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RESEARCH ARTICLE

Toward a computational understanding of how reminiscing about positive autobiographical memories influences decision-making under risk

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Abstract

Recent computational psychiatric research has dissected decision-making under risk into different underlying cognitive computational constructs and identified disease-specific changes in these constructs. Studies are underway to investigate what kind of behavioral or psychological interventions can restore these cognitive, computational constructs. In our previous study, we showed that reminiscing about positive autobiographical memories reduced risk aversion and affected probability weighting in the opposite direction from that observed in psychiatric disorders. However, in that study, we compared positive versus neutral memory retrieval by using a within-subjects crossover posttest design. Therefore, the change of decision-making from baseline is unclear. Furthermore, we used a hypothetical decision-making task and did not include monetary incentives. We attempt to address these limitations and investigated how reminiscing about positive autobiographical memories influences decision-making under risk using a between-subjects pretest posttest comparison design with performance-contingent monetary incentives. In thirty-eight healthy, young adults, we found that reminiscing about positive memories reinforced the commonly observed inverted S-shaped nonlinear probability weighting (f = 0.345, medium to large in effect size). In contrast, reminiscing about positive memories did not affect risk aversion in general. Given that the change in probability weighting after reminiscing about positive memories is in the opposite direction from that observed in psychiatric disorders, our results indicate that positive autobiographical memory retrieval might be a useful behavioral intervention strategy for amending the altered decision-making under risk in psychiatric diseases.

Keywords Positive autobiographical memory retrieval · Decision-making · Probability weighting · Risk preference · Computational psychiatry

Introduction

Computational psychiatry is a rapidly developing field that uses computational tools to address the fundamental challenges of psychiatry research (Montague et al., 2012; Chen et al., 2015; Huys et al., 2021; Friston, 2022). In particular, theory-driven computational psychiatry, by building cognitive theory-informed mathematical models of the human brain and behaviors, may be useful to bridge the explanatory gap between clinical symptoms and hidden neurocognitive computations. For instance, recent research in computational psychiatry employing economic decision-making paradigms has greatly advanced our knowledge of cognitive and motivational dysfunctions in depressive and anxiety disorders (Chen et al., 2015; Bishop and Gagne, 2018).

One of the most important themes of economic decision-making is decision-making under risk, where the outcome of the chosen options is uncertain. Recent research has dissected decision-making under risk into distinct cognitive computational constructs, such as risk preference, probability weighting, and reinforcement learning, and has suggested that there are disorder-specific abnormalities in these cognitive, computational constructs. Whereas generalized anxiety disorder is related to amplified risk aversion (shown

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as a more concave utility function, Charpentier et al., 2017), obsessive-compulsive and hoarding disorders (Aranovich et al., 2017) and depression (Hagiwara et al., 2022) may be related to altered probability weighting (underweighting of small probabilities and overweighting of big probabilities). Therefore, studies are underway to investigate what kind of behavioral or psychological interventions help to reverse the altered cognitive, computational constructs.

In our previous study, we showed that reminiscing about positive autobiographical memories reduced risk aversion and affected probability weighting in the opposite direction from that observed depression and obsessive-compulsive and hoarding disorders (Shimizu et al., 2022). Compared with neutral memory retrieval, subjects showed a greater risk preference parameter λ indicating enhance risk-seeking or reduced risk aversion and a smaller probability weighting parameter γ indicating less S-shaped nonlinear probability weighting (more risk-seeking at small probabilities and more risk-averse at big probabilities). However, in that study, we compared positive versus neutral memory retrieval using a within-subjects crossover posttest design, that is, we administered the decision-making task only after each memory retrieval. Although a crossover pretest posttest design provides the most rigorous evidence (Pontifex et al., 2019), it requires subjects to conduct the test four times, which not only reinforces the practice effect but also poses a greater burden to subjects. In our case, because the decision-making task lasted 15 minutes while each memory retrieval took another 10 minutes for a crossover pretest posttest design, the whole experiment would have taken up to 90 minutes. It has been reported that engaging in 60 minutes of cognitive task causes mental fatigue and risk-aversion in decision-making (Jia et al., 2022). Engaging in 60-90 minutes of cognitive task causes inconsistent choices (Mullette-Gillman et al., 2015). Therefore, to avoid such kind of fatigue effects, we employed a within-subjects crossover posttest design and administered decision-making task only following each memory retrieval. It is thus unsure whether the reduced risk aversion and altered probability weighting were due to the influence of positive or neutral memory retrieval. Furthermore, we used a hypothetical decision-making task and did not include monetary incentives. Although it has been shown that people make similar decisions in response to hypothetical versus real rewards (Kühberger et al., 2002), real monetary incentives may be better able to capture interventional effects.

