

Analytic thinking reduces impact bias in affective forecast

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Abstract

People overestimate the intensity and duration of their affective reactions to events in the future. This is called impact bias (Wilson & Gilbert, 2003). Impact bias influences individuals' satisfaction with their decision making. Few studies have shed light on how to reduce impact bias in affective forecast based on dual-process theories. According to dual-process theories of human thinking, there are two distinct but interacting systems for information processing. System 1 relies on frugal heuristics and produces intuitive responses, while System 2 relies on deliberative analytic processing. System 2 often overrides the input of System 1 when analytic thinking is activated. Thus, we hypothesize that analytic thinking reduces the impact bias in affective forecasting.

In experiment 1, a total of 240 undergraduates were assigned to play an ultimatum game as proposers and asked to predict how they would feel when their proposals were accepted or rejected by responders. At random, they were told their proposals were accepted or rejected. As soon as they knew the result, they were asked to report how they felt. Before the ultimatum game began, participants were randomly assigned to view pictures of *The Thinker* to prime analytic thinking or geometric figures as a control condition. The results showed that analytic thinking reduced impact bias in affective forecasting by reducing the intensity of predicted emotions.

In experiment 2, a total of 52 undergraduates took part in a memory test. They were asked to predict how they would feel if their scores on a memory test exceeded 90% or not before the test. As soon as they knew the result that they did not exceed 90%, they were asked to report how they felt. Before taking the memory test, participants were randomly assigned to perform a verbal fluency task with words related to analytic thinking to prime analytic thinking or a task not related to analytic thinking as a control condition. The results showed that analytic thinking reduced impact bias in affective forecasting by reducing the intensity of predicted emotions.

In experiment 3, a total of 111 women who had only one child were asked to predict how they would feel if they had a second. Before predicting their feelings, they were randomly assigned to view pictures of *The Thinker* to prime analytic thinking or geometric figures as a control condition. Results showed that analytic thinking reduced the positive affect of having the second child but not the negative affect of having the second child.

In sum, the present research shows that analytic thinking reduces impact bias in affective forecasting by reducing the intensity of predicted emotions. It can help us reduce impact bias in affective forecasting when making decisions and be satisfied with those decisions. Limitations and further research are discussed as well.

Key words analytic thinking, affective forecast, impact bias, dual-process theory

1 Introduction

Before making a decision, people usually make predictions about the emotions that will result from the decision. Most decisions are based on people's emotional predictions of the decision. Affective forecasting refers to the prediction of an individual's emotional response to a future event (Wilson & Gilbert, 2003). People are more likely to accept an alternative if they expect it to be emotionally positive, and more likely to reject it if they don't. Studies show that people often overestimate the emotional impact of future events, known as the impact bias (Morewedge & Buechel, 2013; Wilson & Gilbert, 2003).

1.1 Intervention of impact bias

Since impact bias was proposed (Gilbert, Pinel, Wilson, Blumberg, & Wheatley, 1998), numerous studies have exam-

ined the sources of impact bias. According to the different sources of impact bias, the researchers propose different intervention methods.

Early studies have found that focalism and immune neglect are the main sources of impact bias in affective forecasting. Focalism refers to that people focus on the influence of the central event and ignore the influence of the incidental event. Immune neglect is the failure to take into account future events when predicting emotions (Gilbert et al., 1998; Wilson, Wheatley, Meyers, Gilbert, & Axsom, 2000; Geng & Jiang, 2017; Liang, Li, Li, & Liu, 2007). Based on this, the researchers proposed defocusing exercise (Ubel et al., 2001; Wilson et al., 2000) and adaptation exercise (Ubel, Loewenstein, & Jepson, 2005). Defocusing exercise could disperse the illusion of focus by asking participants to report their life experiences after a predicted event in detail involv-

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ing which changed and which stayed the same. For example, in a study by Wilson et al. (2000), fans were asked to predict how they would feel after a game was won or lost. While the diary group wrote down the specific activities (such as eating, socializing with friends, attending class, etc.) that they did on the second and third days after the game and how much time each activity took; the other group, as a control group, did not keep a diary. They found that, compared with the control group, the diary group predicted more moderate and accurate emotions after winning or losing a game. Adaptive exercise was designed to remind people of their adaptability to life events by asking them to recall how their feelings of previous similar experiences have changed over time (Geng & Zhang, 2015).

