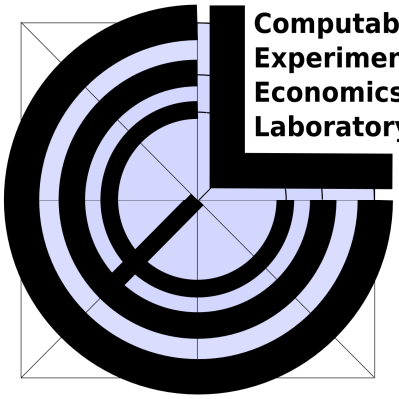

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Regret once, think twice: the impact of experienced regret on risk choice

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Regret Once, Think Twice: The Impact of Experienced Regret on Risk Choice

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Abstract We examine the behavioral consequences of experienced regret on subsequent choice. Previous experimental research findings suggest that the impact of experienced regret on repeating subsequent choice is mediated by the anticipation of experiencing regret again. We argue that this impact is due to a mechanism linked to the subjective probability to regret in the subsequent choice. We conducted an experiment to test whether this hypothesis can be generalized to the case where the subsequent choice is different than the preceding one. Participants were presented with a sequence of two different decision tasks: a choice between two risky gambles followed by a matching task. To induce experienced regret, we provided two different types of feedback on the gambles: regret and non-regret feedback. To gain insights to the role of anticipated regret in mediating the effect of experienced regret, we also introduced two different types of feedback on the matching task: partial and complete feedback. We found that prior experienced regret and complete feedback on the subsequent choice should be both present for a change in behavior in the subsequent different choice. To interpret our results, we provide analytical considerations based on our hypothesis of changed subjective probability to regret, consistent with the observed behavior.

Keywords risk choice · regret theory
JEL classification A12, C91, D03

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1 Introduction

We all have experienced making a decision that we thought was the right one at the time, but later we discovered that there was a better choice we could have made. As a consequence we felt regret for making the wrong choice. Regret is the negative emotion experienced when the comparison process between the chosen outcome ("what is") and the highest outcome produced by alternative options ("what might have been") resulted in an unfavorable difference (Kahneman and Tversky, 1982; Kahneman and Miller, 1986). There is an important condition, which has to be satisfied for experiencing regret: in order to make the comparison one should receive feedback on both chosen outcome and the foregone ones, i.e., complete feedback (Bell, 1982; Loomes and Sugden, 1982). When feedback is provided only on the outcome of the chosen option, i.e., partial feedback, no comparison can be made with "what might have been", and therefore no post-decisional regret can be experienced (Bell, 1982; Loomes and Sugden, 1982; Inman *et. al.*, 1997; Mellers *et. al.*, 1999; Creyer and Ross, 1999; Camille *et. al.*, 2004; Coricelli *et. al.*, 2005; Van Dijk and Zeelenberg, 2005).

Previous research addressing the behavioral consequences of experienced regret on subsequent choice mainly focused on repetitions of the same decision. The behavior in the more general situation where the subsequent choice represents a different decision was only partially investigated (Raeva *et. al.*, 2008). In the experiment reported in this paper, we again consider this more general case. Besides providing further evidence for the effect of experienced regret on an unrelated subsequent decision, our main goal here is to shed light on the underlying mechanisms of the influence of experienced regret on subsequent choice.

The paper is organized as follows. In the next section, we discuss earlier findings on the consequences of experienced regret (on repeating choices), and extend these findings to our wider context. In Section 3, we present the details of the experimental design and the statistical analysis of the results. This is followed by a discussion where we compare our findings to the predictions of a qualitative analytical model. We conclude in Section 4.

2 Behavioral Consequences of Experienced Regret

We first summarize the previous findings on the effect of experienced regret on subsequent (repeating) choices. Zeelenberg and Beattie (1997, Experiment 3) studied the impact of the feedback in the case of a repeated ultimatum game. In the ultimatum game there are two players, a proposer and a responder. The players are endowed with a sum of money and the proposer has to offer how this amount should be divided between the two players. The responder can either accept or reject the offer. In the case when the responder accepts, the amount is divided as suggested in the offer. In the case when the responder rejects, neither player receives any money. In Zeelenberg and Beattie (1997, Experiment 3) the participants played the role of the proposer. After offering some portion of the money to a responder, they learned that their offer was accepted, but also were told for how much less their offer still would have been accepted: one group learned that if their offer was with 2 Guilders[1] less it would been accepted and other group learned if it was with 10 Guilders less it would have been accepted. After the feedback, the experienced regret over their offer was assessed. The authors found that those participants who learned that they should have offered 10 Guilders less experienced more regret than

[1] Guilder is the English translation of the Dutch gulden, which was the currency of the Netherlands from the 13th century until 2002, when it was replaced by the Euro.

participants who learned that they could have offered only 2 Guilders less. Participants then had a second round on the ultimatum game. In this second round, participants who learned before that they could have offered 10 Guilders less lowered the amount offered to the responder substantially, whereas participants who learned before that they could have offered only 2 Guilders less hardly lowered their offers in the second round.

