Social Reference Points Shape Decisions under Uncertainty

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Abstract

We study the impact of social reference points (SRPs) on decisions under uncertainty. Participants in an online experiment observed the earnings of a matched peer, which was either a high or low amount of money (SRP condition). Subsequently, they made decisions under different degrees of uncertainty (uncertainty condition) with known and uncertain probabilities of outcomes. Risky and ambiguous decisions are operationalized by a modified version of the Bomb Risk Elicitation Task (BRET). We find that SRPs shape decisions under uncertainty: observing a high SRP decreases risk aversion significantly, especially when peer earnings are salient. Moreover, our results suggest that the degree of uncertainty affects the impact of SRPs. SRPs loom larger in decisions under ambiguity compared to risky decisions. Further details of the results suggest that behavior is consistent with social comparison theory. Participants observing a low SRP decrease risks taking to avoid social loss by collecting a bomb and receiving zero earnings, while participants observing a high SRP increase risk taking to decrease the gap to the peer and reduce social losses.

Keywords: Choice under uncertainty, risk taking, ambiguity, social comparison, inequity aversion

1. Introduction

Most economic decisions involve uncertainty, and many are made in the presence of or in relation to others. Empirical evidence suggests that individual decisions are shaped by the perceived behavior of others. According to social comparison theory, people compare their beliefs, skills, abilities or achievements with the opinions, behavior, and achievements of others (Festinger, 1954). Others' performance and outcomes are often used as a social reference point (SRP) against which individuals evaluate their own performance, which elicits emotions and well-being or frustration. Perceived differences affect self-evaluation and self-esteem, fairness judgments and emotions, such as pride or anger and shame (Akerlof and Yellen, 1990; Card et al., 2012; Fehr and Schmidt, 1999; Luttmer, 2005; Cruces et al., 2013).

Recently, research has explored the relevance of SRPs in the context of risky decision making (Schwerter, 2023a; Müller and Rau, 2019; Lindskog et al., 2022). However, the role of uncertainty in shaping the influence of SRPs remains unclear. In situations with uncertain outcome probabilities, individuals are challenged to evaluate information and to draw probability judgments. In such situations, SRPs might loom larger as they are perceived as an additional source of information. Moreover, triggered by social preferences, individuals might form overoptimistic probability judgments, even when the outcomes of others are not directly related to one's own decision-making processes. In other words, depending on social references and comparisons, individuals might not only be overoptimistic about outcomes but also about the probability of outcomes.

In this paper, we argue that economic decisions under uncertainty are influenced not only by individuals' risk attitudes but also by social comparison and the desire to avoid social losses. Social loss perception is likely when a person is worse off than relevant reference persons. The threat to be worse off than others triggers decision making and may fuel risk taking. The prospect of catching up with others may impact and bias individuals' risk judgments. This "social status bias" may lead individuals who are better off than comparable others to take less risk to minimize the likelihood of losing. Conversely, individuals facing social loss may exhibit an increased appetite for risk (Schwerter, 2023a).

The social status bias might be particularly pronounced in decisions involving ambiguity, where the probabilities of outcomes are uncertain. While research has extensively documented ambiguity aversion (Fox and Tversky, 1995; Machina and Siniscalchi, 2014), most studies have focused on decisions in social isolation, neglecting the potential effects of social comparison. The information about others' behavior and outcomes may shape judgments and decisions in risky situations and even more in ambiguous situations. When individuals face ambiguous situations, their judgments on the likelihood of success can become biased. For instance, an investor who dislikes driving a smaller car than relevant others may strive for higher gains and be overly optimistic that investments in risky assets will yield high profits and allow purchasing a larger car, and thus, prevent social loss. Consequently, people might overestimate the small chance of winning, and underestimate the probability of losing. As a result, people facing social loss under ambiguity, may not only weight winning probabilities generally higher but also tend to locate the winning probability at the upper end of the ambiguous probability interval.

We design an experiment to test risk-taking behavior in risky and ambiguous decision situations that are embedded in a social context with varying SRPs. We use a 2x2 between-subject design with risky versus ambiguous decision situations as first treatment factor (= uncertainty condition) and high versus low SRPs as second treatment factor (= SRP condition) to estimate willingness to take risk in a slightly modified version of the "bomb risk elicitation task" (BRET), developed by Crosetto and Filippin (2013). Besides testing the effects of risk and ambiguity as well as high or low reference points, we control for belief formation (i.e., the judgment about the number of hidden bombs in BRET), social preferences, and risk attitudes as well as time effects.

In the experiment, each participant is randomly assigned to an uncertainty condition and SRP conditions. Each participant observes the gain of a matched peer s, which is either a high = £6 or low = £2 amount of money. The peer's gain is assumed to induce a relevant SRP. BRET consists of a matrix with 100 boxes, shown to participants on a computer screen. Before the task begins, each participant is informed that figurative bombs are randomly hidden in the boxes. Each selected box that does not contain a bomb provides earnings of £0.1. However, if a box is chosen that contains a bomb, all collected earnings are lost. It is up to the participants to decide how many boxes out of the 100 they select and when they stop the task. In the risky condition, participants are informed that 99 boxes are empty, while one box contains a bomb, thus, failing probability = 0.01. In the ambiguous condition, participants are informed that the number of bombs varies between 0 and 2, thus, no exact probability is known. Each participant plays five rounds. Specifically, participants in the ambiguity condition do not receive feedback about the exact number of hidden bombs after each round and are only informed about the potential payoff if this round is randomly selected for payoff. The lack of specific feedback about the number of hidden bombs in the ambiguity condition prevents participants from learning about the true distribution of bombs. Moreover, the SRP – the earning of the matched peer - is only visible in the first round. The number of chosen boxes in the 2x2 conditions allows identifying the impact of SRPs in risky and ambiguous decision situations. To rule out other peer effects such as social pressure or imitation, the participants' decisions and outcomes are not disclosed to others.

2. Related Literature

The relevance of social comparisons in daily decisions is well known. SRPs impact our goals, goal-directed behavior and may shape risk behavior. The relevance of SRPs is emphasized in two distinct streams of decision making literature. One stream focuses on loss aversion which is an important concept in prospect theory (Kahneman and Tversky, 1979).

Prospect theory describes decision making under uncertainty in two phases. In the editing phase, the complexity of a decision situation is reduced and an option or event and their alternatives are related to a reference point. In the evaluation phase, prospects are assessed relative to the reference point, perceived as gains or losses, and the subjective weighting of outcome probabilities is determined. Loss aversion states that losses loom larger than gains, thus peoples' endeavor to avoid or repair losses is stronger than the effort to increase gains. As a result, people tend to be risk-averse in the domain of gains and risk-seeking in the domain of losses (Kahneman and Tversky, 1973).

Inspired by the assumptions of prospect theory, Schwerter (2023a) examines risk behavior in the presence of SRPs, operationalized as peer outcomes. In the social treatment condition of his experiment, participants' roles are determined by a coin toss, where passive participants receive either a low or high show-up fee, while active participants learn that their own payment depends on a risky choice. To compare the influence of SRPs with private reference points, some participants were assigned to a non-social treatment and only received the information that the coin will determine their own show-up fee, which is either a high or low amount of money.

Schwerter (2023a) reports that sufficiently loss averse individuals behave risk averse around the SRP. Specifically, participants increase their risk-taking behavior when confronted with a high reference point compared to participants who observe passive players with low endowments, representing a low reference point. However, private reference points had no significant effect on risk taking. This suggests that reference points loom only under social comparison and that social preferences might drive risk-taking and lead to social loss aversion; a finding that is not directly rationalized by prospect theory.

The other stream of literature highlights the importance of social preferences. It extends rational decision making by social preferences (Fehr and Schmidt, 2006; Lindskog et al., 2022). In social preference models, the utility of individuals depends not only on their own outcome but also on the outcome of others. According to these theories, people dislike being worse off than others, while being ahead of others can either increase utility (Frank, 1985) or decreases utility (Fehr and Schmidt, 1999). However, only a few studies have analyzed the impact of social preferences under uncertainty (Bolton and Ockenfels, 2010; Brock et al., 2013; Friedl et al., 2014; Heinrich and Mayrhofer, 2018; Lahno and Serra-Garcia, 2015; Müller and Rau, 2019).

Bolton and Ockenfels (2010) report that people prefer a risky option over a safe option in dictator games to avoid social losses, consistent with the predictions of social comparison models (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999). However, the results do not support the theoretical prediction that participants would prefer the safe option yielding equal outcomes over the risky option that yields unequal outcomes in order to avoid advantageous inequality. Applying a design similar to Bolton and Ockenfels (2010), Payne et al. (2017) hypothesize that the effect of unequal outcomes on risk taking is driven by upward comparison if participants are worse off in social comparisons. This assumption is supported by Schmidt et al. (2019). The authors apply a two-stage experimental design, where participants can earn money in the first part and are then randomly assigned to a high- or low-wage condition. In the second part, participants can gain additional money by making risky investment decisions. Participants that were aware of wage inequalities took higher risks in the low-wage condition to decrease social losses. However, an important limitation of the study is that individual risk attitudes and social preferences were not controlled for.

Müller and Rau (2019) study idiosyncratic preferences, trying to find explanations why SRPs trigger risk taking. Their main finding indicates that being ahead of a peer amplifies risk aversion, while disadvantageous inequality attenuates risk aversion (Müller and Rau, 2019). In a related study, Lindskog et al. (2022) find that both the relative rank and the distance to the peer affect risk taking in social contexts. Risk taking is amplified by social status, the potential to outperform the peer in the social ranking. Moreover, the potential to reduce the distance to the peer's outcome increases risk taking.

Other studies report ambiguous results: e.g., Rohde and Rohde (2015) find that SRPs are less salient in the presence of multiple peers. Linde and Sonnemans (2012) observe risk-averse behavior independently of social gains or losses. Unclear, however, remains how SRPs affect risky decisions over time. SRP might loom only after direct exposure and become less relevant over time as people revise, learn, and adapt their behavior. Moreover, the importance of SRPs under different degrees of uncertainty, such as ambiguity, remains an open question.

SRPs could have stronger effects in ambiguous situations, as people have to assess probabilities and form beliefs. Enke and Graeber (2019) find that participants use a cognitive shortcut to assess uncertain situations. If probabilities are difficult to assess or unknown, people compress objective probabilities towards a cognitive default of 50:50. The literature on motivated beliefs, however, shows that people adapt their judgments in a self-serving way to maintain a positive self-image or to make choices that are most desirable but not necessarily supported by evidence (Epley and Gilovich, 2016; Zimmermann, 2020). People generally reason their way to conclusions that align with their preferences. Recent studies support this and indicate that individuals process information asymmetrically, with good news receiving more weight than bad news (Coutts, 2019; Kuhnen, 2015; Mobius et al., 2011; Barron, 2021).