Therefore, in the current study, we attempted to address these limitations and investigated how reminiscing about positive autobiographical memories influences decision-making under risk by using a between-subjects pretest posttest comparison design with performance-contingent monetary incentives. Based on two lines of evidence, we hypothesized that positive autobiographical memory retrieval affects decision-making under risk. First, it has been reported that positive autobiographical memory retrieval activates brain areas, including the medial prefrontal cortex (mPFC) and the striatum (Speer et al., 2014; Lempert et al., 2017; Speer and Delgado, 2017). Both the mPFC and the striatum have been implicated in risk processing. For instance, whereas greater activation of the mPFC is associated with greater risk-seeking (Xue et al., 2009), activation of the striatum is correlated with the nonlinearity in probability weighting (Hsu et al., 2009). Second, positive autobiographical memory retrieval increases positive emotions (Speer et al., 2014; Shimizu et al., 2022), and positive emotions have been associated with risk-seeking behaviors (George and Dane, 2016). For instance, people are more willing to pay for lotteries when in a positive mood (Mano, 1994). As such, by investigating the effect of reminiscing about positive autobiographic memories on decision-making under risk, the present study may help to advance the field of positive autobiographic memory from motivational perspectives (affective influences, e.g., Speer et al., 2014) to cognitive perspectives (influences on cognitive computations).

Materials and methods

Participants

According to a priori power analysis, 34 subjects are required to detect a medium-effect size by using repeated measures ANOVA ($f = 0.25$, 2 time points, 2 interventions) with a power of 0.8 at the significance level of 0.05, two-sided. In case of dropouts, we recruited 38 subjects (19 females, aged 21.74 ± 1.55 years). Inclusion criterion was aged 20 to 29 years, and exclusion criteria were currently suffering from a psychiatric or memory disorder, having attended our previous study of memory retrieval and decision-making, and being an employee of our department. The study was approved by Yamaguchi University Hospital Institutional Review Board and performed following Declaration of Helsinki. All subjects provided written, informed consent.

Procedure and design

The experimental procedure is shown in Fig. 1A. On Day 1, after receiving explanations of the study, subjects gave written, informed consent and answered questions about their demographic information. They were then shown a list of 87 cues of life events (e.g., family vacation) and asked to write down as many memories as possible. The cue list was created in our previous study to probe positive and neutral autobiographical memories (Shimizu et al., 2022) based on early studies (Sharot et al., 2007; Lempert et al., 2017). For each memory, subjects wrote down a brief, but specific enough,