In another study, Zeelenberg *et. al.* (1997, cited in Zeelenberg *et. al.* (2001)) presented participants with an opportunity to win money by drawing a red marble out of an urn that contains both red and white marbles. There were two urns: one containing 1 red and 9 white marbles, and another containing 9 red and 91 white marbles. Participants were asked to choose an urn. After making their choice participants were informed that they did not win any money, i.e., a white marble was drawn from the chosen urn. They were also informed that a red marble was picked out from the other urn. After their evaluation of this choice was assessed, participants were informed that they could play once more, and were asked from which urn they would like to draw this time. The results revealed that the participants turned to the other previously not chosen urn in their second time. Thus, experienced regret on the first choice promoted switching behavior on the second choice. Similar results were reported in Zeelenberg and Pieters (1999).

Two studies (Camille *et. al.*, 2004; Coricelli *et. al.*, 2005) examining how anticipated regret influences choice behavior reported, in addition, the subsequent choice behavior after experiencing regret. In order to investigate the influence of anticipated regret on the subsequent choice process, Camille *et. al.* (2004) presented participants with complete feedback on series of choices between two gambles that always differed in their expected value. One of the gambles was always with higher expected value, but it won less often on average than the gamble with the lower expected value. This was done to ensure that the participants would experience regret more often on the gamble with the higher expected value. The authors observed that over the course of the experiment, the (normal)[2] participants chose more often the gamble with lower expected value. Camille *et. al.* (2004) suggested that this behavior is due to experienced regret on the other gamble. Coricelli *et. al.* (2005) used a similar experimental paradigm. The authors measured brain activity using functional magnetic resonance imaging while participants were presented with a series of choices between two gambles. They found that over the course of the experiment participants displayed a behavioral bias away from choices that previously led to experiencing regret. The proportion of choices avoiding regretted options increased over time with the cumulative experience of regret, which was reflected in the enhanced activity within orbitofrontal cortex (OFC) and amygdale. This pattern of neural activity reoccurred just before making choice, which suggested that the same neural circuitry mediates the experience of regret and its anticipation[3].

We interpret the pattern of behavior found in Camille *et. al.* (2004) and Coricelli *et. al.* (2005) as suggesting that when making a choice, people anticipate the experience of regret based on their previous experience of regret relevant to the choice option. This leads to the general conclusion that the impact of experienced regret on subsequent choice is mediated through the anticipation of the experience of regret. In this paper, our goal is to gain insight into the underlying mechanism of this impact.

The pattern of the behavior found in Camille *et. al.* (2004) and in Coricelli *et. al.* (2005) also revealed that the more the negative regret experience was accumulated the more it guided the choice behavior, independently

[2] Normal participants and patients with orbitofrontal cortex lesions participated in the study of Camille *et. al.* (2004).

[3] Coricelli *et. al.* (2007) argued that OFC activity related to the effect of experienced regret and its anticipation suggests that the OFC integrates cognitive and emotional information.

of the components of the option itself (i.e., the payoffs of the option and the probability associated to the payoffs). Therefore, if one assumes that experienced regret causes people to attach a negative attribute to the option corresponding to how often this option has led to experiencing regret, one could conclude that experienced regret throughout the sequence of choices altered the subjective probability of experiencing regret again. Note that a similar mechanism is implemented in regret learning algorithms in artificial intelligence and game theory, where the accumulation of experienced regret was used to determine the choice behavior (Foster and Vohra, 1999; Hart and Mas-Colell, 2000).

We take this interpretation as a base to assume that the mechanism by which experienced regret influences anticipated regret is linked to influencing the subjective probability of experiencing regret, i.e., we assume that the accumulated previous experience of regret alters the participants' belief about the probability to regret associated to that option. This assumption is in accord with the argument that when making choices people are mostly concerned with the anticipated probability of regret (Ritov, 1996). The more the attractiveness of an option will decrease the higher is the probability for regret to occur for this option.

One could argue, however, that the mechanism by which experienced regret modifies the subjective probability to regret in subsequent choice is closely connected to the fact that the effect of experienced regret was examined using a sequence of choices of the same type. In a repeating decision context there is a direct mapping between the choice on which regret was experienced and the subsequent choice. In this context, experienced regret could be treated as an emotion based information that is attributed to the decision option (integral emotion, see Schwarz and Clore, 1988; Loewenstein and Lerner, 2003; Slovic *et. al.*, 2007) rather than as an independent influence on the decision processes. This raises the question whether experienced regret could influence the behavior in subsequent choice differently than recalling previous experienced regret relevant to the choice.

