60 trials in total (20 trials of each balloon color) and blue, yellow and grey balloons are presented to participants in random order.

Results

Barratt Impulsiveness Scale (BIS-11)

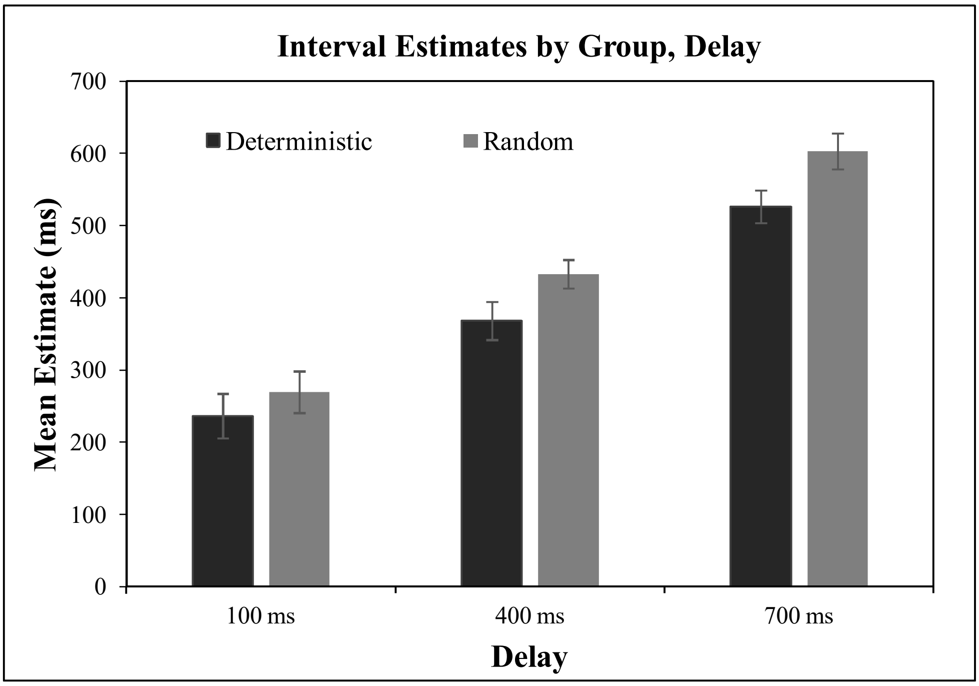
The independent sample t-test was used to analyse the differences in the impulsivity levels of the Deterministic A-O Group participants and the Random A-O Group participants before the experiment. As a result of the analysis that conducted according to BIS-11 scores, no statistically significant difference was found between Deterministic A-O Group participants ($M = 63.52$, $SD = 8.39$) and Random A-O Group participants ($M = 63.16$, $SD = 6.69$) ($t\ (48) = .17$, $p = .867$, $d = .05$). These results emphasize that there was no significant difference between the impulsivity levels of the two group participants before their participation in the experiment.

Interval Estimation Task

For binding analysis, first of all, the actual interval between keypress and appearance of stimuli was subtracted from the estimated interval which was given as an answer to the implicit measurement questions by each participant at the end of each trial. Then, these subtraction results were grouped according to their actual intervals (100 ms, 400 ms, 700 ms) and the average of them was taken. 2 x 3 (Group x Delay) mixed factors Analysis of Variance (ANOVA) was carried out on participants' mean interval estimation errors. Mauchly's Test of Sphericity indicated that the assumption of sphericity was violated therefore the Greenhouse-Geisser correction was used, $\chi^2(2) = 55.66$, $p < .001$.