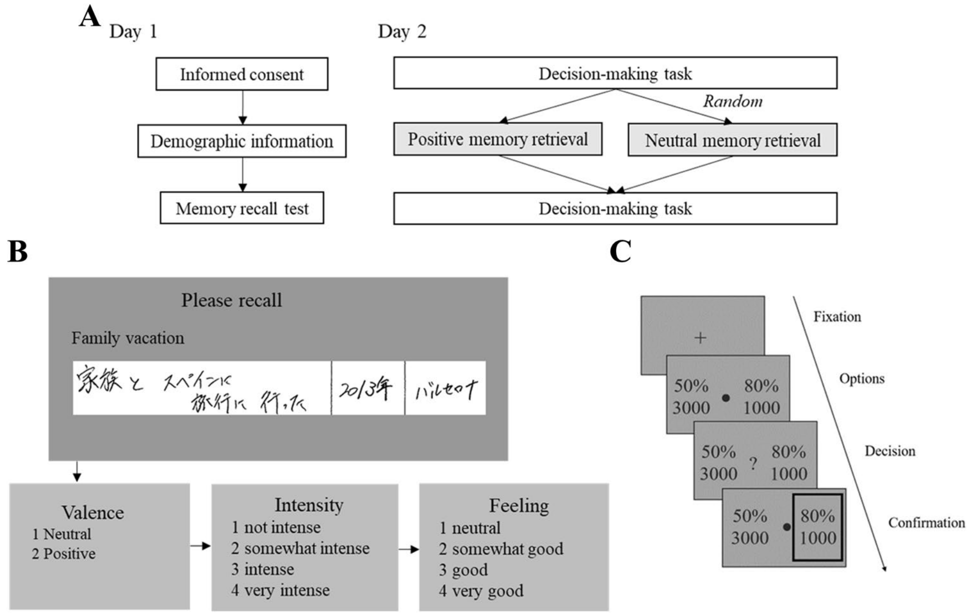

Fig. 1 Experimental procedure. **A.** Procedure on Day 1 and Day 2, respectively. On Day 1, subjects received a memory recall test in which they were required to write down as many as possible their positive and neutral memories in response to a cue list. On Day 2, subjects were randomly allocated to recall either positive or neutral memories that they wrote down on Day 1, before and after which they performed a decision-making task. **B.** Procedure for memory retrieval. For each memory, the initial cue and the scanned record of each subject's written memory were presented. In this example, the subject recalled a memory of family vacation in Barcelona, Spain, in 2013. After reminiscing about a memory, subjects evaluated the valence, intensity, and feeling of that memory. **C.** Decision-making task. Subjects chose from two gambling options to maximize the reward. Each gambling option comprised a reward (in JPY) and the probability of that reward

description of the event, including where and when it happened so that they could later recognize the memory correctly based on the description. For each memory, subjects also evaluated the valence (positive or neutral), intensity (1-4, from not intense to very intense), and feeling (1-4, from neutral to very good). Following previous studies (Lempert et al., 2017; Shimizu et al., 2022), the top 20 positively valenced memories with the highest rating of intensity and feeling were chosen as positive memories. Similarly, the bottom 20 neutrally valenced memories with the lowest rating of intensity and feeling were chosen as neutral memories.

Within a week after Day 1, subjects returned to the laboratory for the main experiment (i.e., Day 2). They were asked to get enough sleep and refrain from smoking, consuming caffeine, and intensive physical activities for at least 2 hours before the laboratory visit. After entering the laboratory, subjects were asked to check if they had followed these requirements.

For Day 2 intervention, we used a between-subjects pretest posttest comparison design (Fig. 1A). After performing a baseline decision-making task, subjects were randomly allocated to recall positive or neutral memories. Immediately following each memory recall, they performed the decision-making task again (i.e., post-intervention). Because the decision-making task had 120 trials and needed a short break in the middle, following previous studies (Lempert et al., 2017; Shimizu et al., 2022), we cut the memory retrieval intervention and post-intervention decision-making task into two sessions. In the first session, subjects reminisced about ten memories and performed the first half of the decision-making task. Following a 1-minute rest, the second session started and subjects reminisced about the rest ten memories and subsequently performed the second half of the decision-making task. The data from these two sessions were merged for final analysis.

With regard to each memory retrieval (Fig. 1B), subjects were shown the initial cue as well as the scanned record of their written memory and were asked to reminisce about that memory for 14 seconds. They then evaluated the valence, intensity, and feeling of the memory (within 4 seconds each).

To validate the effectiveness of memory retrieval, we asked subjects to report their momentary mood before the first session of memory recall and immediately after the first and second sessions of memory recall. The mood test we administered was a visual analog scale consisting of three items, pleasure, relaxation, and vigor, which were created according to the valence-arousal affect grid (Aga et al., 2021; Yamashita et al., 2021; see Figure S1 for a detailed description of this mood test).

Decision-making task

We used a decision-making task modified from Hsu et al. (2009) (Fig. 1C). Given two gambling options, subjects chose to maximize the reward that they would receive. Each gambling option comprised a reward (in JPY) and a probability. We employed the stimuli of Hsu et al. (2009) but converted the reward initially generated in USD to JPY by multiplying 100.

The task had 120 trials. For each trial, a cross fixation was first shown for 1.5 seconds. Then, the gambling options were presented for 2 seconds. Following an interrogation mark, subjects pressed a predefined key to show their choice within 3 seconds. The option that they chose was then emphasized by a gray frame for 1 second.

We employed performance-contingent monetary incentives such that among all the trials that subjects performed during the whole experiment, one trial was later randomly selected and executed. For instance, if on the selected trial subjects chose the option "80% 1,000 JPY," 80% was then executed. If the subject won the gamble, they received 1,000 JPY. If they lost or failed to respond within 3 seconds (i.e., no response on the selected trial), they received no reward. Subjects on average won 3,068 ± 4,577 JPY, with a range of 0-20,000.