In addition, Bursztyn et al. (2014) demonstrates the importance of social learning from peers in financial decision-making. In particular, they highlight how investors often use the asset purchase decisions of their peers as a relevant indicator for their own buying behavior. The authors distinguish between two channels of social influence: social learning and social utility. Social learning occurs when individuals observe and learn from the financial decisions of their peers, while social utility refers to how an individual's utility from owning an asset is directly affected by their peers owning the same asset. The findings suggest that both channels are important drivers in financial decision-making, with social learning being particularly relevant among unsophisticated investors (Bursztyn et al., 2014). Such investors are likely to view the investment choices of their peers, especially those considered more knowledgeable, as valuable information that diminishes uncertainty surrounding their own investment decisions. Similarly, Lahno and Serra-Garcia (2015) suggest that imitation emerged as the most dominant form of peer effect, suggesting that individuals tend to copy the behaviors of their peers in risky situations.

In our case, the disposition towards social losses can affect the process of belief formation. Participants who aim to outperform peers form more optimistic beliefs and underestimate the probability of collecting a bomb in the BRET task and to lose the whole gained amount of money. The self-serving formation of beliefs can be useful to justify extensive risk taking. Self-serving attenuates risk aversion and is especially pronounced in ambiguous situations where peers receive high endowments. The belief that zero bombs are hidden in the BRET matrix serves participants to justify excessive risk taking in order to achieve the goal to catch up with the matched peer. To examine how participants form their beliefs, we directly ask them to rank the likelihood that zero, one, or two bombs are hidden in the BRET boxes.

Our paper makes two specific contributions. First, we contribute to the literature on decision making under uncertainty by analyzing the impact of SRP on decisions under ambiguity. Second, we develop a social preference model that explains how SRP might affect decision making by triggering social loss aversion.

3. Experimental Design

To examine the impact of SRPs on decision making, we conduct a 2x2 between-subject design that divides participants into four groups. Table 2 reports the descriptors of the sample, which will be discussed in more detail later. First, each participant observes the endowment of a matched peer, which is either high = £6 or low = £2 amount of money (SRP condition). The endowment of the peer serves as the SRP. Second, each participant is randomly allocated either to the risky or the ambiguity condition (uncertainty condition). The SRP where collected in a pre-study (N=129), which tested the survey and the implementation of the BERT. Detailed instructions are in Appendix A. The dependent variable, risk-taking, is assessed by a slightly modified version of the BERT (Crosetto and Filippin, 2013). In the task, participants face a 10x10 matrix in which each cell represents a box. Figure 1 illustrates the task and shows how the SRP condition was implemented. In the respective case, a participant is informed that the matched peer earned £6. Three reasons make the BRET a key feature for answering our research questions. First, it is an accurate risk elicitation task (Crosetto and Filippin, 2013). Second, the task can be easily extended to ambiguity by making the interval of bombs uncertain, and third, the task can be played over multiple rounds.

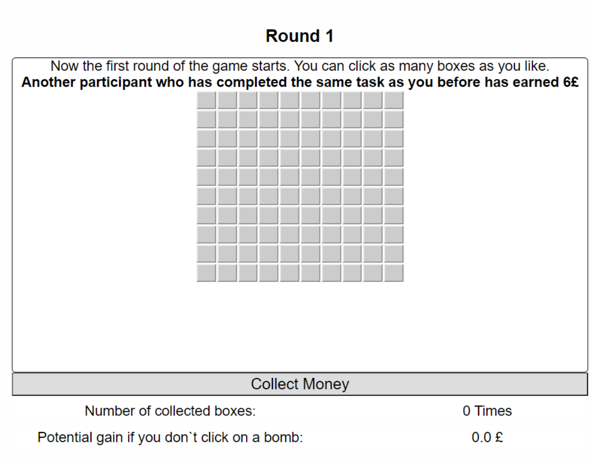

Figure 1: Illustration of the bomb risk elicitation task (BRET) for the ambiguity condition and high treatment.

Participants in the risky condition learn that 99 boxes are empty, while one box contains a bomb. The position of the bomb b is predetermined and randomly hidden in the matrix. Participants can click on boxes to highlight them. The total number of highlighted boxes indicates the number of boxes $k \in [0, 100]$ they want to collect. Participants earn 0.1£/box, unless they collect a bomb. If a bomb is hidden under the collected boxes, the participant receives zero payoff. Before participants can choose a number of boxes, they learn about the earnings of a matched peer (slow/shigh). They are also informed that their earnings are not disclosed to the peer. Participants only learn whether the bomb was selected after having confirmed their decision (see Appendix B.13). In total, each participant plays five consecutive rounds. In the end, one of the five rounds is randomly selected for the payoff. Since the only difference between treatment groups is the SRP, the comparison of individual choices between both groups shows whether the SRP impacts willingness to take risk.

Participants in the ambiguity condition are not fully informed about the exact number of bombs. They only know that there could be either 0, 1, or 2 hidden bombs $b \in 0, 1, 2$. Each of these events can be expressed as a single lottery with objective probabilities. However, the likelihood $\pi(L)$ to end up in one of the three cases, i.e. whether 0, 1, or 2 bombs are hidden, remains unknown. The missing information about $\pi(L)$ makes the task ambiguous. Figure 2 gives an overview of the experimental setting.

According to related literature, three other factors might influence the impact of SRP on decisions under uncertainty: i) motivated beliefs (Zimmermann,

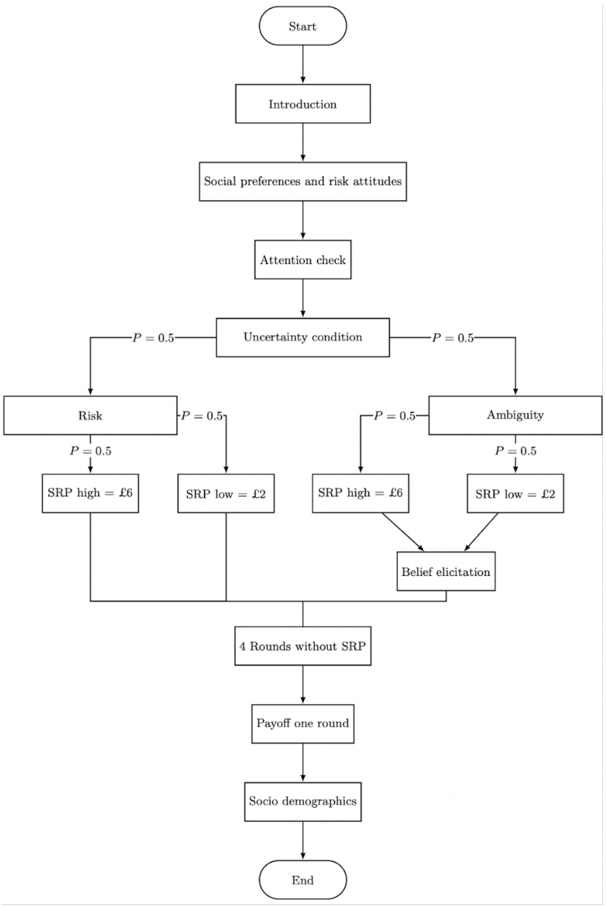

Figure 2: Flowchart of the experimental procedure

2020), ii) social preferences (Bolton and Ockenfels, 2000), and iii) individual risk attitudes (Müller and Rau, 2019).

3.1. *Motivated beliefs*

Inspired by the approach by Karni (2009), we directly elicit the belief about the number of hidden bombs by asking participants to rank the likelihood of each of three possible events: 0, 1, or 2 bombs (see Appendix A, Figure B.12). Participants receive 100 points and have to allocate them between the three events. The allocated points must add up to 100 and can be interpreted as percentage points (Epley and Gilovich, 2016). This method provides information about participants' beliefs $\pi(L)$ and their confidence. For instance, if a participant is certain that exactly one bomb is hidden, all 100 points should be allocated to this event and zero to the other events. If participants are unsure and perceive each event as equally likely, the points should be distributed equally among the three options.

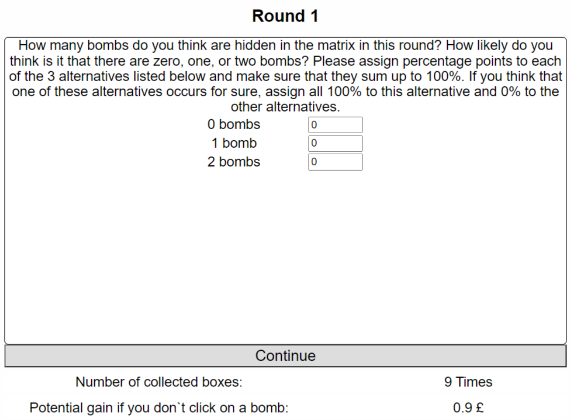

Figure 3: Belief Elicitation in BRET

3.2. *Social preferences*

The impact of SRP might be shaped by individual social preferences The impact of SRP might be shaped by individual social preferences (Müller and Rau, 2019). Blanco et al. (2011) use a modified dictator game and an ultimatum game to control for: the aversion to disadvantageous inequality (α), and advantageous inequality (β). Aversion to disadvantageous inequality (α) is elicited usigng an ultimatum game (see Appendix A, Figure B.9). Thereby, each participant acts as first- and second mover. First, all participants simultaneously act as proposers. This role requires participants to split an initial endowment (£20) between themselves and the second mover - the responder. Afterward, all participants act as responders. Thereby, they have to indicate which minimum-first-mover-offer they would accept. If an offer is rejected, both players end up with £1. In both roles, individuals are restricted to selecting integer values. The main objective is to identify when responders switch from rejecting an offer to accepting it (Müller and Rau, 2019). Accepting a lower offer corresponds to a lower aversion to disadvantageous inequality, while respondents who accept only a very high offer score high on disadvantageous inequality. Social preference theory shows that being ahead of others can positively and negatively affect utility. In our case, we use the fraction offered by the participant to the other person to control for advantageous inequality (see Appendix A, Figure B.8). Higher offers correlate with lower utility when one is ahead of the other and vice versa.

3.3. *Individual risk preferences*

We use a risky choice task to elicit individual risk attitudes in the absence of social impacts Schwerter (2023b); Müller and Rau (2019). We use the same lottery as (Müller and Rau, 2019). They found strong support that the risk preferences elicited in their task correspond to individual risk preferences commonly measured in the laboratory (e.g., Eckel and Grossman (2008)). The choice sheet is illustrated in Table 1. Participants choose one of nine lotteries. Each decision is a choice between a binary lottery, fully described in terms of probabilities and payoffs. Each binary choice realizes either a high payoff (Event A) or a sure payoff of £0.1 (Event B). Risk-averse individuals should prefer one of the first seven lotteries, while the last two lotteries capture risk-loving behavior. Participants were presented with only columns (1)-(4) from Table 1.