To answer this question, in this paper, we investigate the effect of experienced regret on a different subsequent choice, i.e., on a subsequent choice where no direct mapping between the choices is present, but only remote resemblance. The experienced regret on a prior different type of choice is an irrelevant factor for the new choice type, according to the standard expected utility theory, as it is the emotion which arises from a dispositional or a situational source that is considered objectively unrelated to and not affected by the decision at hand. That is, experienced regret is an incidental emotion (Loewenstein and Lerner, 2003). To our knowledge, Raeva *et. al.* (2008) is the only study so far demonstrating that experienced regret as incidental emotion has an influence on sequential different decision. In that study, the subsequent different decision was intertemporal choice. It was found that when regret was experienced on a risk choice prior to the intertemporal choice, the future was discounted more, compared to the discounting when no regret was experienced. This study provided evidence that experienced regret exert considerable influence on different subsequent choice even when this emotion is considered as an incidental emotion to the decision at hand. To better understand the psychological mechanism behind the behavioral consequences of experienced regret on sequential decisions, in this paper we extend the investigations to risk choice.

3 The Experiment

The experiment was designed to test, first, whether the impact of experienced regret on unrelated subsequent choice is mediated by the anticipation of regret in this choice, and, second, whether a mechanism connected to

the subjective probability to regret could account for the impact. We introduced a sequence of two tasks. The first task was a choice between two risky gambles with equivalent probabilities associated to the outcomes. This was the emotion manipulation task. Two different types of feedback were provided on the first task: non-regret feedback and regret feedback. In *non-regret feedback*, the outcome of the chosen gamble was shown, whereas in *regret feedback*, the outcomes of both gambles were revealed, such that participants discovered that they would have been better off if they have made the alternative choice.

The second task was a matching task. The matching procedure is a common method to assess indifference between two options. Participants are presented with two options that are described on two dimensions. One attribute value is missing and participants are instructed to fill in a value for this attribute such that the two options will become equally attractive (i.e., one would be indifferent between the two options). The matching task in the experiment required to state the *certainty equivalent* of a gamble offering a 50% chance at 100 Euro and a 50% chance at 1 000 Euro, i.e., to state the minimal amount of sure money they would accept instead of the gamble. The certainty equivalent was our main dependent variable. We hypothesized that the regret induced in the first choice would influence the evaluation processes in the second choice, and that this influence would be captured by the difference between the certainty equivalent in non-regret condition and the one reported in regret condition. We conjecture that the direction of the difference between the certainty equivalents could be predicted by a mechanism associated with the subjective probability to regret. Based on a qualitative analysis of the decision situation (to be discussed below), we expect that the direction of adjustment is downward when the subjective probability of regret is changed due to experienced regret.

To better capture the role of anticipated regret in mediating the effect of experienced regret on subsequent choice, we introduced different types of feedback on the second task: complete feedback and partial feedback. In the *complete feedback* participants were instructed when making the matching task to consider that whatever they would decide, the outcome of the gamble would be revealed. The participants thus knew in advance that they would find out whether they won 1 000 Euro or 100 Euro in the gamble. In *partial feedback*, participants were instructed that if the sure money was accepted, the outcome of the gamble would not be revealed to them. The introduction of different types of feedback on the second task will allow us to test the effect of experienced regret not only on choices where one can anticipate the experience of regret, but also on choices where one can anticipate that the experience of regret can be entirely avoided.

One could think of the certainty equivalent in the case of partial feedback as the cancellation price of the lottery. The cancellation price implies that a decision-maker would choose to cancel the lottery or not to play on it in return for a payment, given that the lottery would not be resolved. In the case of complete feedback on the second task, the certainty equivalent could be treated as the selling price of the lottery. This naming convention was introduced by Bell (1983).

In the following, we outline our predictions regarding the certainty equivalent in different conditions. We perform a qualitative analysis, within the framework of a simplified version of Bell's regret theory model (Bell, 1983), which we extend to account for the effect of experienced regret. The basic assumption is that, when choosing between different options, people maximize their expected utility, which for a certain option is given by

$$EU = \langle v \rangle + p_R r(s).$$

Here, $\langle v \rangle$ is the expectation for the value attributed to the option. The second term expresses the influence of regret. It is the combination of two components: p_R, the probability to regret with this option, and $r(s)$, the magnitude of a regret of size s. We assume that the size of regret is quantifiable by the monetary difference between the chosen and the foregone outcomes. It is assumed that the form of the regret function $r(.)$ translates the size of regret into an emotional equivalent, such that the higher the size of regret the higher the magnitude of regret experience. Note that this formula implies that we neglect the influence of anticipated rejoicing[4]. In the complete feedback condition, the decision situation is represented as

$$(1-p)v(1000) + pv(100) + pr(100-z) \gtreqless v(z) + (1-p)r(z-1000), \tag{1}$$

where the left hand side describes the gamble, the right hand side describes taking the bank offer z, and p is the probability of winning 100 Euro ($p = 0.5$ objectively). In partial feedback, the outcome of the lottery would not be revealed, thus no regret is anticipated for taking the bank offer. The decision situation is therefore

$$(1-p)v(1000) + pv(100) + pr(100-z) \gtreqless v(z). \tag{2}$$

The left hand side of Eq. (1) and Eq. (2) are the same, describing that if the gamble is played, the two conditions are equivalent. The difference between Eq. (1) and Eq. (2) is that the regret term is absent in Eq. (2), corresponding to avoiding regret entirely if the bank offer is taken in the partial feedback condition.