Computational modeling of decision-making

We fitted four computational models to the subjects' choices (Table 1). Model 1 employed the standard value function for the calculation of expected value (reward × probability). Models 2-4 additionally incorporated a nonlinear function for utility (a power function with a parameter λ) and/or probability weighting (a Prelec-1 parameter γ, Prelec 1998). For utility parameter λ, 1 implies being risk-neutral, <1 implies being risk-averse, and >1 implies being risk-seeking. For probability weighting parameter γ, 1 implies objective probability weighting, <1 implies overweighting of small probabilities and underweighting of big probabilities (inverted S-shaped), and >1 implies underweighting of small probabilities and overweighting of big probabilities (S-shaped). Subjects were then simulated to choose from two gambling options based on their value difference following the softmax rule with an inverse temperature parameter β.

These computational models were fitted to the trial-by-trial choices of the subjects with a Bayesian hierarchical expectation-maximization method (Eldar et al., 2016). This method introduces group-level previous distributions, which help to avoid overfitting problems that are common to maximum likelihood estimation. With this method, for a certain estimate of the group-level prior distribution (i.e., modeled with gamma distributions), we randomly selected 100,000 sets of parameters and applied their likelihoods as importance weights to reform the present prior distribution. This process was repeatedly performed until convergence. The weighted mean of the last 100,000 parametrizations was used to estimate the parameters for each subject.

We used the integrated Bayesian Information Criterion (iBIC) for model selection (Huys et al., 2012). iBIC penalizes model evidence for parameter numbers; lower values of iBIC indicate a more parsimonious model fit. We fitted the models for all subjects together at baseline, whereas for postintervention, we fitted the models for subjects assigned to positive and neutral memory retrieval separately. As shown in Table 1, model 4 with utility and probability weighting both being nonlinear had the smallest values of iBIC. Model 4, therefore, was chosen as the best model and its parameter estimation was employed for data analysis.

Statistical analysis

Statistical analysis was performed with MATLAB2018b and IBM SPSS Statistics 28.0. For the comparison of intensity and feeling of memory, t-test or Mann-Whitney *U* test (where data were not normally distributed according to the Shapiro-Wilk test) was used. For the comparison of mood and computational parameters, an intervention and time two-way repeated measures ANOVA was used. To examine the role of mood in the effect of memory recall on decision-making parameters, we conducted a correlation analysis between changes in mood and changes in decision-making parameters following positive memory recall using Pearson

Table 1 Model details and fitting results

Model No.	Model description	Equation	iBIC Baseline	iBIC postintervention	
				Positive	Neutral
1	Standard value function	$V(X) = rp$	6188.6	3054.4	3081.3
2	Nonlinear utility and linear probability weighting	$V(X) = r^{\lambda}p$	5969.2	2902.2	3021.6
3	Linear utility and nonlinear probability weighting	$V(X) = re^{-(-\ln p)^{\gamma}}$	5150.8	2454.5	2325.7
4	Nonlinear utility and nonlinear probability weighting	$V(X) = r^{\lambda}e^{-(-\ln p)^{\gamma}}$	4921.4	2238.6	2222.5

Lower iBICs indicate better model fit. Positive, positive memory retrieval. Neutral, neutral memory retrieval or Spearman correlation, depending on the normality of the data. We also conducted a mediation analysis to test whether mood change mediates the effect of positive memory recall on decision-making parameters. The mediation analysis was executed with the SPSS based PROCESS procedure with 5,000 bootstrap samples (Hayes 2017). A significance level of $p < 0.05$, two-sided, was used.

Results

Memory and feeling ratings, mood

Subjects rated 93.95% of the memories recalled during neutral memory retrieval as being neutral and 100% of the memories recalled during positive memory retrieval as being positive (Fig. 2A). Furthermore, subjects reported higher intensity (U = 5.283, $p < 0.001$, d = 5.36) and better feeling (U = 5.289, $p < 0.001$, d = 5.23) for the memories recalled during positive versus neutral memory retrieval.