Table 1: Options in the individual risk task to measure individual risk attitudes.

Choice	Event	Prob. (%)	Payoff (£)	Exp. Payoff	Risk aversion
1	A	100	5.00	5.00	High
	B	0	0.10		
2	A	90	8.05	7.26	Moderate
	B	10	0.10		
3	A	80	10.25	8.22	Moderate
	B	20	0.10		
4	A	70	12.46	8.75	Moderate
	B	30	0.10		
5	A	60	15.15	9.13	Low
	B	40	0.10		
6	A	50	18.80	9.45	Low
	B	50	0.10		
7	A	40	24.08	9.69	Low
	B	60	0.10		
8	A	30	32.07	9.69	Risk loving
	B	70	0.10		
9	A	20	40.88	8.26	Risk loving
	B	80	0.10		

4. Theoretical Framework

In this section, we model the behavior of participants using the parameters described above and derive our hypotheses. The first model describes how subjects should behave in the BERT according to expected utility theory. This approach shows how rational participants behave in the absence of social preferences. Next, we extend the analysis by considering social context effects and model behavior of a rational individual that is driven by social preferences. The second model provides the theoretical basis for why social preferences could explain the effect of SRPs. The model extends the approach to decisions under uncertainty (risk and ambiguity) by Fehr and Schmidt (1999) and consists of an expected consumption utility and an expected social utility function.

4.1. Expected Utility

According to expected utility theory, participants maximize the expected outcome, if framed as a decision under uncertainty. A participant's decision in the BRET can be formalized as the preferred choice among the following options (Crosetto and Filippin, 2013):

$$L : \begin{cases} 0 & \text{with a probability of: } \frac{k}{100} \\ \gamma k & \text{with a probability of } \frac{100-k}{100} \end{cases}$$

where k corresponds to the number of boxes collected and γ is a scale factor and in my case 0.1£. The position of the bomb $b \in \{1, 100\}$ is determined by drawing a number from 1 to 100 from an urn. Participants receive γk with the probability of $100 - k$. The expected value of these lotteries is equal to $\gamma\{k - 0.01k^2\}$ with a maximum at $k = 50$ and zero for $k = 0$ and $k = 100$. Implying that a risk-neutral person should choose $k^* = \frac{100}{2}$ (Crosetto and Filippin, 2013).

Under ambiguity, the optimal choice depends on the number of hidden bombs. Participants that believe that zero bombs are hidden should collect all 100 boxes. If one bomb is hidden, the task is equivalent to the task under risk with $k^* = 50$. In the case of two hidden bombs, the optimal number of boxes is $k^* = 33$. Under the ambiguity condition, participants do not know the exact likelihood that each of the three events (e.g., 0, 1 or 2 bombs) occurs ($\pi(L)$). In the task, we assigned each event the same likelihood $\pi = 33\%$. Research has shown that unknown probabilities are also subjectively interpreted as equally distributed (Enke and Graeber, 2019). If participants behave according to this heuristic, all three events occur with the same likelihood and the average number of hidden bombs is (0+1+2)/3=1. This makes the uncertainty conditions (risk and ambiguity) comparable, as the average number of hidden bombs in both uncertainty conditions is one. Therefore, we should observe no difference in risk taking between both tasks. Moreover, if participants behave according to the standard economic theory, SRP provides no additional information and should be ignored, leading to the same risk taking behavior between both SRP conditions, independent of the uncertainty condition. To test whether participants interpret probabilities as equally distributed, we directly ask participants to indicate their belief about the number of hidden bombs.

4.2. Ex-ante Fairness

We focus on social preferences as the main factor explaining the impact of SRPs on decisions. Thereby, we extend the Fehr and Schmidt (1999) model of inequality aversion to the context of uncertainty. In doing so, we assume that participants behave according to the expected utility theory and maximize their own utility by also considering the outcome of others. Notably, we do not assume that probability judgments are biased due to motivated beliefs induced by SRPs but follow the literature and assume that participants' average belief of hidden bombs is one, which allows us to focus only on the risk condition without loss of generality. The Fehr and Schmidt (1999) model is given by $U(x, s) = x - \alpha * max\{s - x, 0\} \pm \beta * max\{x - s, 0\}$

for a given own income x and the peer´s income s. The value x corresponds to the expected value. The parameter α measures aversion to disadvantageous inequality affecting the utility negatively, and we define β as ahead-seeking preference, that enters the relationship positively or negatively[1]. Moreover, losses loom larger than gains $\beta < \alpha$ (Fehr and Schmidt, 1999). Extending the model to uncertainty leads to the following utility function:

$$U(k, s|s) = p(k)k + \beta\,(p(k)(k - s)) - \alpha\,(p(k)(s - k)) + \alpha\,(1 - p(k))\,(0 - s) \quad (1)$$

The first part of the utility function $p(k)k$ is the expected consumption utility and corresponds to the expected outcome for k clicks. The second part captures the social utility and describes two states, the expected outcome ($p(k)k$) can either be above the peer outcome (s) or be below the peer outcome. Moreover, there is always the possibility to collect a bomb and receive zero earnings, which is captured in the last part of the utility function. Being behind the peer outcome affects the utility negatively, which is captured by the parameter α, while being ahead of the peer affects utility positively (β). To understand how SRPs influence risky decision-making, we must consider these two cases separately.

If the number of clicks (k) and the corresponding payoff exceeds the SRP, the participant faces an advantageous position ($k > s$) with probability $p(k)$. However, there is also the possibility of collecting a bomb and earning zero. With the probability $(1 - p(k))$, a participant ends up in a disadvantageous position $(0 - s)$. The following utility function captures the relationship.

$$U(k, s|s) = p(k)k + \beta\,(p(k)(k - s)) + \alpha\,(1 - p(k))\,(0 - s) \quad (2)$$

In this case, the parameter α affects utility negatively and enters the utility function if a bomb is collected $(0 - s)$. The participant is facing a disadvantageous position, and the utility $U(k, s|s)$ decreases due to social loss aversion. The parameter β, ahead-seeking behavior, influences the utility positively and enters the utility if no bomb is selected and the expected outcome lies above the peer earnings. The values for $p(k)k$ are derived from the model parameters of the BRET. In the BERT, participants receive k with a probability of $p(k) = \frac{100-k}{100}$, and with the probability $1 - p(k) = \frac{k}{100}$ a bomb is collected. The optimal decision (k^s for a risk-neutral person facing an advantageous position is given by[2]

$$\frac{dU(k, s)}{dk} \overset{!}{=} 0 \left\{ k^s = k^* + \frac{(\beta-\alpha)}{2(1+\beta)} s \right.$$

If the typical relation $\beta < \alpha$ holds, participants are expected to collect fewer boxes than optimal, $k^s < k^*$. In other words, participants do not maximize the expected value of the lottery k^* but collect fewer boxes than optimal to reduce the risk of falling behind the relevant peer by collecting a bomb. The exact derivation is provided in Appendix C.

In the second case, participants are facing a disadvantageous position. The following utility function shows the relation if $k < s$:

$$U(k, s|s) = p(k)k - \alpha(p(k)(s - k)) + \alpha(1 - p(k))(0 - s) \quad (3)$$

In this case, our model predicts that participants maximize the expected value if they are behind a peer (see Appendix C). In a disadvantageous position where the SRP is lower than the optimal expected outcome ($k < s < k^*$) participants can gain additional utility by collecting more boxes, first, because the expected value increases, and second, because they decrease the social gap $(s - k)$. If the SRP is higher than the optimal outcome ($s > k^*$) our model does not predict that SRPs induce participants to collect more boxes than optimal ($k^s > k^*$). Collecting more boxes than optimal would only reduce the expected payoff. The marginal expected evaluation of risk taking is:

$$\frac{dU(k, s)}{dk} \overset{!}{=} 0 \begin{cases} < 0 & \text{if } k > k^* \\ > 0 & \text{if } k < s < k^* \end{cases}$$

Taken together, the model shows that participants facing a SRP that is feasible to match under expected utility theory ($s < k^*$) will collect fewer boxes than optimal ($k^s < k^*$) if they show social preferences. If the SRP is higher than the optimal outcome ($s > k^*$) participants try to reduce the gap between their own outcome and the peer outcome but will not take excessive risk and collect more boxes than optimal. Thus, the social optimum is equivalent to the optimum without social preferences ($k^s = k^*$). In our case, the low SRP is feasible under expected utility theory ($SRP_{low} < k^*$) while the high SRP exceeds the rational optimum ($SRP_{high} > k^*$). Therefore, the model predicts that participants in

[1] If β enters the relationship positively, subjects show ahead seeking preferences, while a negative relationship describes the original Fehr and Schmidt (1999) guilt parameter.

[2] The expected outcome of the lottery is maximized at $k^* = \frac{100}{2}$

the low SRP condition collect fewer boxes than optimal ($k^s_{low} < k^*$), while participants in the high SRP condition try to match the maximum outcome ($k^s_{low} = k^*$) and comparing both conditions intuitively shows that $k^s_{low} < k^s_{low}$ leading to the second hypothesis.

[H4.2] Participants that face high social reference point (SRP) take more risk than participants facing low SRP.

4.3. Sample

In total, 173 out of 180 participants completed all five rounds of the experiment, yielding 865 observations. We calculated the necessary sample size using a power analysis informed by the findings from (Schwerter, 2023a; Müller and Rau, 2019). Even though participants have passed the attention check, some collected all boxes in the risk treatment. Therefore, 19 observations were deleted, leading to a total of 846 observations. The experiment was conducted in Prolific and the questionnaire was programmed using Qualtrics. A detailed introduction and an illustration of the bomb risk elicitation task can be found in Appendix A. The experiment lasted on average 21 minutes, the average amount of clicks was 35 and the average payoff was £4.3. Overall, 71% of participants were female, and the average age was 26 years.

Regarding the number of hidden bombs, participants believed that each of the three events occurred with a probability of approximately one-third (zero bombs = 32%, one bomb = 34%, two bombs = 34%).

Social preferences were measured before the implementation of treatment conditions. In the ultimatum game (UG), which captures the parameter α, participants kept on average £11 for themselves (UG own share A) and gave on average £8.9 to the other person (UG others share). The lowest offer that participants accepted was on average £5.6. To elicit the parameter β, the modified dictator game (MDG) was used. Around 17% preferred an equal distribution, where both players received £1 instead of the selfish distribution (19,1). Around 25% preferred a situation where both players receive £10. Regarding individual risk attitudes, the majority (47%) was classified by moderate risk aversion, while only a small proportion showed either high-risk aversion (14%) or risk-loving behavior (16%). Table 2 shows that these variables are highly similar in uncertainty and SRP conditions. However, the t-test results indicate significant differences between the High and Low Risk groups in terms of Income, Age, female representation, and Education level. Specifically, individuals in the High Risk group tend to have higher incomes, younger ages, higher female representation, and lower education levels compared to those in the Low Risk group. Therefore all our regression results control for these socio economic differences.