The two formulas above already allow us to relate the partial and complete feedback conditions. Assume that z_0 is the certainty equivalent for the partial feedback condition, i.e., Eq. (2) is an equality if z_0 is substituted. Then, substituting this z_0 into Eq. (1), the left hand side is the same as for Eq. (2). The right hand side of Eq. (1) is smaller than of Eq. (2), due to the regret term, i.e., the left hand side of Eq. (1) is larger than the right hand side if z_0 is substituted, meaning that the lottery would be preferred in the complete feedback condition, if the bank offer would be z_0. That is, z_0 is not enough for indifference between the two options in the complete feedback condition, i.e., the certainty equivalent in the complete feedback condition is higher than in the partial feedback condition.

It is worthwhile to formulate this prediction using Bell's terminology introduced earlier. Bell's definition for the cancellation price covers the measure we use in the second task. The cancellation price is the smallest monetary equivalent necessary to cancel the lottery in return for a payment of any amount greater than this monetary equivalent. Likewise, we followed Bell's definition in calling the certainty equivalent in complete feedback the selling price of the lottery. The selling price is the smallest monetary amount for which a decision-maker, knowing that the lottery will be resolved, is prepared to sell the lottery. Bell (1983) defined the resolution premium as the amount by which the selling exceeds the cancellation price. Our prediction is therefore, that the resolution premium is positive, that is, the selling price is higher than the cancellation price. This prediction is the same as the one made in Bell (1983), indicating that the used, simpler version of his model captures the essentials of the theory regarding our experiment.

Next, we compare the certainty equivalent between regret and non-regret conditions. As stated previously, we assume that the mediating mechanism responsible for the carryover effect of experienced regret is related to the

[4] We neglect the influence of anticipated rejoicing based on previous research findings which suggest that the effect of anticipated rejoicing on decision behavior is relatively weak (Beattie *et. al.*, 1994; Larrick and Boles, 1995; Zeelenberg *et. al.*, 1996; Inman *et. al.*, 1997; Mellers *et. al.*, 1999).

increased probability to regret (on the gamble). We base this assumption on the remote similarity of the gamble to the previous choice, where regret was experienced, i.e., being a choice involving risk. Mathematically, our assumption corresponds to an increase of p in the regret condition compared to the partial feedback condition[5]. In our analysis, we discuss the complete and partial feedback situations, Eq. (1) and Eq. (2) simultaneously. Due to the increase of p, the left hand side of Eq. (1) and Eq. (2) decreases, since the expected value of the gamble decreases and the probability to regret on the gamble increases (and the regret term is negative). The right hand side is unaffected for the partial feedback condition, and it increases for the complete feedback condition, since $(1 - p)$ decreases. This implies that if in the non-regret condition the certainty equivalent is z_0, i.e., the relations are satisfied with an equality in the non-regret condition, for a bank offer z_0 in the regret condition the right hand side is larger, i.e., the bank offer is preferred. Therefore there is still room to reduce z_0 in the regret condition till indifference (i.e., the certainty equivalent for the regret condition) is reached. We thus predict for both partial and complete feedback that the certainty equivalent is smaller in the regret condition than in the non-regret condition.

Method

3.1 Design and Participants

118 students at Leiden University participated voluntarily. Two participants were excluded due to providing an answer that lies outside of the possible domain of the task (one reported 3 000 Euro and the other 5 000 Euro as amount for the certainty equivalent). The data from 116 participants (35 males (30%); 81 females (70%); and $M_{\text{age}} = 20.81$ years) were considered in the statistical analysis. They were randomly assigned to the cells of a 2 (experienced feedback on the fist task: non-regret versus regret) $\times$ 2 (expected feedback on the second task: partial versus complete) between-participants design. Participants received monetary compensation for their participation (1 Euro).

3.2 Experimental Tasks and Procedure

Each participant was seated in an individual box-room equipped with a personal computer with a keyboard and a computer mouse. In the beginning of the experiment, participants were informed that they participated in a survey for the TV game show "Deal or no deal". They received a brief explanation of the rules of the game (in the Dutch format). The essence of the game is that there are 20 boxes (containing amounts of money from 1 Euro to 250 000 Euro) each belonging to one of 20 contestants. One contestant is selected to play the game (the other contestants are only assisting from this point on). The contestant starts opening the boxes of the others one by one. In predetermined intervals, she is presented with "bank offers" (the offer depends on the value of the unopened boxes) – the opportunity to take for sure some amount of money to give up the amount in her own box – and she is asked the question "Deal or no deal?" If she answers "No deal", she continues to open boxes. If she answers "Deal", she gets the bank offer, and gives up the amount in her box. At this point in time the contestant does not know what is in her box. She continues to open boxes until all boxes are opened, thereby revealing the content of the contestant's box in the end of the game. In the experiment, participants were informed that the survey was intended to improve the algorithm used to calculate the bank offers.

[5] We assume that the regret function $r(.)$ is not affected by experienced regret, in line with the findings of Ritov (1996), outlined in Sec. 2, that the main attribute of regret influencing choice behavior is the probability to regret.