Mood change from baseline to postintervention is presented in Fig. 2B. As indicated by the significant intervention*time interaction in repeated measures ANOVA, subjects reported greater feelings of pleasure ($F_{1,36} = 19.178$, $p < 0.001$, f = 0.74) and vigor ($F_{1,36} = 7.556$, $p = 0.009$, f = 0.46) following positive compared with neutral memory retrieval. With regard to relaxation, the intervention*time interaction was nonsignificant ($F_{1,36} = 0.193$, $p = 0.663$, f = 0.07). These results indicate that positive memory retrieval was appropriately established.

Decision-making parameters

The change of decision-making parameters from baseline to postintervention is presented in Fig. 3A. Whereas there was no intervention*time interaction in repeated measures ANOVA of λ ($F_{1,36} = 4 \times 10^{-5}$, p = 0.995, f = 0.001), there was a significant intervention*time interaction in repeated measures ANOVA of γ ($F_{1,36} = 4.310$, p = 0.045, f = 0.346). Subjects recalling neutral memories showed a bigger γ (being more risk-averse at small probabilities and risk-seeking at big probabilities), whereas subjects recalling positive memories showed a smaller γ (being more risk-seeking at small probabilities and risk-averse at big probabilities).

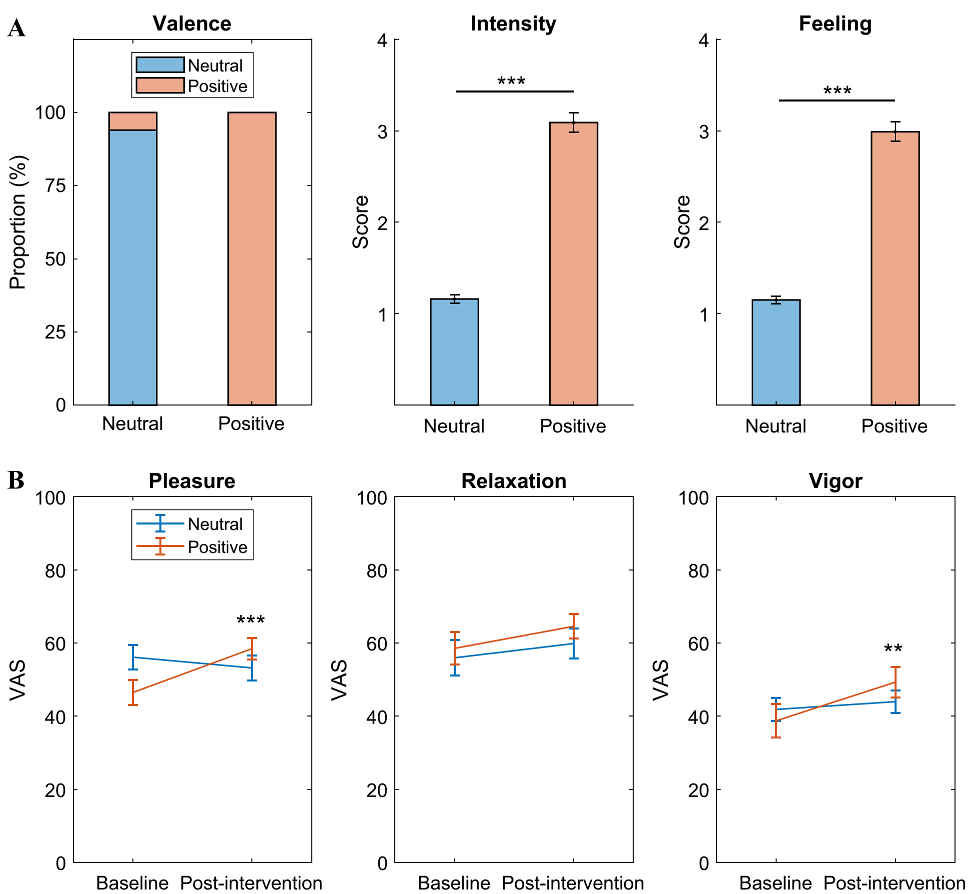

Fig. 2 Memory retrieval and ratings of memory, feeling, and mood. **A.** Memory and feeling ratings. ***$p < 0.001$, Mann-Whitney *U* test. **B.** Mood. **$p < 0.01$, ***$p < 0.001$, group*time interaction of repeated measures ANOVA. VAS, visual analog scale. Data are mean ± SE