The main effect of Group (Deterministic A-O Group or Random A-O Group) was determined to be significant $F(1, 48) = 4.30$, $p = .043$, $\eta_p^2 = .08$. As expected, Deterministic A-O Group participants, -- in other words, the participants who reported a high amount of SoA on the explicit SoA measurement question -- estimated shorter intervals than the actual time ($M = -22.98$ ms) compared to Random A-O Group participants ($M = 35.35$ ms) in intentional binding reports -- implicit measurement of SoA. After confirming that participants' interval estimations were generally appropriate for the group that they were in, the main effect of the delay was highly significant $F(1.18, 56.67) = 101.56$, $p < .001$, $\eta_p^2 = .68$. Regardless of group difference, participants tended to overestimate the delay of 100 ms ($M = 153.10$ ms) and underestimate the delay of 700 ms ($M = -135.28$ ms). They also estimated a very close interval to actual delay for the delay of 400 ms (M = 0.73 ms). As shown in **Fig. 3a**, both Deterministic A-O Group participants and the Random A-O Group participants reported longer interval estimations than the actual interval for delay of 100 ms (Deterministic A-O Group, $M = 236.53$ ms; Random A-O Group, $M = 269.68$ ms), and reported shorter interval estimations than the actual interval for delay of 700 ms (Deterministic A-O Group, $M = 526.24$ ms; Random A-O Group, $M = 603.21$ ms). In addition, for the 400 ms delay, while the Deterministic A-O Group participants reported shorter intervals ($M = 368.30$ ms), the Random A-O Group participants estimated longer intervals than the actual interval ($M = 433.16$ ms). However, the Group x Delay interaction was not significant $F(1.18, 56.67) = 0.62$, $p = .458$, $\eta_p^2 = .01$.

a



b

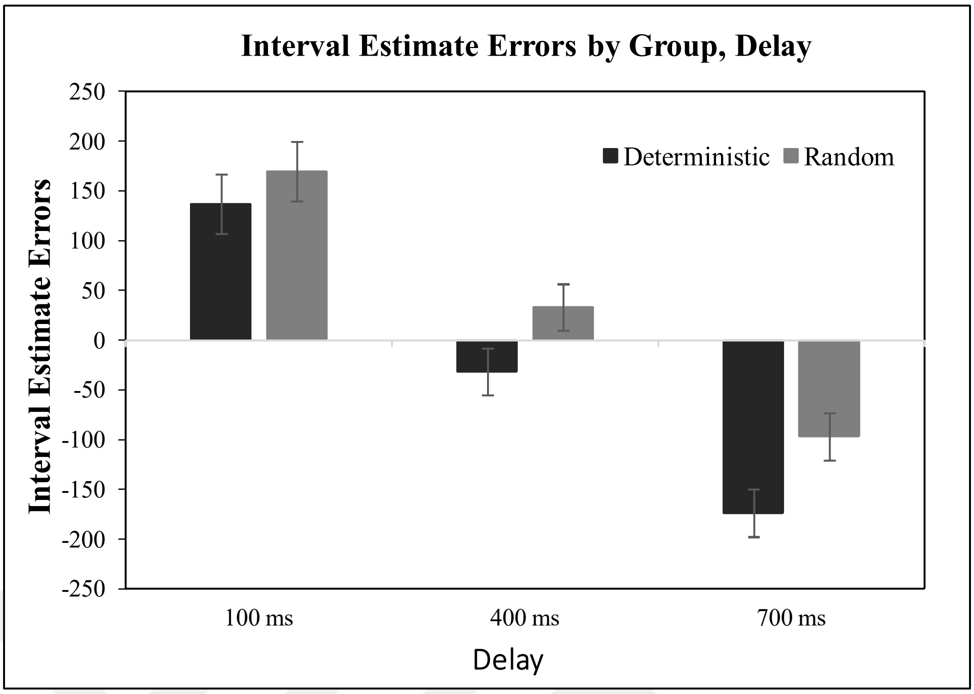


Fig. 3. Graphs are (a) mean interval estimates and (b) interval estimate errors (estimated interval – actual interval) by group and delay in Interval Estimation Task. Error bars display Standard Error (SE) across participants.

The Balloon Analogue Risk Task (BART)

The performance of the participants on BART was calculated based on the adjusted number of pumps score (see Lejuez et al., 2002). The adjusted pumps represent the average number of pumps when the balloon does not explode (when participants stop pumping the balloon and transfer the earned virtual money to the bank). Higher adjusted pump scores of the participants correspond to greater risk-taking behavior. At the first stage, the balloons which were unexploded were grouped according to their colors and the number of pumps of the participants was averaged for each group of balloon colors. For analysis, 2 x 3 (Group x Balloon color) mixed factors ANOVA performed on the adjusted number of pump scores of participants. Mauchly's Test of Sphericity indicated that the assumption of sphericity was violated therefore the Greenhouse-Geisser correction was used, $\chi^2(2) = 10.67$, $p = .005$.