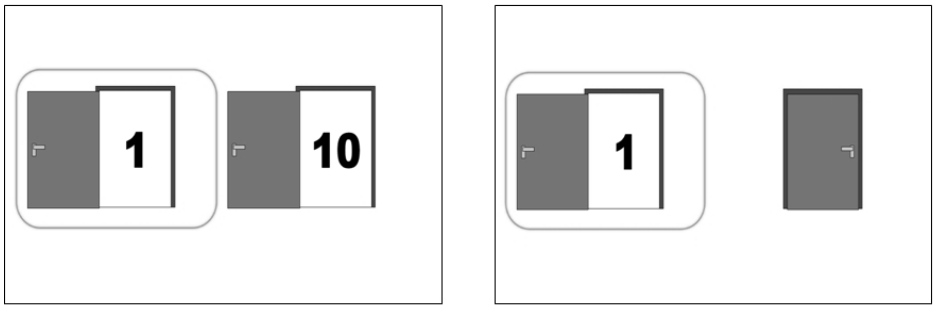

Fig. 1 Feedback on emotion manipulation task. Two identical closed doors were used to represent the choice between two identical gambles: 50% chance to win 1 Euro and 50% chance to win 10 Euro. A green rounded square highlighted the selected door. The left panel represents the regret feedback where feedback was provided on both doors. The right panel represents the non-regret feedback where a feedback was provided only on the selected door.

Participants were next introduced to the emotion manipulation task. They were presented with the following scenario:

> *Before we begin with the survey, we will first start with a part to determine how much you will get paid for your participation. You could be paid either 1 € or 10 €. How much you will receive, depends on your decision.*
>
> *You must choose between two doors, door A and door B. Behind each door there is either 1 € or 10 €. Each door has a 50% chance that 1 € is behind it and 50% chance that there are 10 € behind it.*

On a computer screen participants saw two identical doors representing the choice between door A and door B. Participants were required to use the computer mouse to indicate their choice. After making their choice participants received feedback (see Fig. 1). In all conditions, irrespectively of the choice, the outcome of the selected door was predetermined for each participant to obtain 1 Euro for her/his participation. In the non-regret feedback condition only the amount behind the chosen door was revealed. In the regret feedback condition both the amount behind of the chosen and the amount behind the alternative door were shown, and participants discovered they could have won 10 Euro if they had chosen differently.

After participants made their first choice and the feedback on it was shown, participants in the partial feedback condition were introduced to a new rule of the game called "Deal & Go". According to this new rule, once a bank offer is accepted the game is over and the contestant will never find out what is in her box. In complete feedback no modifications of the rule of the game was introduced. In contrast to "Deal & Go", the rule of "Deal or no deal" states that irrespectively of whether the bank offer is accepted or not the game is only over when all boxes are opened.

Next, participants were presented with the scenario of the matching task:

> *Imagine you are at the last stage of game. There are only two boxes left: 100 € and 1 000 €. What is the lowest offer you would accept from the bank?*

On a computer screen participants were next presented with the matching task in the format used in the TV game show "Deal or no deal" (see Fig.2). Participants were asked to type using the keyboard what is the

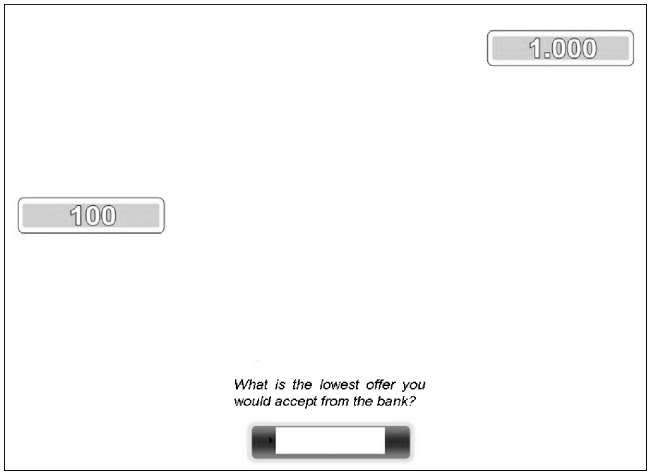

Fig. 2 Matching task. The matching task was designed to resemble the format used in the TV game show "Deal or no deal". Each amount in the game is shown in a rounded rectangle. The position of 100 Euro and 1 000 Euro, and the bank offer follows the positions seen in the TV game in the corresponding situation.

smallest amount they would accept to play on the gamble. After recording the response and the response time (RT) on the matching task, participants were asked to judge on a 7-point scale (1 = "not at all"; 7 = "very much") to what extent they would regret to accept a bank offer that is equal to the certainty equivalent they just indicated.