Table 2: Main dependent and independent variables across SRP and uncertainty conditions

	Ambiguity			Risk			
	High	Low	T-Test	High	Low	T-Test	Total
Clicks	42.00	35.08	2.71	33.59	29.97	1.89	35.32
Belief 0 bombs	28.45	34.92	2.09	-	-	-	31.69
Belief 1 bomb	35.04	32.77	0.96	-	-	-	33.90
Belief 2 bombs	36.50	32.25	1.62	-	-	-	34.38
Bombs hidden	1.07	1.09	−0.23	1	1	-	1.04
Bombs clicked	0.43	0.42	0.22	0.36	0.30	1.43	0.38
MDG	5.70	5.61	5.78	0.33	5.33	1.73	5.61
UG own share	10.95	11.18	−0.97	10.71	11.44	−2.94	11.07
UG others share	9.05	8.82	−0.97	9.29	8.56	−2.94	8.93
High risk aversion	0.09	0.18	2.90	0.18	0.10	2.42	0.14
Moderate risk aversion	0.50	0.48	0.58	0.43	0.48	2, 84	0.47
Low risk aversion	0.23	0.20	0.48	0.29	0.18	−0.98	0.23
Risk loving	0.18	0.14	1.30	0.10	0.24	−4.21	0.16
Income	661	875	−2.41	832	1, 304	−4.42	908.78
Age	24.48	26.89	−4, 59	25.52	27.04	−2, 48	25.96
Female	0.82	0.61	4.87	0.75	0.65	2.21	0.71
Education	3.18	3.73	−4.67	3.59	3.45	1.12	3.49
Observations	220	220		209	197		865

Comparison of mean values for various variables between High and Low Ambiguity conditons, and between High and Low Risk conditions including T-test results.

5. Results

The results are presented in two steps. First, we discuss the predictive power of the regression model at the aggregate level, considering data from all five rounds jointly, and second, we consider individual rounds. The dependent variable "number of clicks" represents a count variable that can take non-negative integer values ranging from 1-100. We, therefore, apply a Poisson regression model with robust standard errors, which is best suited for the analysis of count data (Cameron and Trivedi, 1986) (Table 2). Finally, we transform the coefficient estimates from the Poisson regression into average marginal effects, as they allow a straightforward and intuitive interpretation. The marginal effects show how a one unit change in the predictor x_j impacts the number of clicks (Leeper, 2017).

To test whether SRPs affect decision making under uncertainty (H4.2), we regress the number of clicks on the dummy variable SRP-condition, which takes the value 1 if participants were confronted with a low SRP. Column (1) of Table 3 shows that participants accumulate fewer boxes and thus take less risk when framed with a low SRP. The mean difference between the SRPs is 5 clicks ($p < 0.01$). This result supports the assumption that SRPs influence decisions under uncertainty and confirms the previous findings of (Lindskog et al., 2022; Schwerter, 2023a). This effect is stable in both Poisson and OLS regressions. Table A.8 from Appendix B shows that the results do not change significantly when all participants are included.

Finding 1 *Participants in the high treatment take a higher risk and collect more boxes than individuals in the low treatment.*

Table 3: Regression results from the Poisson model reported as average marginal effects

	Poisson		*OLS*	
	(1)	(2)	(3)	(4)
Condition_SRPLow	−4.931***		−4.984***	
	(1.580)		(1.609)	
Condition_UncertaintyRisk	−6.880***		−6.973***	
	(1.560)		(1.590)	
Feedbackno feedback	4.251	4.239	3.932	3.914
	(2.961)	(2.959)	(2.795)	(2.793)
FeedbackFeedback_bomb	12.499***	12.519***	12.274***	12.300***
	(2.040)	(2.044)	(1.962)	(1.966)
Round2	−1.245	−1.235	−1.285	−1.299
	(2.451)	(2.451)	(2.548)	(2.547)
Round3	−0.353	−0.372	−0.296	−0.305
	(2.483)	(2.484)	(2.591)	(2.591)
Round4	−0.357	−0.368	−0.346	−0.361
	(2.416)	(2.416)	(2.519)	(2.517)
Round5				
Ambiguity & SRP=High		12.559***		11.857***
		(2.437)		(2.172)
Ambiguity & SRP=Low		5.743**		5.167**
		(2.351)		(2.074)
Risk & SRP=High		3.590		3.132
		(2.193)		(1.933)
Constant			37.506***	26.506***
			(2.422)	(2.168)
Observations	846	846	846	846
R^2			0.077	0.079
Adjusted R^2			0.070	0.070
Log Likelihood	−8,349.296	−8,344.492		
Akaike Inf. Crit.	16,714.590	16,706.990		

Column (1) shows the impact of the SRP condition (1 if SRP is low) and the uncertainty condition (1 if risk), while Column (2) shows the impact of the interaction of both conditions (SRP and Uncertainty). The symbols *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

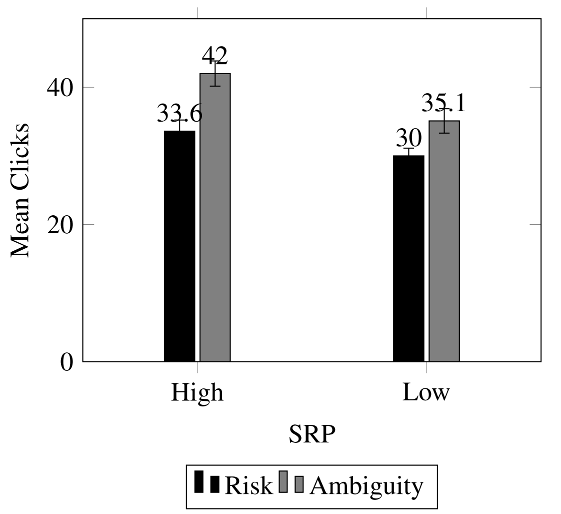

Figure 4: Mean clicks for "High" and "Low" conditions under "Risk" and "Ambiguity".

Second, we find a significant difference in risk taking between both uncertainty conditions (risk and ambiguity). Column (1) shows the main effect between the risk and ambiguity condition, indicating that higher levels of uncertainty are associated with higher risk taking. In other words, participants that know that exactly one bomb is hidden in the task behave more risk averse than participants in the ambiguity condition. The mean difference between risk and ambiguity is 7 clicks ($p < 0.01$).

Finding 2 *Participants in the ambiguity condition take on average a higher risk by collecting more boxes than individuals in the risk treatment.*

Column (2) of Table 6 includes separate dummy variables for the interaction effect of both conditions and allows identifying if the impact of SRPs depends on the degree of uncertainty. The results confirm that SRP influences decisions under ambiguity significantly more than under risk. Participants in the low (high) ambiguity condition accumulate on average 5.7 (12.5) boxes more than participants from the low risk condition while the difference between high risk and low risk is 3.6 clicks. Figure 4 highlights that SRPs affect decisions differently and loom larger under a higher degree of uncertainty.

5.1. Impact of SRP over time

Next, we analyze the impact of SRP over time and repeat the former analysis for every single round. Figure 7 reveals two important findings. In the first round, there is no difference between risk and ambiguity conditions, and only SRPs impact decision making. However, over time the importance of SRP decreases and stabilizes, especially in the risk treatment, while a difference between conditions becomes clearly visible. The marginal effects in the Poisson regression confirm this finding. Table 4 shows that SRPs are only significant in the first round ($p < 0.05$), while participants in the ambiguity condition collect significantly more boxes from round 3 onwards. These findings support our assumption, implying that social comparison is especially relevant at the beginning when the SRP is most salient. Other factors, such as learning effects or private reference points might dominate subsequently, and shape risk taking over time.

Figure 5 illustrates how the feedback of whether a bomb was collected affects decision making. The results show that immediate feedback indicating that a bomb was collected in round 1 leads to fewer clicks in round 2. Conversely, the absence of a collected bomb leads to an increase in average clicks. Over time, the importance of feedback diminishes, possibly indicating learning and strategy adaptation. Furthermore, the level of uncertainty interacts with the feedback dynamics. Specifically, in the second round, feedback induces more (or fewer) clicks depending on whether no bomb (or a bomb) was selected. Notably, starting from the second round, individuals in the ambiguity condition tend to collect more boxes than in the first round, regardless of feedback, while the opposite trend is observed for the risk group. In addition, Figure 6 suggests that social reference points do not induce social learning, as evidenced by the lack of differences in post-click behavior between the SRP conditions. This suggests that expected changes (increase or decrease) in behavior are not influenced by social reference points. An alternative explanation could be manipulated beliefs.

5.2. Manipulated beliefs

The results confirm that SRPs shape decisions under uncertainty. Moreover, we find a stronger impact of SRPs on decisions under ambiguity. To keep up with their peer, participants might bias their beliefs about the number of hidden bombs to maintain parity with their peers. Therefore, manipulated beliefs could be one of the reasons why SRP loom larger under ambiguity. Participants in the high SRPs condition form more optimistic beliefs and systematically underestimate the likelihood that more than one bomb is hidden. This bias should not be present under risk as the number of bombs is given. To test this hypothesis, we regress the belief about the number of hidden total (zero, one and two) bombs occur on the dummy variable SRP and control for time effects, risk attitudes, and whether a bomb was selected or not. The results do not confirm our hypothesis that motivated beliefs bias risk judgments. We rather find the reverse effect as participants from the high SRPs condition form more pessimistic beliefs and think

Table 4: Marginal effects for each individual round from the Poisson regression model

	Clicks				
	Round 1	Round 2	Round 3	Round 4	Round 5
1 if SRP Low	−8.910**	−3.894	−3.924	−6.272*	−8.883**
	(3.841)	(3.317)	(3.272)	(3.262)	(3.787)
1 if Risk	2.454	−4.751	−7.550**	−8.503***	−11.439***
	(3.676)	(3.145)	(3.261)	(3.224)	(3.743)
Risk Attitude: Low aversion	2.464	1.985	1.123	3.499	0.670
	(6.091)	(5.924)	(6.051)	(5.639)	(6.677)
Risk Attitude: Moderate aversion	4.612	4.207	7.113	5.397	5.140
	(5.427)	(5.123)	(5.073)	(4.402)	(5.910)
Risk Attitude: Risk loving	13.365*	12.017*	12.409*	15.271**	8.241
	(7.816)	(6.882)	(7.196)	(6.763)	(7.919)
1 if Female	−2.102	−7.613**	−9.142**	−4.972	−2.963
	(3.996)	(3.685)	(3.733)	(3.569)	(4.263)
Monthly Income	−0.002	−0.001	−0.001	0.0001	0.001
	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
1 if Feedback Bomb		8.242**	15.068***	9.752***	12.208***
		(3.921)	(3.682)	(3.545)	(3.946)
Observations	168	168	169	170	171
Log Likelihood	−1,808.584	−1,470.513	−1,515.207	−1,451.411	−1,799.147
Akaike Inf. Crit.	3,633.168	2,959.027	3,048.413	2,920.821	3,616.295

Each row corresponds to a separate round, where the number of Clicks is modeled as a function of SRP (High and Low), Condition Uncertainty (Risk and Ambiguitu), Risk attitude (reference is high risk aversion), Female, Age, and Feedback (reference is no bomb). Robust standard errors are calculated to account for potential heteroskedasticity.