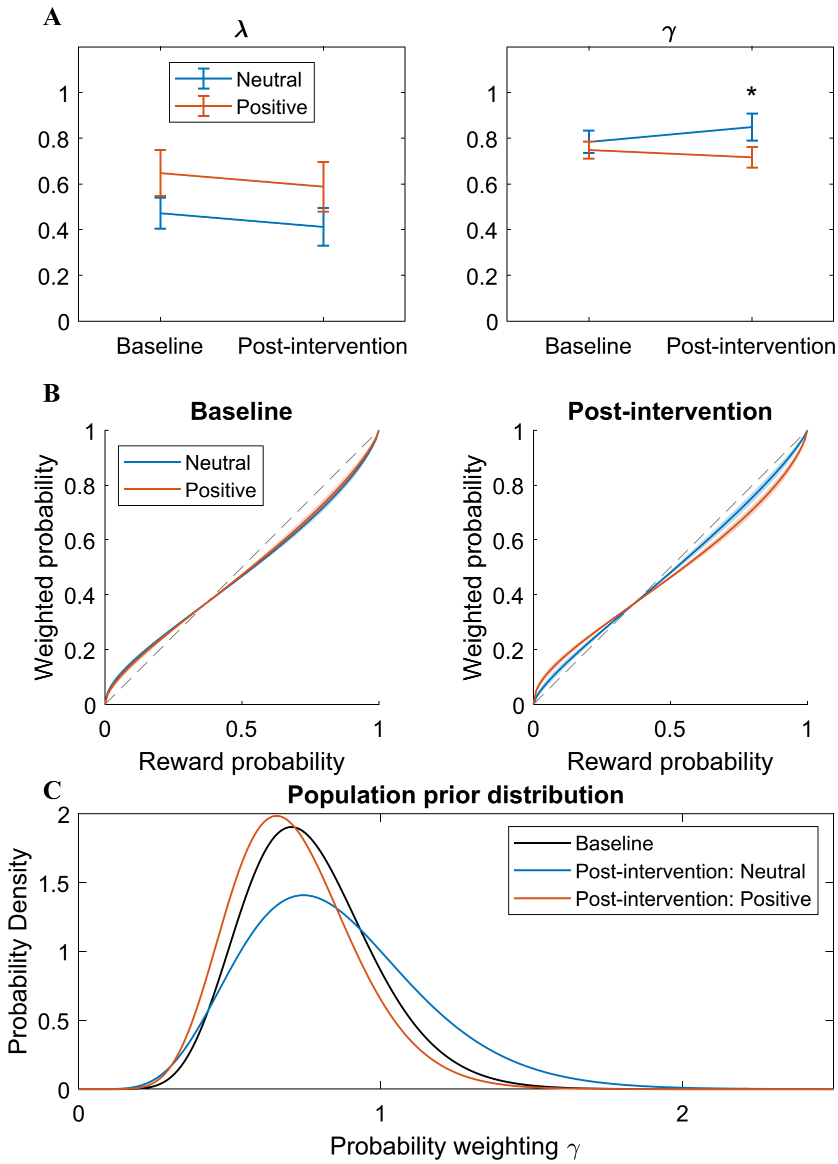

Fig. 3 Effect of memory retrieval on decision-making parameters. **A.** Risk preference λ and probability weighting γ. *$p < 0.05$, intervention*time interaction in repeated measures ANOVA. Data are mean ± SE. **B.** Probability weighting function, γ plotted as mean ± SE. Dashed line indicates linear probability weighting. **C.** Population prior distribution of γ at baseline and after neutral and positive memory retrieval

There was a significant effect of time ($F_{1,36} = 5.986$, p = 0.019, f = 0.408) but not intervention ($F_{1,36} = 1.917$, p = 0.175, f = 0.232) for λ, indicating that subjects became more risk-averse at postintervention compared with baseline. For γ, there was no effect of time ($F_{1,36} = 0.515$, p = 0.477, f = 0.119) nor intervention ($F_{1,36} = 1.747$, p = 0.195, f = 0.220).

A descriptive plot of the probability weighting function is presented in Fig. 3B. There was no significant difference in probability weighting at baseline, following the intervention; however, the probability weighting curve of subjects recalling positive memories became more inverted S-shaped. That is, the commonly observed inverted S-shaped, nonlinear probability weighting was enhanced after recalling positive memories. These changes were confirmed at the level of population prior distribution (Fig. 3C). Whereas recalling neutral memories shifted the prior distribution of γ toward bigger values, recalling positive memories shifted the prior distribution of γ toward smaller values.