Results revealed the significant main effect of balloon color, $F(1.66, 79.79) = 3.66$, $p = .038$, $\eta_p^2 = .07$. The adjusted pump scores of the participants were higher for the blue balloon ($M = 24.32$, $SD = 1.49$) and yellow balloon ($M = 24.89$, $SD = 1.52$) than the grey balloon ($M = 22.00$, $SD = 1.42$). However, the main effect of the group was not significant $F(1, 48) = 2.36$, $p = .131$, $\eta_p^2 = .05$, so independently from the balloon color, there was no significant difference in participants' adjusted number of pumps in terms of the group which they were in. In addition to these findings, the analysis showed a highly significant Group x Balloon Color interaction, $F(1.66, 79.79) = 5.17$, $p = .011$, $\eta_p^2 = .10$.

To examine the effect of balloon color in terms of the groups in which the participants were in, Post hoc analysis with Bonferroni correction -- two separate one-way ANOVAs for each group -- was carried out. According the results by evaluating with Greenhouse-Geisser correction ($\chi^2(2) = 10.04$, $p = .007$), the main effect of balloon color was significant for Deterministic A-O Group, $F(1.48, 35.46) = 5.63$, $p = .026$, $\eta_p^2 = .19$. While the adjusted pump scores of the participants in the Deterministic A-O Group were significantly higher for the yellow balloon ($M = 28.25$, $SD = 2.32$) than the grey balloon ($M = 21.95$, $SD = 2.11$, $p = .023$), there was no significant difference between the yellow balloon and the blue balloon ($M = 27.11$, $SD = 2.36$, $p = 1.000$). In addition, although the adjusted pump scores for the blue balloon were higher than the grey balloon, this difference was not significant ($p = .12$). Moreover, results by evaluating with Sphericity Assumption ($\chi^2(2) = 2.26$, $p = .323$) revealed the main effect of balloon color was not significant for Random A-O Group, $F(2, 48) = .15$, $p = 1.000$, $\eta_p^2 = .01$ so they had similar adjusted pump scores for all balloon colors (**Fig. 4**).

As a result, while Deterministic A-O Group participants took more risk on blue and yellow balloons, Random A-O Group participants generally tended to take less risk than Deterministic A-O Group participants for all balloon colors.

In addition to the adjusted pump score analysis to measure risk-taking behavior, the mixed factors ANOVA was carried out on the average number of popped balloons as well. Mauchly's Test of Sphericity indicated that the assumption of sphericity was not violated therefore the Sphericity Assumption was used, $\chi^2(2) = 1.63$, $p = .443$. The results revealed that there was no significant main effect among the participants in terms of balloon colors ($F(2, 96) = 1.14$, $p = .323$, $\eta_p^2 = .02$), and their group ($F(1, 48) = 3.67$, $p = .061$, $\eta_p^2 = .07$). Furthermore, the interaction effect between balloon color and group was not significant for average number of popped balloons, $F(2, 96) = 1.93$, $p = .151$, $\eta_p^2 = .04$.