3.3 Results

A 2 (experienced feedback on the fist task: non-regret versus regret) × 2 (expected feedback on the second task: partial versus complete) factorial ANOVA on the mean certainty equivalents per conditions yielded a significant main effect for the regret feedback on the first task ($F(1, 112) = 3.86$; $p = 0.05$): in the regret feedback condition ($M = 548.45$, $SD = 23.22$) participants indicated lower amounts for the certainty equivalent overall than did the participants in the non-regret feedback condition ($M = 482.56$, $SD = 24.21$). The main effect was qualified, however, by the significant interaction between partial feedback and complete feedback on the second task, in regret feedback condition ($F(1, 112) = 4.31$; $p < 0.05$). An independent-samples t-test revealed that when there was the complete feedback on the second task, participants in regret feedback condition reported significantly ($t(65) = 3.10$, $p < 0.05$) lower amounts for the certainty equivalent ($M = 422.72$, $SD = 198.47$) than did the participants in non-regret feedback condition ($M = 558.24$, $SD = 157.35$). Participants with partial feedback on the second task did not report considerably different certainty equivalents in the regret feedback condition ($M = 542.39$, $SD = 160.16$) and in the non-regret feedback condition ($M = 538.65$, $SD = 191.43$) (see Fig. 3). To summarize, these results suggest that the joint effect of the regret feedback on the first task and the complete feedback on the second task is necessary to lower the amount for the certainty equivalent.

In addition to the certainty equivalent, we collected the RT (in ms) of the reply to the matching task. We measured the time between initiating the stimulus presentation of the matching task and the initiation of the response on it (i.e., typing of the certainty equivalent). A 2 × 2 factorial ANOVA on the collected RT of the certainty equivalents revealed main effect of the emotion manipulation ($F(1, 112) = 4.14$; $p < 0.05$). The results show that participants in regret feedback condition ($M = 2091.31$, $SD = 185.27$) responded faster overall on the matching task than did participants in the non-regret feedback condition ($M = 2613.59$, $SD = 177.70$). The

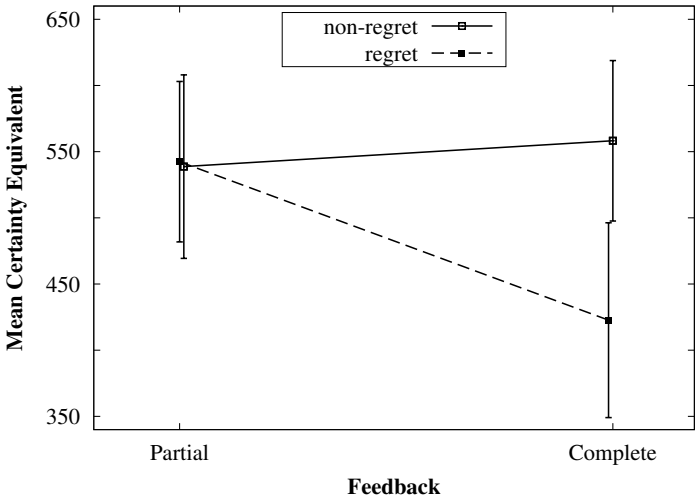

Fig. 3 Mean Certainty equivalent per condition. (Error Bar: 95% confidence interval). The white square indicates the mean certainty equivalent for non-regret feedback, the black square indicates the mean certainty equivalent for regret feedback. The solid line connects the mean certainty equivalents of partial and complete feedback conditions for the non-regret feedback on the first; the dashed line connects the mean certainty equivalents of partial and complete feedback conditions for regret feedback on the first task.

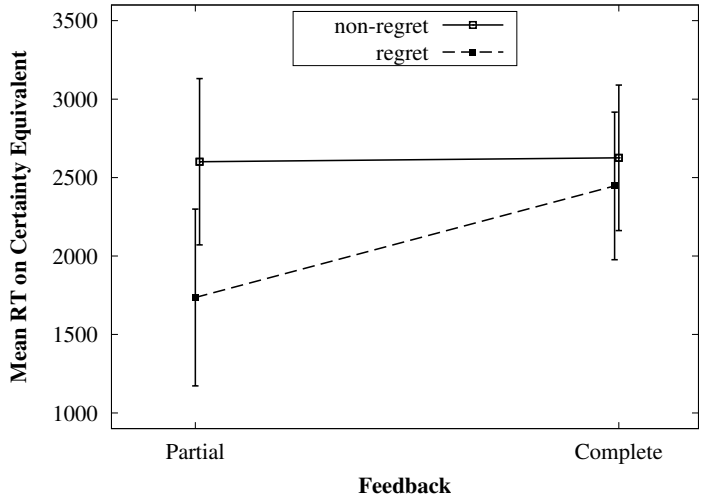

Fig. 4 Mean RT on certainty equivalent per condition. (Error Bar: 95% confidence interval). The white square indicates the mean RT on certainty equivalent for non-regret feedback, the black square indicates the mean RT on certainty equivalent for regret feedback. The solid line connects the mean RT certainty equivalents of partial and complete feedback conditions for non-regret feedback on the first task; the dashed line connects the mean RT certainty equivalents of partial and complete feedback conditions for regret feedback on the first task.

interaction between types of feedback on the first and the second task was not significant ($F(1, 112) = 1.79$; $p > 0.05$) (see Fig. 4).