To investigate the role of mood changes after positive memory recall in the changes in decision-making parameters, we conducted a correlation analysis and tested a mediation model. A scatterplot of the associations between mood changes and changes in decision-making parameters is shown in Figure S2. For this analysis, no significant correlation was identified. For the mediation model, we tested whether changes in pleasure, relaxation, or vigor mediate the effect of memory recall on λ and γ, respectively. As shown in Table S1, no significant mediation effect was detected.

Last, we compared subjects' mean reaction time in the decision-making task from baseline to postintervention for each memory recall condition (Figure S3). An intervention and time two-way repeated measures ANOVA indicated that subjects became faster in reaction at postintervention compared to baseline, whereas there was no effect of intervention or intervention*time interaction. These results suggest that positive and neutral memory recall did not differentially affect reaction time.

Discussion

Using a between-subjects pretest posttest comparison design with performance-contingent monetary incentives, we found that reminiscing about positive memories reinforced the commonly observed inverted S-shaped nonlinear probability weighting ($f = 0.345$). That is, subjects overweighted small probabilities (risk-seeking at small probabilities) and underweighted big probabilities (risk-averse at big probabilities). In contrast, reminiscing about positive memories did not affect risk aversion in general, as indicated by nonsignificant between-intervention changes in risk preference parameter λ ($f = 0.001$).

For the present study, we used the same memory recall protocol for the intervention as well as the same Bayesian hierarchical expectation-maximization method for computational modeling with our previous study (Shimizu et al., 2022). The only difference was that instead of a within-subjects crossover posttest design, we used a between-subjects pretest posttest design to include a baseline measurement, and that instead of hypothetical rewards, we adopted performance-contingent monetary incentives in the present study. The change in probability weighting after reminiscing about positive memories in the present study is consistent with our previous study (Shimizu et al., 2022). By introducing performance-contingent monetary incentives, the effect size we observed increased from $d = 0.427$ (small to medium) in our previous study to $f = 0.346$ (medium to large, Cohen 1992) in the present study. Given that the change is in the opposite direction from that observed in obsessive-compulsive and hoarding disorders (Aranovich et al., 2017) and depression (Hagiwara et al., 2022), our results indicate that positive autobiographical memory retrieval might be a useful behavioral intervention strategy for amending altered decision-making in these psychiatric disorders. It has to be noted that much of the effect of memory retrieval on probability weighting that we observed was driven by change after neutral memory recall. The change in probability weighting after neutral memory recall (i.e., less risk-seeking or more risk-averse) may be due to simple exposure to the same decision-making task twice or due to boredom (the neutral memory recall caused slight decrease in the rating of pleasure). On one hand, our results suggest the possibility that positive memory recall may be able to offset this kind of practice or boredom effect on probability weighting. On the other hand, our results call for further investigations to verify the effect of positive memory recall on probability weighting with other control interventions.

Although it has been reported that positive emotions are associated with risk-seeking behaviors (George and Dane, 2016) and that people are more willing to pay for lotteries when in a positive mood (Mano, 1994), we failed to detect a statistically significant correlation between mood change and change in the probability weighting parameter γ. Neither did we find significant mediating effect of mood between memory recall and probability weighting. These results suggest that mood may not account for the effect of positive memory recall on probability weighting that we observed in this study. Future studies can further test whether such a speculation is true using, for instance, other interventions that boost positive mood other than positive memory recall.