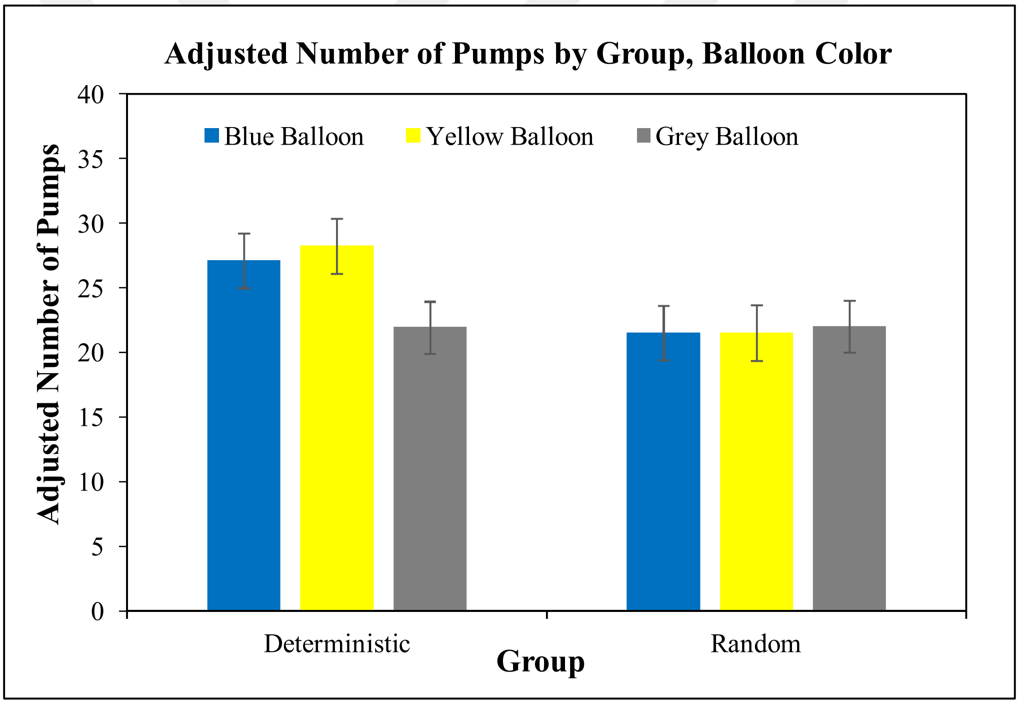


Fig. 4. Mean adjusted number of pumps by group and balloon color. Error bars show SE across participants.

Discussion

The present study aimed to investigate whether the SoA could affect risk-taking behavior. Our findings showed that the SoA is an important predictor for risk-taking; individuals who had a strong SoA (Deterministic A-O Group participants) were more likely to take a risk. This result is in line with the only study which was done about the relationship between SoA and risk-taking (e.g. Damen, 2019).

Firstly, in Phase 1, the agency was successfully manipulated by using the procedure of predictability of the outcomes of the actions – by using the A-O contingency task. This procedure is thought to have an important role for SoA manipulation (Frith et al., 2000; Blakemore et al., 2002; Moore et al., 2011). At the end of Phase 1, the explicit SoA measurement question was used to check whether the manipulation was successful. This measurement enabled us to ensure the amount of SoA of the participants before the BART. In the literature, there are numerous studies analysed by explicit and implicit SoA measures supporting the fact that the predictability of the outcome of actions – causal role of A-O relation -- is a valid manipulation procedure for the SoA (e.g. analysed by explicit SoA measurement; Sato, & Yasuda, 2005; Van Der Weiden et al. 2011, analysed by implicit SoA measurement; Engbert, & Wohlschläger 2007; Moore, & Haggard 2008; Voss et al. 2010). However, the relationship between these two methods remains unclear in terms of measuring the amount of SoA (Moore, & Obhi, 2012). Therefore, considering the study of Ebert and Wegner (2010), we used the explicit SoA measurement as a manipulation check of the amount of SoA. In their study, when two measures of SoA were not presented consecutively – we also presented them separately --, it was shown that explicit measurement gave more sensitive results compared to the implicit measurement for the A-O consistency. The second reason for using explicit measurement in the present experiment was the idea that various factors affecting an individual's time perception such as drive states, emotional states, individual's mood and attention that given to the temporal duration may affect the implicit SoA measurement (Wittmann, & Paulus, 2008). Furthermore, the manipulation task we used based on learning the causal association between action and outcome (Moore et al., 2011; Moore, & Obhi, 2012). Due to the content of the BART, the fact that the participants learned about the key-color causal relationship and reported their amount of SoA through subjective evaluations was reasonable for manipulation check and exclusion criteria. In addition, the measurement that we used as an agency evaluation procedure was the same as the other study examined the relationship between risk-taking and SoA (Damen, 2019).

We calculated the risk-taking behaviors in the BART by considering the adjusted number of average pumps for unexploded balloons (Lejuez et al., 2002). In addition to this most widely used calculation method for BART (Lejuez et al., 2003a; Lauriola et al., 2014), we conducted an additional analysis to assess whether the number of popped balloons would reflect risk-taking. The results highlighted the inconsistency between the two measurement methods. While there was a significant difference between unexploded balloon colors calculated with adjusted pumps -- Deterministic A-O Group participants took more risk for yellow and blue balloons than grey balloons--, there was no difference between the number of popped balloons colors. Damen (2019) stated that as a result of his additional analysis, the number of popped balloons may be associated with risk-taking, and analysis with unexploded balloons could constrain the number of trials. However, due to the probability of the balloon explosion used in his study (ranged from 1-30), the balloons exploded quickly, therefore he may have concluded that the number of popped balloons may be associated with risk-taking. In the present study, we set the probability of a balloon explosion ranged from 1-100. Therefore, the validity of the calculation with the adjusted number of pumps for unexploded balloons in the analysis was strongly supported by revealed significant results.