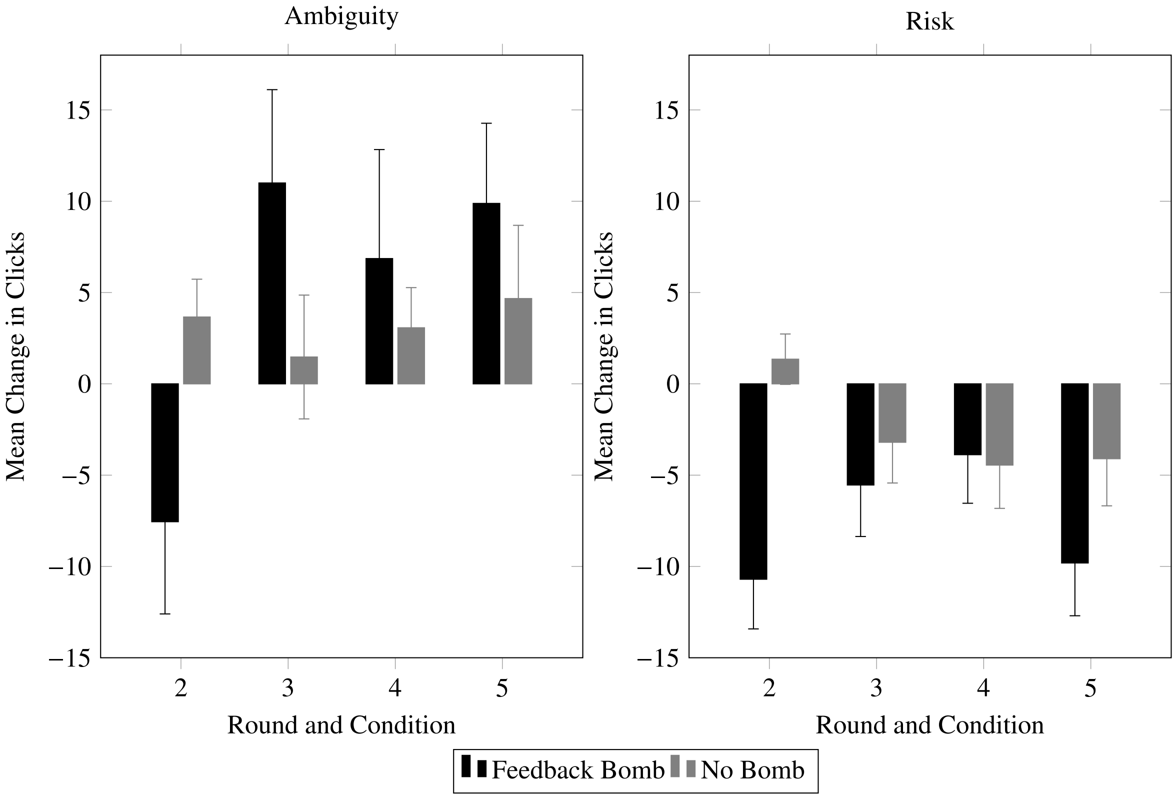

Figure 5: Immediate effect of feedback on mean change in clicks across rounds, separated by conditions of Ambiguity and Risk.

that more bombs are hidden on average (Table 5). However, the effects are small and the results rather indicate that participants use a mental shortcut to assess probabilities in the context of uncertainty, as described in Enke and Graeber (2019). In our case, participants seem to believe that the likelihood of each event (zero, one, two bombs) is equally distributed and assumed that one bomb is hidden on average.

5.3. Social Preferences

In the following part of the analysis, we focus on one channel through which SRP might shape participants' willingness to take risks, namely social preferences. The theory described in section 4 predicts that social preferences only matter in the low SRP condition. Participants in the high condition would try to maximize the outcome given their individual risk attitudes. Therefore, we regress participants' choices from the UG on risk taking for both SRP conditions separately. Moreover, we include the quadratic term of both coefficients to control for the non-linear relationship, using both a linear and a Poisson regression with marginal effects. We assume that disadvantageous inequality initially reduces risk aversion, but after a certain point, the relationship turns, as individuals fear falling behind others because a bomb has been selected. Advantageous inequality might affect risk-taking both negatively and positively as the literature shows. The results from Table 6 column (1) confirm our assumption. Disadvantageous inequality correlates positively with the number of clicks at the beginning, however, the quadratic term shows that the relationship has a turning point at (-8.054/(2*-0.576)) and decreases risk taking significantly afterward. In other words, participants that accept only offers above £7 are on average more risk averse and collect fewer boxes. Moreover, advantageous inequality correlates positively with risk taking, however, this effect is only significant in the Poisson model. Turning to the high SRP condition, we find that disadvantageous inequality does not significantly predict risk taking as our theory suggests. However, advantageous inequality has a significant impact. Again, the relationship is non-linear and has a turning point at (17.83/)2*-0.778)) indicating that participants that shared more with the other player behave on average more risk averse.

6. Conclusions

Many daily decisions involve uncertainty and are taken in social contexts. Yet, most studies ignore the interdependence of uncertainty and social comparisons and focus on decisions either under uncertainty or in

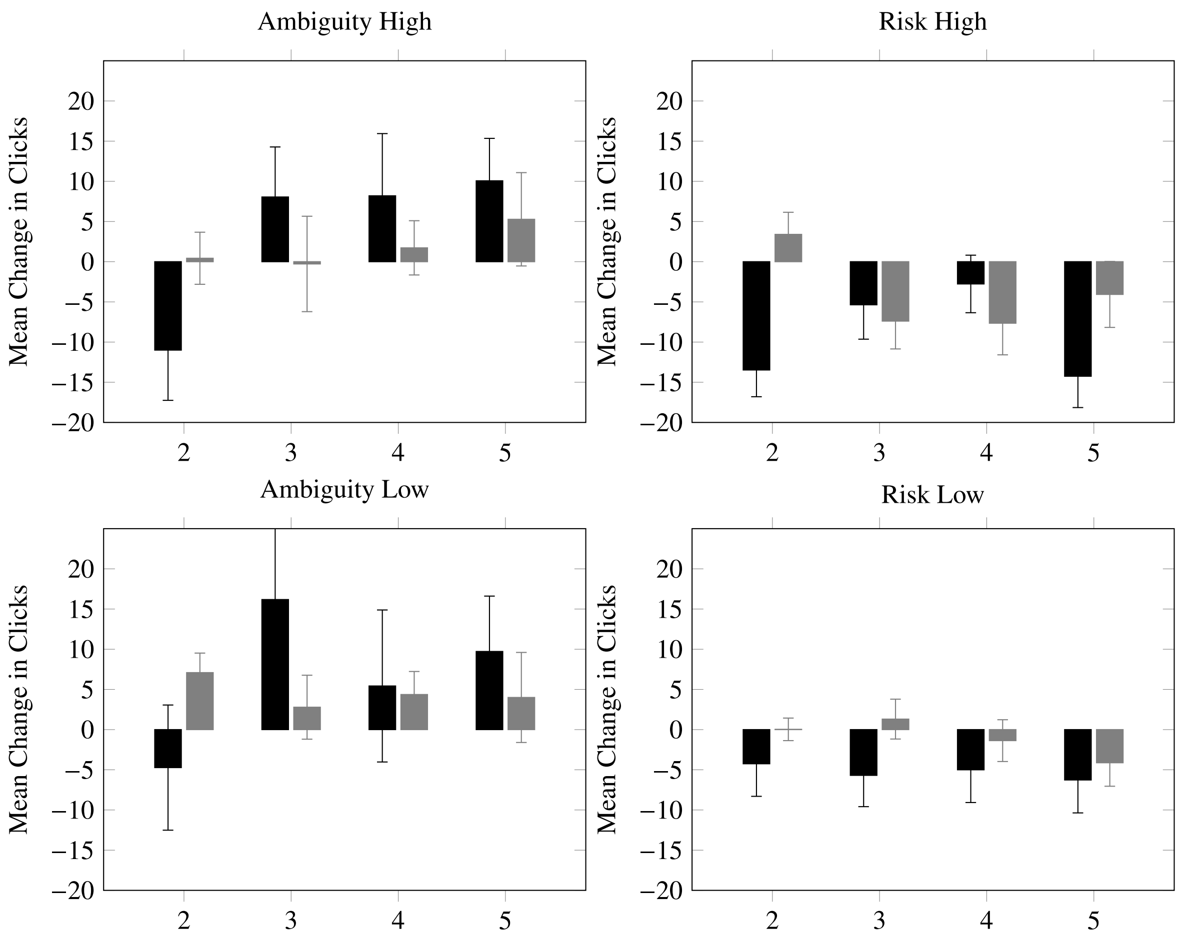

Figure 6: Feedback effect on mean change in clicks across rounds 2 to 5, categorized by SRP condition (High or Low) and uncertainty condition (Ambiguity or Risk). Black bars represent Feedback: Bomb and gray bars represent Feedback: No bomb. Error bars indicate standard errors.