The neurobiological mechanism of the influence of reminiscing about positive memories on probability weighting is considered relevant to the striatum. On one hand, reminiscing about positive memories increases the activation of the striatum (Speer et al., 2014; Lempert et al., 2017; Speer and Delgado, 2017). On the other hand, activation of the striatum is correlated with the nonlinearity in probability weighting (Hsu et al., 2009). Together with previous reports that obsessive-compulsive disorders (Menzies et al., 2008; Burguiere et al., 2015) and depression (Pizzagalli et al., 2009; Chen et al., 2015) are associated with dysfunctional striatum, these findings call for in-depth investigation of the therapeutic effects of positive autobiographical memory retrieval in these disorders. By showing that positive autobiographical memory retrieval affects probability weighting in a way that is opposite to the changes in psychiatric disorders, the present study advances the field of autobiographical memory in two ways. First, it promotes the field of positive autobiographical memory by providing evidence on the cognitive (or cognitive computational) impacts of positive autobiographical memory, given that our current understanding of its impacts is primarily motivational or affective (Speer et al., 2014). Second, the present study advances the field of autobiographical memory by providing evidence on the beneficial or potential therapeutic effects of autobiographic memory retrieval. Research in the past decades has been focusing on the dysfunctional characteristics of autobiographic memories in psychiatric disorders, especially depression. For instance, patients with depression often show overgeneral autobiographic memory (i.e., a lack of specific details) and ruminative thinking focusing on negative autobiographic memories (Dalgleish and Werner-Seidler, 2014). By providing evidence that positive autobiographical memory retrieval may help to rectify decision-making deficits in psychiatric disorders, the present study advances the field from focusing on the negative roles of autobiographic memory to paying attention to the beneficial effects of autobiographic memory.

With regard to risk aversion in general, we were unable to confirm our previous observation that in comparison to recalling neutral memories, recalling positive memories led to a bigger λ, indicating reduced risk aversion. The explanation may be relevant to performance-contingent monetary incentives. Both memory retrievals led to a smaller λ or greater risk aversion (Fig. 3A, left panel). The opportunity to win as high as 20,000 JPY (approximately 200 USD) may have caused such risk-averse behavior, refraining us from detecting any between-intervention difference. As such, in face of real reward, reminiscing about positive memories may not affect risk aversion in general, but specifically reinforce the commonly observed inverted, S-shaped, nonlinear probability weighting, causing people to overweight small probabilities and underweight big probabilities to a greater degree. This speculation is supported by a between-study difference in probability weighting, that is, compared with Shimizu et al. (2022) who used hypothetical rewards, the present study using performance-contingent monetary incentives found an inverted, S-shaped, nonlinear probability weighting such that subjects overweighted small probabilities (risk-seeking at small probabilities) and underweighted big probabilities (risk-averse at big probabilities; Figure S4).

Another possible explanation of our failure to confirm our previous finding that positive memory recall reduced risk aversion (as indicated by a smaller λ, Shimizu et al., 2022) may be relevant to the between-study differences in subjects' positive feelings in response to the positive memory recall. Subjects reported significantly lower scores of Pleasure after positive memory recall in the present study compared with those in Shimizu et al. (2022) (Figure S5). Therefore, it is possible that our failure to detect a significant effect of positive memory recall on the risk preference parameter λ was due to weakened positive feelings of Pleasure. Regarding the underlying mechanism of such a difference in positive feelings, the only difference between the two studies was the employment of real monetary incentives in the present study (whereas Shimizu et al., 2022, used hypothetical rewards). It is indeed possible that the employment of monetary incentives may have dampened the intrinsically rewarding value of positive memory recall. This kind of devaluation by extrinsic reward has been extensively reported in the field of educational psychology and has been accounted for by theories such as Ryan and Deci's Self-determination Theory (Ryan and Deci, 2000).

Future research may confirm and extend our findings in several ways. First, we asked subjects to silently reminisce about positive memories. Future research may use pictures or videos of happy moments or ask subjects to elaborate and speak out their memories, which may bring greater intervention effects. Second, for the control intervention, following previous studies, we used neutral memory retrieval. In consideration of the clinical application, future studies may compare positive memory retrieval to antidepressants, cognitive, and other therapies. Third, we included only description-based reward conditions in our decision-making task. Future research may want to examine whether recalling positive memories influence decision-making with experience-based reward conditions as well as loss conditions (Hertwig and Erev, 2009; Chen et al., 2022).

Conclusions

For 38 healthy young adults, we found that reminiscing about positive memories reinforced the commonly observed inverted S-shaped, nonlinear probability weighting ($f = 0.345$, medium to large in effect size). Given that the change in probability weighting after reminiscing about positive memories is in the opposite direction from that observed in psychiatric disorders, our results indicate that positive autobiographical memory retrieval might be a useful behavioral intervention strategy for amending the maladaptive decision-making in psychiatric disorders.

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Open Practices Statements The data that support the findings of this study are available from the corresponding author upon reasonable request. The experiment was preregistered on the University hospital Medical Information Network Clinical Trial Registry (UMIN-CTR, register ID: UMIN000048281).