Importantly, in BART, the Deterministic A-O Group participants took a significantly greater risk on the blue and yellow balloons compared to grey balloons because they experienced SoA only on that balloons in the SoA manipulation task. However, Random A-O Group participants did not experience SoA on blue and yellow balloons in Phase 1, thus the grey balloons had no effect for them, and they took a similar level of risk for all balloon colors. This finding indicated the SoA was proportional to the content and was successfully transferred to the BART. In other words, the balloons (blue and yellow), which only Deterministic A-O Group participants felt in control created a change in the amount of risk-taking. Thus, it was supported that the manipulation procedure used, that is, the matching of the predicted outcome and observed outcome generated a strong SoA (e.g., Frith et al., 2000; Sato, 2009 Experiment 3).

As another examination point, we focused the result which is participants in Deterministic Action-Outcome Group had shorter interval estimates compared to participants in the Random A-O Group in interval estimation task. Other studies that support current finding suggested, for intentional binding and increase of causal relation predictability, the A-O relation is a crucial factor (Engbert and Wohlschläger 2007; Moore and Haggard 2008; Buehner & Humphreys 2009; Voss et al. 2010). On contrary, Moore et al. (2011) emphasized intentional binding is stronger when the A-O association is more surprising. Taken together, in intentional binding studies some factors like the measurement method used (Libet clock or interval estimation task) or content of the experimental task may lead to differences in results. Therefore, we used the interval estimation task to allow participants to focus on action and outcome rather than paying attention to a clock (Libet Clock) (Ebert, &Wegner, 2010). Although explicit SoA measurement was used as exclusion criteria, the results showed, both measures were influenced by the predictability of the A-O association similarly. To be sure, much more research should investigate the connection between the two measurements and the findings should be increased.

While the present study adds crucial findings to the literature about the relationship between SoA and risk-taking, it also includes some limitations and some points that need to be addressed in the future. Although previous studies have shown that men tend to take more risks than women in general, (e.g. Jianakoplos, & Bernasek,1998; Sunden, & Surette, 1998; Hill, & Chow, 2002), due to the inequality between male and female participant numbers, the effect of gender on SoA and risk-taking relationship could not be investigated in our study. Nevertheless, gender impact can add as a new determinant to the relationship between SoA and risk-taking in future studies. In addition, in our study, we used two separate tasks for SoA manipulation and risk-taking. Although significant results showed that the SoA effect was reflected in the BART, the SoA effect could be more clearly observed if risk-taking and SoA were assessed within the same task (e.g. Damen, 2019). Future research may consider these limitations, as well as they may investigate the effect of SoA on risk-taking using other SoA manipulations – e.g. perceiving others as a possible agent (Dijksterhuis et al., 2008), the temporal delay between A-O (Sato & Yasuda, 2005; Damen, 2019). Thus, with the findings they will add to the literature, they will contribute to the clarification of this relationship more strongly.

The present study was the first to investigate the relationship between SoA and risk-taking using the predictability of the outcomes of actions procedure. The results support the only study in the literature that has proven this relationship using temporal delay manipulation (Damen, 2019). Moreover, considering that SOA has been often evaluated from a cognitive perspective in the literature, the association of SoA with risk-taking which is a socially crucial subject underlines the importance of the current study.

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Appendices

Appendix A: Barratt Impulsiveness Scale (BIS-11)

DIRECTIONS: People differ in the ways they act and think in different situations. This is a test to measure some of the ways in which you act and think. Read each statement and put an X on the appropriate circle on the right side of this page. Do not spend too much time on any statement. Answer quickly and honestly.