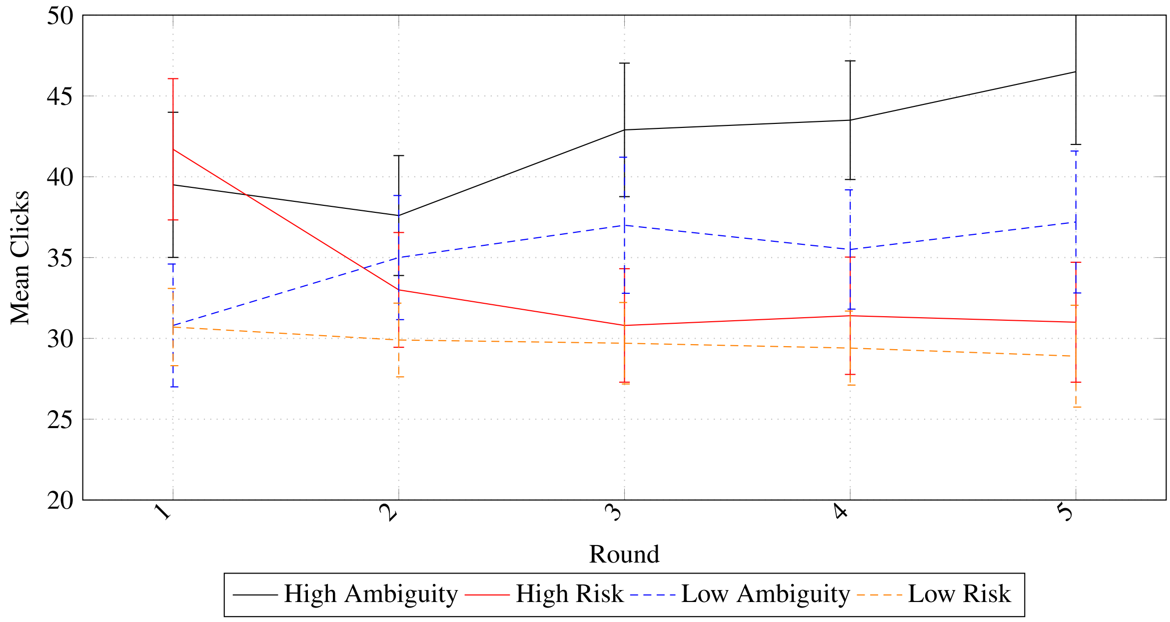

Figure 7: Mean Clicks by Round, SRP Condition, and Uncertainty Condition

social contexts. Using a straightforward experimental design, we provide evidence that social concerns shape decisions under uncertainty. Participants in the high SRP condition take on average higher risk than participants in the low SRP condition. This result reaffirms the results found by Schwerter (2023a). However, we additionally show that the impact of SRPs is most pronounced in the first round, when peer earnings are directly visible. In the following rounds, when the social comparison becomes less salient, the importance of SRP decreases, and other effects such as learning or private reference points might dominate. Moreover, the results indicate that the impact of SRP depends on the degree of uncertainty. In situations with given objective probabilities, SRP is perceived as less informative compared to situations with an unknown number of hidden bombs (ambiguity condition). In the ambiguity condition, participants need to make a more complex decision, as the exact number of hidden bombs is missing. Peer earnings could therefore be perceived as additional information and serve as a stronger social reference point. Different from those of Schwerter (2023a) who refers to prospect theory, we focus on social preferences to explain the impact of SRP on risk-taking. Thereby, we rely on the concept of social preferences and extend the model developed by Fehr and Schmidt (1999) to decisions under uncertainty. The theoretical framework implies that participants that are characterized by disadvantageous inequality aversion decrease their risk taking to avoid social losses if they are ahead of the relevant peer. As the SRP in the high treatment exceeds the rational optimum, we predict that social preferences affect only decisions in the low SRP condition. Indeed, the results confirm this relationship to a certain extent. In the low SRP condition, participants scoring high on disadvantageous inequality collect fewer boxes, as they might fear falling behind by collecting a bomb. In contrast to our theory, we find that advantageous inequality also predicts risk taking in the high SRP condition. The results show that participants who keep a higher share of the initial split for themselves collect more boxes. The quadratic term indicates again a non-linear relationship that becomes negative for people that keep very high shares for themselves. The results concerning the social preference model should however be interpreted with caution, as we did not directly manipulate social preferences. Moreover, the data taken from the ultimatum game were not payoff relevant, which might decrease their predictive power. Another limitation regards the fact that participants observed only one social reference point, while in daily life people are likely to face social comparisons. Further research should therefore vary social reference points or expose each participant's multiple reference points. Thus far, it is not clear which social reference points are perceived as most salient. Another interesting avenue for further research would be to endogenously manipulate social preferences to identify the causal relationship between SRP and inequality aversion.

Table 5: Regression results from the belief elicitation question

	Belief hidden bombs			
	Total Bombs	Belief Zero	Belief One	Belief Two
1 if SRP Low	−0.166***	9.822***	−3.184	−6.689**
	(0.053)	(3.159)	(2.308)	(2.642)
Round 1 no Feedback	0.024	−2.043	1.667	0.379
	(0.081)	(4.847)	(3.984)	(4.157)
Feedback Bomb	−0.184***	10.946**	−3.495	−7.443**
	(0.070)	(4.304)	(3.135)	(3.257)
Rounds	Yes	Yes	Yes	Yes
Risk attitudes	Yes	Yes	Yes	Yes
Socio Demographic	Yes	Yes	Yes	Yes
Observations	440	440	440	440
R^2	0.067	0.067	0.035	0.055
Adjusted R^2	0.043	0.043	0.010	0.031

Column (1) presents the effect of SRP (1 if SRP = low) on belief formation. Participants were instructed to distribute 100 percentage points among the three events (0, 1, 2) bombs to indicate their belief about the total number of hidden bombs. Column (2) displays the regression results for the belief that zero bombs were hidden, column (3) for one bomb, and column (4) for two bombs. We control for time effects (round), bombs, risk attitudes, and socio-demographic variables such as age, gender, and income. The symbols *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

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Table 6: The impact of social preferences on SRP

	Clicks			
	Poisson		*OLS*	
	SRP = low	SRP = high	SRP = low	SRP = high
1 if Risk	−6.139***	−6.345***	−5.896***	−6.720***
	(1.783)	(2.269)	(1.936)	(2.416)
Round 2	−1.381	−7.968**	−1.426	−8.567**
	(2.924)	(3.300)	(3.138)	(3.928)
Round 3	−1.204	−6.659**	−1.082	−6.817*
	(3.115)	(3.366)	(3.340)	(3.945)
Round 4	−2.096	−5.705*	−2.122	−5.878
	(2.888)	(3.414)	(3.134)	(3.975)
Round 5	−2.739	−4.044	−2.771	−4.028
	(3.150)	(3.633)	(3.452)	(4.176)
1 if Feedback Bomb	10.096***	12.950***	10.489***	12.896***
	(2.521)	(2.680)	(2.680)	(2.636)
Risk attitude: Low aversion	−3.144	−0.315	−1.802	−0.945
	(3.297)	(3.804)	(3.336)	(3.613)
Risk attitude: Moderate aversion	3.096	−0.094	4.076	−0.286
	(2.816)	(3.676)	(2.812)	(3.619)
Risk attitude: Risk loving	5.224	13.686**	5.066	13.555***
	(3.747)	(5.482)	(3.436)	(4.714)
1 if Female	−5.489***	−5.276*	−5.868***	−5.744**
	(1.927)	(2.720)	(2.058)	(2.903)
Disadvantageous ineq	8.054***	−0.275	7.461***	−0.781
	(1.388)	(1.540)	(1.379)	(1.742)
Disadvantageous ineq squared	−0.576***	−0.015	−0.537***	0.018
	(0.120)	(0.136)	(0.125)	(0.149)
Advantageous ineq	2.459*	17.829***	0.726	11.479***
	(1.307)	(6.882)	(1.004)	(3.318)
Advantageous ineq squared	−0.028	−0.778***	0.042	−0.522***
	(0.054)	(0.291)	(0.048)	(0.154)
Constant			−6.881	2.684
			(7.393)	(22.853)
Observations	417	429	417	429
R^2			0.182	0.154
Adjusted R^2			0.151	0.124
Log Likelihood	−3,297.637	−4,329.064		
Akaike Inf. Crit.	6,627.275	8,690.127		

Column (1)-(2) presents the marginal effect of the poisson regression on risk taking, while column (3)-(4) show regression results from OLS.

Appendix A. Robustness

Appendix B. Experimental Design

Appendix B.1. Questionnaire: Social Preferences

Welcome and thank you for participating in this study about decision-making. In the first part of the study, your task is to complete a questionnaire. You will earn 2,5£ for completing this part of the study. In the second part of the study, you can receive additional earnings depending on the choices you make. We will explain the second part after you have completed the questionnaire. Please note that you will be paid only if you complete the entire study.

Appendix B.2. Intro BRET Ambiguity High

Thank you for completing part 1 of the study. Now, the second part of the study starts. Please read the following instructions carefully. Your earnings will depend on your choices. It is therefore important that you take your time to understand the instructions clearly. Click on "the lower arrow" after you have read and understood the instructions.
The experiment consists of a short task, followed by a questionnaire. We will now explain the task: On the next page, you will see a matrix composed of 100 boxes. Your task is to decide how many out of 100 boxes to open. To open a box, simply click on it. Note that you cannot unselect a field once you click on it. For each box that you open, you earn 0.1£. However, some of the boxes can contain a time bomb. At the time when you do the task, you do not know how many boxes contain a bomb. You only know that there can be either ZERO, ONE, or TWO time bombs hidden in the matrix. Time bombs are programmed to explode after you have completed the task. If you have opened a box containing a time bomb your earnings from the task will be zero, i.e., all earnings from the task will be lost. On the screen where you do the task, please click on the boxes you want to open and confirm your decision by clicking the button "Collect Money". Afterwards, you will learn how many bombs were hidden and whether you clicked on a box containing a bomb.
In total, you will do the task five times. After you are done, one of the five tasks will be randomly chosen for payment; that is, you will be paid only the amount of money that you have earned in that randomly selected task. Your choices in the other tasks do not count for your earnings.
Finally, we would like to inform you that another participant who has completed the same task as you before has earned £6,–. This other person (unlike you) did not learn anything about how much another person earned in the task.