To the ratings of the question to what extent the participants would feel regret to accept a bank offer equal to their certainty equivalent, a 2 × 2 factorial ANOVA also revealed a main effect of the emotion manipulation ($F(1, 112) = 8.14$; $p < 0.05$). The results showed that participants in regret feedback condition ($M = 5.31$, $SD = 0.17$) reported lower expected regret ratings overall than did the participants in non-regret feedback condition ($M = 4.61$, $SD = 0.18$). The interaction between types of feedback on the first and the second task was not significant ($F(1.112) = 0.27$; $p > 0.05$). An independent-samples t-test revealed that participants with partial feedback on the second task reported that they would experience significantly more regret ($t(47) = 2.14$;

$p < 0.05$) in non-regret feedback condition ($M = 5.38$, $SD = 0.98$) compared to the expected regret in regret feedback condition ($M = 4.57$, $SD = 1.64$). It is worthwhile noticing that similarly the participants in complete feedback condition reported higher expected regret ($t(65) = 1.84$; $p = 0.7$) in non-regret condition ($M = 5.24$, $SD = 1.08$) compared to regret condition ($M = 4.67$, $SD = 1.43$) (see Fig. 5).

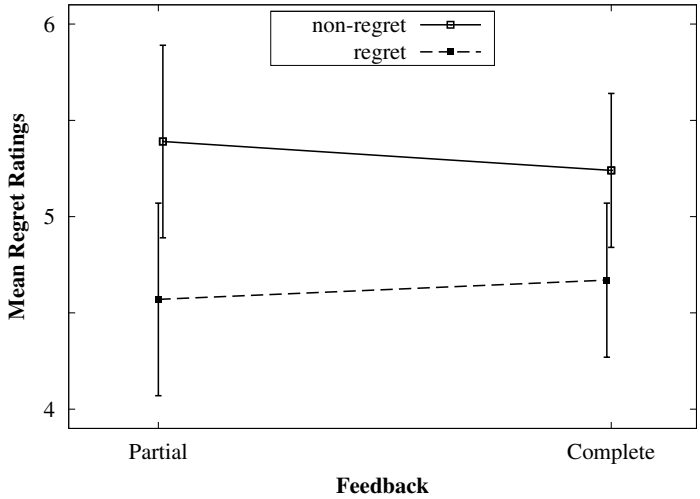

Fig. 5 Mean regret ratings per condition. (Error Bar: 95% confidence interval). The white square indicates the mean regret ratings for non-regret feedback; the black square indicates the mean regret ratings for regret feedback. The solid line connects the mean regret ratings of partial and complete feedback conditions for non-regret feedback on the first task; the dashed line connects the mean regret ratings of partial and complete feedback conditions for regret feedback on the first task.

3.4 Discussion

Let us first start with discussing our results regarding the role of anticipated regret in mediating the effect of experienced regret on subsequent choice. We had two types of feedback on the second task. We assumed that in partial feedback, one can anticipate that the experience of regret can be entirely avoided, whereas in complete feedback the experience of regret can be only reduced, but not avoided. Our qualitative analysis based on Bell's model (Bell, 1983) predicted that the certainty equivalent z_0 in the complete feedback condition would be higher than in the partial feedback condition, regardless whether regret or non-regret feedback was provided on the first task. We found no significantly different z_0 between the partial feedback and complete feedback conditions, overall. These results disagree with the prediction, which suggest that the processes leading to decisions with different types of anticipated feedbacks may not be represented accurately by the traditional regret theory formulation. We did find, however, a significant difference between the certainty equivalents in partial and complete feedback, if we restricted the comparison to the regret condition of the first task. Surprisingly, the direction of the change was the opposite of what Bell's theory (Bell, 1983) predicts, i.e., we find a negative resolution premium instead of a positive one, which follows from Bell's model (cf. Sec. 3).

Our second prediction was that z_0 is lower if regret was experienced after the first task compared to the non-regret condition. The overall behavior of participants in the regret and non-regret conditions confirms this prediction. A closer look on the subgroups, however, shows that this significant reduction of certainty equivalents is due to the participants in the complete feedback condition. Participants in the partial feedback condition

reported the same z_0 regardless whether the first task provided regret or non-regret feedback, which is another discrepancy from our predictions.

To summarize, we found that for a different z_0 in partial and complete feedback conditions, experiencing regret in the first task is needed, and for a different z_0 in regret and non-regret conditions, complete feedback in the second task is needed. This is a more complex pattern than the one suggested by the qualitative analysis based on Bell's (Bell, 1983) regret theory model.

As a possible post-hoc explanation of our behavioral results, here we suggest an alternative model that can account for all aspects regarding the reported values of the certainty equivalent. We make the assumption about the anticipated partial feedback condition that the circumstance that accepting the bank offer leaves the gamble unrevealed makes participants focus on the bank offer and they do not consider the lottery situation in detail, i.e., they do not contemplate how much they could regret if they play the lottery. This corresponds to the decision situation

$$(1-p)v(1000) + pv(100) \gtrless v(z) \tag{3}$$

in partial feedback (i.e., we disregard the regret term on the lottery side of the relation, cf. Eq. (2)). Now we consider the effect of experienced regret. The probability to regret does not enter and therefore the effect of experienced regret is diminished[6]. This leads to the absence of significant difference between the regret and non-regret conditions. Note that assuming a weak risk aversion encoded in the value function v, Eq. (3) leads to a certainty equivalent z_0 slightly below 550 Euro, in agreement with our experimental findings.