① Rarely/Never ② Occasionally ③ Often ④ Almost Always/Always

1	I plan tasks carefully.	①	②	③	④
2	I do things without thinking.	①	②	③	④
3	I make-up my mind quickly.	①	②	③	④
4	I am happy-go-lucky.	①	②	③	④
5	I don't "pay attention."	①	②	③	④
6	I have "racing" thoughts.	①	②	③	④
7	I plan trips well ahead of time.	①	②	③	④
8	I am self controlled.	①	②	③	④
9	I concentrate easily.	①	②	③	④
10	I save regularly.	①	②	③	④
11	I "squirm" at plays or lectures.	①	②	③	④
12	I am a careful thinker.	①	②	③	④
13	I plan for job security.	①	②	③	④
14	I say things without thinking.	①	②	③	④
15	I like to think about complex problems.	①	②	③	④
16	I change jobs.	①	②	③	④
17	I act "on impulse."	①	②	③	④
18	I get easily bored when solving thought problems.	①	②	③	④
19	I act on the spur of the moment.	①	②	③	④
20	I am a steady thinker.	①	②	③	④
21	I change residences.	①	②	③	④
22	I buy things on impulse.	①	②	③	④
23	I can only think about one thing at a time.	①	②	③	④
24	I change hobbies.	①	②	③	④
25	I spend or charge more than I earn.	①	②	③	④
26	I often have extraneous thoughts when thinking.	①	②	③	④
27	I am more interested in the present than the future.	①	②	③	④
28	I am restless at the theater or lectures.	①	②	③	④
29	I like puzzles.	①	②	③	④
30	I am future oriented.	①	②	③	④

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Appendix B: Ethical Approval of Application

APPROVAL OF APPLICATION

The following research project has been approved

by your supervisor.

Date: 2019/03/17

Code: 201915528527185567

Applicant details:

Name: Ezgi Yalciner

Status: MSc Student

Email address: ey42@kent.ac.uk

Title of the research:

Effect of Voluntarily Action on Time Perception and Risky Decision Making

When carrying out this research you are reminded to

* follow the School Guidelines for Conducting Research with Human Participants

* comply with the Data Protection Act 1998

* refer any amendments to the protocol to the Panel

Please keep this form in a safe place. You may be asked to present it at a later stage of your study for monitoring purposes. Final year project students and MSc students will need to submit a copy of this form with their project.

Appendix C: Study Information Sheet

Title of Project:	Effect of Voluntarily Action on Time Perception and Risky Decision Making	**Ethics Approval Number:**	201915528527185567
Investigator(s):	Dr. Brianna Beck Ezgi Yalciner	**Researcher Email:**	ey42@kent.ac.uk b.c.beck@kent.ac.uk

Introduction and Aims of the Study:

I would like to invite you to participate in this study. This project is my master's degree dissertation project at the University of Kent. The purpose of the study is to measure time perception and risky decision making.

Eligibility Requirements:

Participants who are 18-35 years of age and fluent in English.

What you will need to do and time commitment:

This experiment takes approximately 45 minutes to complete. Before the experiment, you will be asked to fill out a questionnaire about your process of thinking and acting under different situations in your daily life. In the experiment, firstly, you will complete a task in which you will press one of two keys on a keyboard. After you press the key, a visual stimulus will appear. Your task will be to estimate the time interval between your keypress and the appearance of the visual stimulus. After this phase, you will be asked to play a balloon inflating game on a computer with the opportunity to earn virtual money. You will earn 5 pence virtual money each time you pump up the balloon. However, if the balloon explodes, you will lose all the virtual money that you earned from inflating that balloon. It is up to you to decide when to stop inflating each balloon and collect your virtual earnings. At the end of the experiment, the top scorers in this game will win small prizes. For the purpose of administering those prizes, your score will be stored along with your name and e-mail address in a secure file, which will be destroyed after the prizes have been delivered. If you do not wish your score to be stored with your name and contact information, you may participate in the experiment but opt out of the competition for the prizes. Please inform the experimenter if you wish to do so.

Risks/Discomforts involved in participating:

There are no risks/discomforts involved in participating.

Confidentiality of your data (below are typical, default statements – amend if needed):

Any responses you provide will be treated confidentially. Any publication resulting from this work will report only aggregated findings or fully anonymised examples that will not identify you.