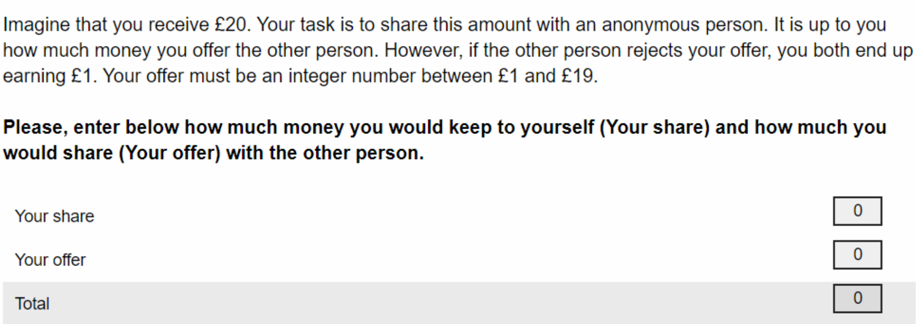
Appendix B.3. Intro BRET Condition Risk, Treatment Low

Thank you for completing part 1 of the study. Now, the second part of the study starts. Please read the following instructions carefully. Your earnings will depend on your choices. It is therefore important that you take your time to understand the instructions clearly. Click on "the lower arrow" after you have read and understood the instructions.
Part 2 consists of a short task, followed by a questionnaire. We will now explain the task: On the next page, you will see a matrix composed of 100 boxes. Your task is to decide how many out of 100 boxes to open. To open a box, simply click on it. Note that you cannot unselect a field once you click on it. For each box that you open, you earn 0.1£. However, one of the boxes contains a bomb. At the time when you do the task, you do not know where the bomb is hidden. You only know that there is ONE bomb hidden in the matrix. The bomb is programmed to explode after you have completed the task. If you opened the box with the bomb, your earnings in this task will be zero, i.e., all earnings from the task will be lost. On the screen where you do the task, please click on the boxes you want to open and confirm your decision by clicking the button "Collect Money". Afterwards, you will learn whether you clicked on a box containing a bomb.
In total, you will do the task five times. After you are done, one of the five tasks will be randomly chosen for payment; that is, you will be paid only the amount of money that you have earned in that randomly selected task. Your choices in the other tasks do not count for your earnings.
Finally, we would like to inform you that another participant who has completed the same task as you before has earned £2,–. This other person (unlike you) did not learn anything about how much another person earned in the task.

Table A.7: Marginal effects for each individual round from the Poisson regression model

	Clicks				
	Round 1	Round 2	Round 3	Round 4	Round 5
Condition_SRPLow	−11.840***	−4.203	−3.912	−6.972*	−8.384**
	(4.194)	(3.701)	(3.625)	(3.588)	(3.967)
Condition_UncertaintyRisk	6.449	−1.800	−4.187	−6.008*	−9.598**
	(3.931)	(3.343)	(3.459)	(3.426)	(3.914)
Risk_attitudeLow_aver	−0.085	0.027	0.922	3.562	−1.266
	(6.589)	(6.377)	(6.670)	(6.332)	(6.941)
Risk_attitudeModerate_aver	0.592	−0.044	4.885	2.987	2.523
	(6.079)	(5.817)	(5.648)	(5.241)	(6.318)
Risk_attitudeRisk_loving	7.554	8.177	10.638	11.957	4.807
	(7.940)	(7.358)	(7.701)	(7.363)	(8.001)
Female1	−4.300	−7.831*	−8.218**	−3.921	−2.631
	(4.376)	(4.069)	(4.067)	(3.825)	(4.446)
Monthly_Income	−0.002	−0.0003	−0.0005	0.001	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
FeedbackFeedback_bomb		14.541***	20.338***	14.348***	15.458***
		(4.426)	(4.216)	(4.054)	(4.224)
Constant					
Observations	173	173	173	173	173
Log Likelihood	−1,948.078	−1,631.740	−1,666.372	−1,597.825	−1,908.928
Akaike Inf. Crit.	3,914.155	3,283.479	3,352.745	3,215.649	3,837.856

Each row corresponds to a separate round, where the number of Clicks is modeled as a function of SRP (High and Low), Condition Uncertainty (Risk and Ambiguitu), Risk attitude (reference is high risk aversion), Female, Age, and Feedback (reference is no bomb). Robust standard errors are calculated to account for potential heteroskedasticity.


Imagine that you receive £20. Your task is to share this amount with an anonymous person. It is up to you how much money you offer the other person. However, if the other person rejects your offer, you both end up earning £1. Your offer must be an integer number between £1 and £19.

Please, enter below how much money you would keep to yourself (Your share) and how much you would share (Your offer) with the other person.

Your share	0
Your offer	0
Total	0

Figure B.8: Illustration of modified ultimatum game developed by Blanco et al. (2011).

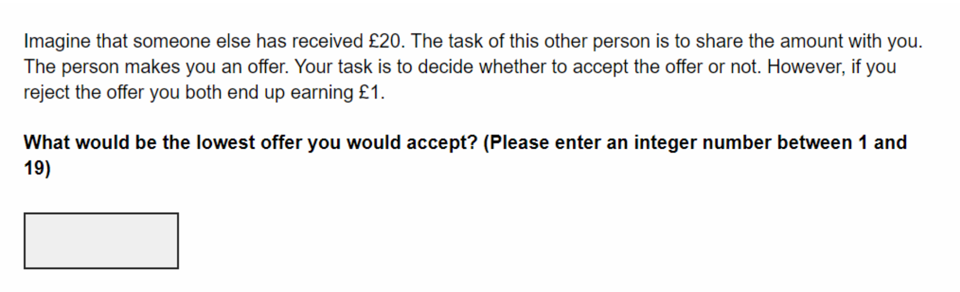


Figure B.9: Illustration of modified ultimatum game developed by Blanco et al. (2011).

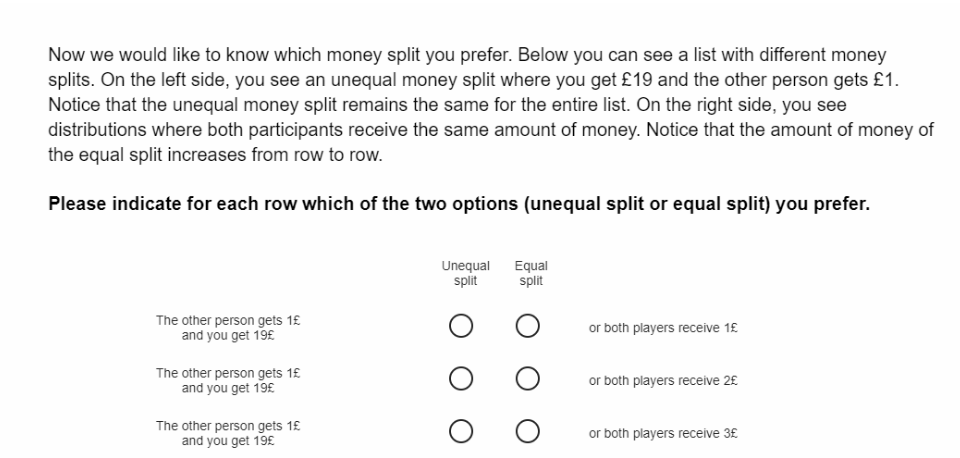


Figure B.10: Illustration of modified dictator game developed by Blanco et al. (2011).

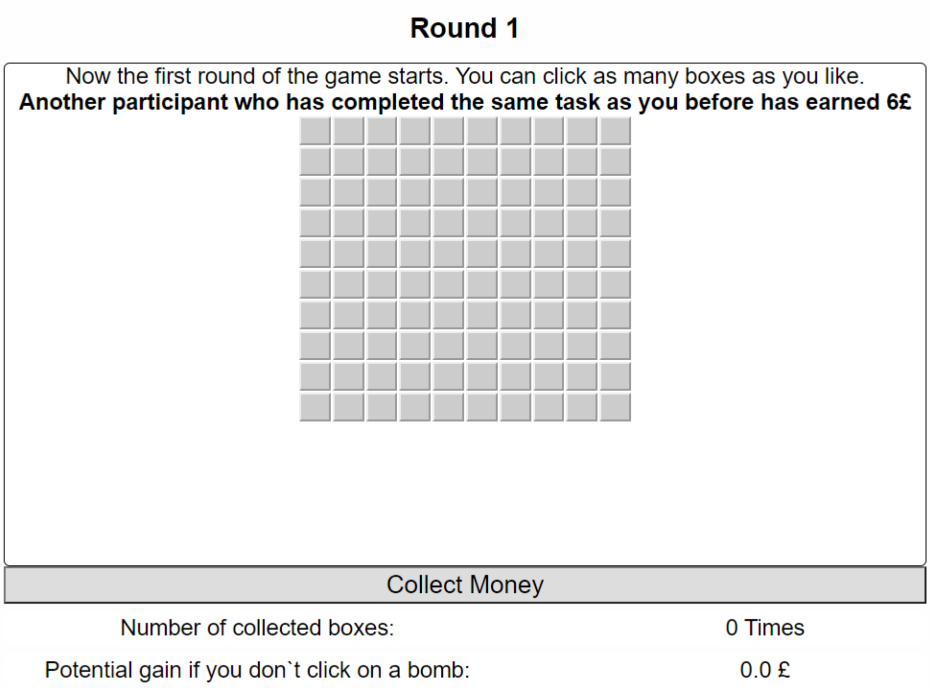


Figure B.11: Illustration of the bomb risk elicitation task (BRET) for the ambiguity condition and high treatment.