We do not use any additional assumptions compared to our original predictions in the complete feedback condition. The representation of the decision situation for complete feedback is therefore the same as Eq. (1),

$$(1-p)v(1000) + pv(100) + pr(100-z) \gtrless v(z) + (1-p)r(z-1000). \tag{4}$$

In this situation, for $p = 0.5$ and for z_0 of the partial feedback condition (which is slightly below 550 Euro), the regret terms on the left and right hand side are approximately equal and therefore roughly cancel each other (they would cancel exactly for $z = 550$), i.e., what remains from Eq. (4) is approximately Eq. (3), therefore, due to the definition of z_0, we have an approximate equality. This translates to a behavior that in the complete feedback, non-regret condition (we assume that in the non-regret condition the objective value $p = 0.5$ for the probability to regret is used), the certainty equivalent is not significantly different than in the partial feedback case. Now we consider the effect of experienced regret. Experienced regret in the complete feedback case acts the same way as outlined in our predictions, i.e., the subjective probability to regret on the gamble p is increased. As explained earlier, the consequence is a decrease in the certainty equivalent z_0 when regret feedback was provided compared to the cases when there was non-regret feedback. To summarize, the description suggested here leads to difference in z_0 between partial and complete feedback if regret is experienced in the first task, and leads to a difference between regret and non-regret feedbacks, if complete feedback is provided in the second task. The above hypothesis results in a decreased certainty equivalent in the regret, complete feedback condition compared to the other conditions. This is precisely the observed behavior (see Fig. 3).

It is worthwhile to emphasize that the decision model outlined above provides an effective description for the behavior regarding the certainty equivalent, but naturally, it cannot aim for including all the aspects of the

[6] Mathematically, this corresponds to the assumption that $p = 0.5$ is used in the decision relation, irrespective of the condition of the first task – this assumption is plausible given the situation that the lottery is not considered in detail.

decision processes. For example, in Eq. (3) for the partial feedback condition, the model does not discriminate between regret and non-regret feedbacks. This does not mean, however, that the decision process after the different feedbacks on the first task is the same. Indeed, we found that participants in the partial feedback condition responded faster when regret was induced prior to the decision. We also found that participants with regret feedback on the first task were more confident that they would not experience regret if they accept a bank offer equal to their certainty equivalent – a main effect which is *not* due to the regret condition, complete feedback subgroup. This indicates another aspect of the decision mechanism which is not captured by our effective decision model.

4 Conclusion

In this paper, our goal was to gain insight into a possible mechanism behind the effect of experienced regret on a subsequent choice. Based on previous findings on repeating choices, we suggested that the impact of experienced regret on subsequent choice is mediated through the anticipation of the experience of regret in this choice. We argued that the mechanism by which experienced regret influences anticipated regret is linked to the subjective probability to regret, i.e., we assumed that experienced regret alters the belief about the probability to regret again. We conducted an experiment to test whether this mechanism underlies the impact of experienced regret on a subsequent different choice as well. We studied the combined effect of experienced regret and the nature of the anticipated feedback (complete feedback vs. partial feedback). Participants were presented with a sequence of two decision tasks: a choice between two risky gambles followed by a matching task. The regret emotion was manipulated thought the feedback on the first task, where we provided either regret feedback or non-regret feedback on the gambles. To capture the influence of experienced regret on the decision behavior in the subsequent choice, we compared the certainty equivalents reported in a matching task in regret feedback and in non-regret feedback conditions. To capture the role of anticipated regret in mediating the effect of experienced regret on subsequent choice, we introduced partial feedback and complete feedback on the matching task. Our main finding is that, on the one hand, for obtaining a different certainty equivalent in partial feedback than the one in complete feedback, the experience of regret in a previous choice is necessary. On the other hand, for experienced regret to have an effect on the certainty equivalent, complete feedback should be provided on the second task. That is, prior experienced regret and complete feedback on subsequent different choice should be both present in order to lead to changes in the monetary aspects of choice behavior. The observed behavior presents a contradiction to the Bell's regret model (Bell, 1983), i.e., we found that under the influence of experienced regret, the resolution premium is negative, which is in contrast to the positive value for the resolution premium predicted by the Bell's model. It is, however, in accordance with the qualitative analysis based on our suggestion that the mediating mechanism of experienced regret is linked to the subjective probability to regret on the next choice. This leads us to conclude that similarly to the case of repeated choices, the subjective probability to regret in subsequent different choice is altered by experienced regret on a preceding choice, provided that the experience of regret in the subsequent choice cannot be avoided. Further experiments to validate this (post-hoc) conclusion could serve as a future direction of research.

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