To enable this study, we need to collect some personally identifiable information from you. To safeguard your rights, we will use the minimum personally identifiable information possible, and act according to the principles of the General Data Protection Regulation (GDPR) as outlined in the University Privacy Notice (https://research.kent.ac.uk/researchservices/wp-content/uploads/sites/51/2018/12/GDPR-Privacy-Notice-Research-updated.pdf). Only members of the research team will have access to any personal information that may identify you, which will be stored separately from your other responses and securely. Any such identifying information will be removed and destroyed as soon as possible after necessary data processing has been completed – for example, records from separate files merged, or audio recordings transcribed. Once fully anonymised, the responses you provide may be used by the research team, shared with other researchers, or made available in an online data repository.

Details of any payments/RPS credits (must be approved by ethics committee)

2 RPS credits (and the possibility to win £10 voucher)

Remember that participation in this research study is completely voluntary. Even after you agree to participate and begin the study, you are still free to withdraw at any time and for any reason. Please note that once your data have been included in published analysis or data repositories, they cannot be withdrawn.

If you would like a copy of this information sheet to keep, please ask the researcher. If you have any complaints or concerns about this research, you can direct these, in writing, to the Chair of the Psychology Research Ethics Committee by email at: psychethics@kent.ac.uk. Alternatively, you can contact us by post at: Ethics Committee Chair, School of Psychology, University of Kent, Canterbury, CT2 7NP.

Gender:

Age:

Dominant Hand:

E-mail:

Appendix D: Research Informed Consent Form

Title of Project:	Effect of Voluntarily Action on Time Perception and Risky Decision Making	**Ethics Approval Number:**	201915528527185567
Investigator(s):	Ezgi Yalciner Dr Brianna Beck	**Researcher Email:**	ey42@kent.ac.uk b.c.beck@kent.ac.uk

Please read the following statements and, if you agree, initial the corresponding box to confirm an agreement:

	Initials
I confirm that I have read and understood the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason.	
I understand that my data will be treated confidentially and any publication resulting from this work will report only data that does **not** identify me. My anonymised responses, however, may be shared with other researchers or made available in online data repositories.	
I freely agree to participate in this study.	

Signatures:

Name of participant (block capitals)	Date	Signature
Researcher (block capitals)	Date	Signature

If you would like a copy of this consent form to keep, please ask the researcher. If you have any complaints or concerns about this research, you can direct these, in writing, to the Chair of the Psychology Research Ethics Committee by email at: psychethics@kent.ac.uk. Alternatively, you can contact us by post at: Ethics Committee Chair, School of Psychology, University of Kent, Canterbury, CT2 7NP.

Appendix E: Debriefing Form

Effect of Voluntarily Action on Time Perception and Risky Decision Making

Individuals have to make decisions that involve risk and uncertainty in different subjects in their lives. The conditions under which decisions are made play an important role in the willingness to take risks. This study was conducted to investigate how the sense of control that you feel over your environment affects your risk-taking behaviors. The sense of control might be related to risk-taking behaviors. Gender might also be an important factor in determining risk-taking behaviors. In this study, we want to investigate the relations between gender, feelings of control, and risk-taking.

In the first phase of the experiment, we aimed to manipulate your sense of control over your environment. You were assigned at random to one of the two groups. If you were in the first group, the key that you pressed (D or L) consistently predicted the visual stimulus that appeared on the screen (blue or yellow shape). If you were in the second group, the color of the stimulus was random and had nothing to do with which key you pressed. In addition to asking you to report your feelings of control, we also used your time interval estimations as an indirect, implicit measure of your sense of agency (with shorter perceived action-outcome intervals indicating stronger implicit agency). We used the Balloon Analogue Risk Task (BART) in the second phase of the experiment to measure your risk-taking behavior.

We anticipate that individuals who feel more in control will subsequently engage in riskier behavior in the BART and that males will show more risk-taking behaviors than females. In addition, participants who feel in control are expected to make a shorter time interval estimation than participants who do not feel control. This study will be the first study to examine the relationship between sense of control and risk-taking behaviors with a computer-aided experiment under properly controlled circumstances.

To conduct a reliable experiment, we kindly ask you to keep the purpose and content of the experiment secret.

If you have further questions about this study, please feel free to contact Ezgi Yalciner at the following e-mail address ey42@kent.ac.uk, School of Psychology, University of Kent.

THANK YOU AGAIN FOR YOUR CO-OPERATION