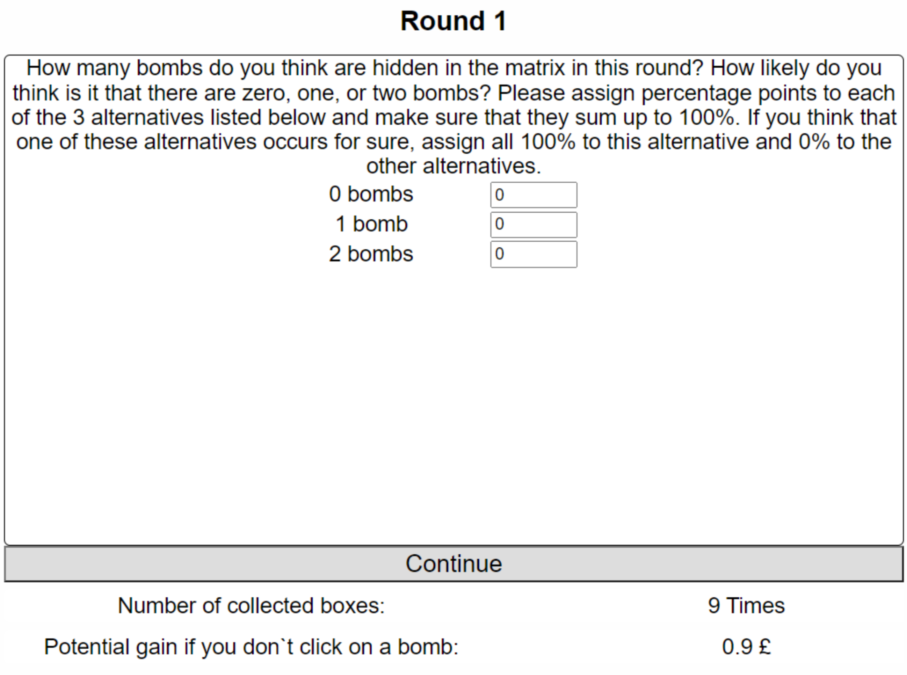


Figure B.12: Belief Elicitation in BRET

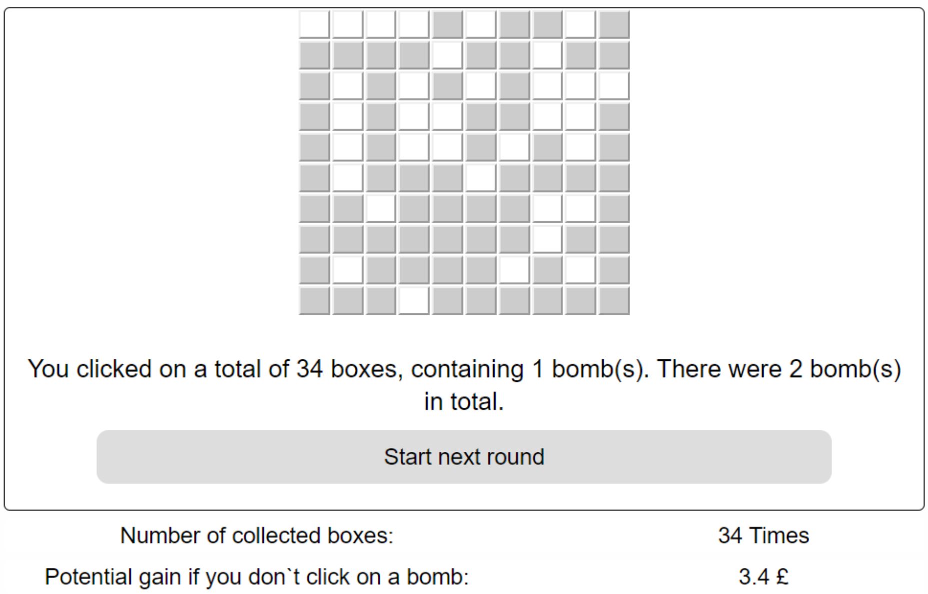


Figure B.13: Feedback BRET

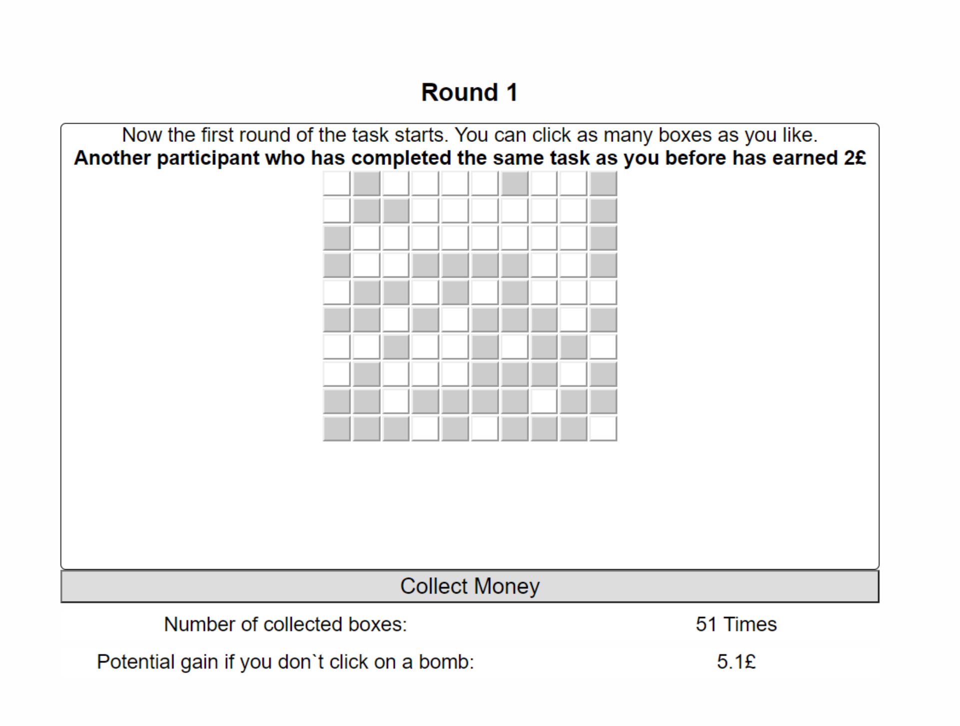


Figure B.14: Illustration of the bomb risk elicitation task (BRET) for the risk condition and low treatment.

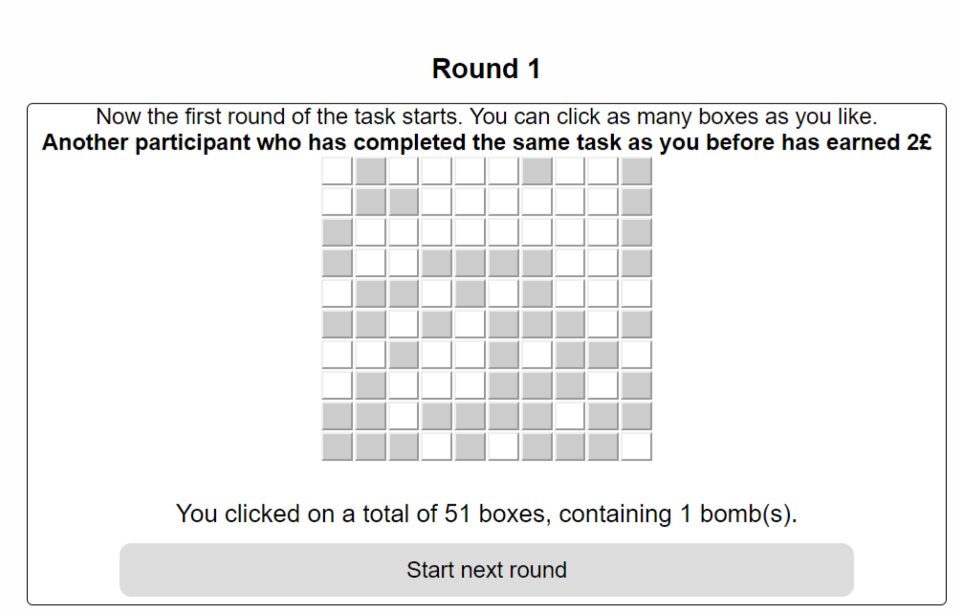


Figure B.15: Feedback BRET

Table A.8: Regression results from the Poisson model reported as average marginal effects

	Poisson		*OLS*	
	(1)	(2)	(3)	(4)
Condition_SRPLow	−5.645***		−5.734***	
	(1.665)		(1.695)	
Condition_UncertaintyRisk	−3.691**		−3.749**	
	(1.646)		(1.685)	
Feedbackno feedback	7.387**	7.383**	6.543**	6.548**
	(3.421)	(3.421)	(3.063)	(3.064)
FeedbackFeedback_bomb	17.150***	17.164***	16.570***	16.588***
	(2.252)	(2.252)	(2.112)	(2.112)
Round	−0.018	−0.022	−0.039	−0.039
	(0.830)	(0.830)	(0.846)	(0.846)
SRP = High Ambiguity		9.865***		9.451***
		(2.566)		(2.321)
SRP = Low Ambiguity		3.067		2.839
		(2.458)		(2.216)
SRP = High Risk		5.167**		4.832**
		(2.443)		(2.247)
Baseline SRP = Low Risk				
Constant			35.995***	26.978***
			(3.276)	(3.234)
Observations	870	870	870	870
R^2			0.090	0.091
Adjusted R^2			0.085	0.084
Log Likelihood	−9,164.231	−9,163.073		
Akaike Inf. Crit.	18,340.460	18,340.150		

Column (1) shows the impact of the SRP condition (1 if SRP is low) and the uncertainty condition (1 if risk), while Column (2) shows the impact of the interaction of both conditions (SRP and Uncertainty). The symbols *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 levels, respectively.

Appendix C. Proof: Social comparison model

We start with the initial equation 4.1:

$$U(k, s|s) = p(k)\,k + \beta\,(p(k)\,(k - s)) - \alpha\,(p(k)\,(s - k)) + \alpha\,(1 - p(k))\,(0 - s) \tag{C.1}$$

First, we consider the case where a subject is facing an advantageous position $k > SRP$, described in equation **??**:

$$U(k, s|s) = p(k)\,k + \beta\,(p(k)\,(k - s)) + \alpha\,(1 - p(k))\,(0 - s) \tag{C.2}$$

Now, we insert the probability of success $p(k) = \frac{100-k}{100}$ for $p(k)$ and the probability that a bomb is collected $\frac{k}{100}$ for $(1 - p(k))$:

$$U(k, s|s) = \left(\frac{100-k}{100}\right)k + \beta\left[\left(\frac{100-k}{100}\right)(k - s)\right] - \alpha\left(\frac{k}{100}\right)(s) \tag{C.3}$$

Now, we take the derivative $dU/dk = 0$ from equation C.8:

$$\frac{dU}{dk} = \frac{\beta}{100}\cdot\frac{d}{dk}\left[(100-k)(k-s)\right] + \frac{1}{100}\cdot\frac{d}{dk}\left[(100-k)k\right] \tag{C.4}$$

$$- \frac{\alpha s}{100}\cdot\frac{d}{dk}[k] = 0 \tag{C.5}$$

from the previous derivation, we simplify the equation further:

$$\begin{aligned}
&= \frac{\beta(-k + s + 100 - k)}{100} + \frac{-k + 100}{100} - \frac{\alpha s}{100}\\
&= \frac{\beta(-2k + s + 100)}{100} + \frac{100 - k}{100} - \frac{\alpha s}{100}\\
&= \frac{-2\beta k - \beta s + \beta 100 - k + 100 - \alpha s}{100}\\
&= \frac{-2k(1+\beta) - s(\beta+\alpha) + 100(1+\beta)}{100} = 0
\end{aligned} \tag{C.6}$$

Solving for the optimal amount of clicks k^*, given $50 = k^*$:

$$\begin{aligned}
-2k(1+\beta) - s(\beta+\alpha) + 100(1+\beta) &= 0\\
2k(1+\beta) &= 100(1+\beta) + s(\beta-\alpha)\\
k &= 50 + \frac{s(\beta-\alpha)}{2(1+\beta)}
\end{aligned} \tag{C.7}$$

For a disadvantageous position $k \leq s$:

$$U(k, s|s) = \left(\frac{100-k}{100}\right)k - \alpha\left[\left(\frac{100-k}{100}\right)(s-k)\right] - \alpha\left(\frac{k}{100}\right)s \tag{C.8}$$

Taking the derivative to maximize expected utility:

$$\begin{aligned}
\frac{dU}{dk} &= \frac{-k + 100 - \alpha(s-k) - \alpha s}{100}\\
&= \frac{-k(1+\alpha) + 100 - \alpha s}{100} = 0
\end{aligned} \tag{C.9}$$

Solving for k^s under social preferences, given $50 = k^*$:

$$\begin{aligned}
k(1+\alpha) &= 50(1+\alpha)\\
k &= 50\\
k^s &= 50 = k^*
\end{aligned} \tag{C.10}$$