Later, Gilbert and Wilson (2007, 2009) explained the source of the impact bias from the perspective of mental simulation. When people make emotional predictions, they first make mental previews about future events, then produce a preemotion, and then use that as a basis for predicting future emotional responses. Only when the content and the situation of the simulation are consistent with the content and the situation of the real event, can the emotion produced by the simulation accurately predict the real emotion, otherwise it will produce impact bias. Thus, impact bias can be reduced by reducing the reliance on mental simulations of future events. For example, researchers have proposed a surrogation strategy in which people do not rely on their mental simulations of future events to predict their emotions but on the reports from others who have went through the same thing. The study found that surrogation strategy could effectively improve the accuracy of emotion prediction (Eggleston, Wilson, Lee, & Gilbert, 2015). In addition, the researchers examined whether mindfulness training could improve the accuracy of affective forecasting by improving people's understanding and awareness of emotions. The study found that people with high trait mindfulness were more accurate at predicting their emotions about future events (Emanuel, Updegraff, Kalmbach, & Ciesla, 2010; Kong, 2015). Hong, Lishner, Vögels and Ebert (2016) further investigated the effect of mindfulness training on impact bias through field experiments and found that participants in mindfulness interventions predicted negative emotions more accurately than those in the control group, which showed that mindfulness intervention could improve the accuracy of affective forecasting.

The accessibility model of emotional self-report (Robinson & Clore, 2002) analyzes the information on which that different types of emotional reports rely from the perspective of information accessibility. According to it, when predicting future emotions, people are unable to access any specific episodic memory information and intuitively predict emotions based on existing beliefs. Research on consumer decision-making has also shown that consumers often make predictions about the emotions a product might bring based on common sense and beliefs (Xu & Jiang, 2009; Schwarz & Xu, 2011). People's affective forecasting are based on common sense and beliefs, while actual emotional experiences are based on immediate emotion experiences. Beliefs tend to be abstract, and actual emotional experiences are influenced by events unrelated to the predicted event, so emotional predictions tend to be biased. So, does intervening in beliefs reduce impact bias?

Previous studies have rarely examined impact bias from the perspective of intervention on intuitive beliefs. Dual-process theory holds that there are two systems for human decision-making—a heuristic system based on intuition (system 1) and an analytic system based on reasoning (system 2) (Kahneman, 2003; Sun, Li, & Yin, 2007). Intuitive systems rely on fast, automatic, parallel processing, and almost do not take up psychological resources. Analytic systems rely more on rationality, serial processing, and take up more psychological resources. Compared with the intuitive system, the analytic system is not susceptible to background similarity and stereotype, and is mainly rule-based, whose process and result can be realized (Evans, 2008; Kahneman, 2003). In the competition between two systems, the heuristic system usually wins, which is the source of the biases in decision-making (Evans, 2003). However, system 2 would override system 1 (Evans, 2008; Kahneman, 2003) when analytic thinking was primed. Therefore, the question to be solved in this study is: can the analysis system intervene the intuitive beliefs used in affective forecasts, and then reduce the impact bias of affective forecasting?

1.2 Analytic thinking and impact bias

Previous research has suggested that intuitive thinking is system 1 and analytic thinking is system 2 (Gervais & Norenzayan 2012). Studies have shown that priming with analytic thinking can weaken the influence of beliefs. For example, analytic thinking can undermine religious belief (Gervais & Norenzayan, 2012; Stagnaro, Ross, Pennycook, & Rand, 2019), prejudice against anti-atheists (Yilmaz, Karadöler, & Sofuoğlu, 2016; Franks & Scherr, 2017), and weaken conspiracy beliefs (Swami, Voracek, Stieger, Tran, & Furnham, 2014).

According to availability model of emotional self-report (Robinson & Clore, 2002), people intuitively predict emotions based on existing beliefs. When analytic thinking is initiated, system 2 overrides system 1 (Evans, 2008), thus weakening belief-based intuitive processing. As a result, when people make predictions about the emotions on future events, initiating analytic thinking weakens the effect of beliefs on affective forecast and reduces the intensity of affective forecast. Lower intensity of affective forecasting further reduces impact bias and improves accuracy of affective forecast (Wilson et al., 2000; Eggleston et al., 2015; Hong et al., 2016; Hoerger, Quirk, Lucas & Carr, 2010). For example, Wilson et al. (2000) found that the de-focused intervention group had a more moderate, accurate, and less biased affective forecast of winning or losing matches. Emanuel et al. (2010) found that people with high trait mindfulness were less extreme in their affective forecast and had less biases. According to this, we think that priming analytic thinking will weaken the influence of belief on affective forecast, reduce the intensity of affective forecast, and thus reduce the impact bias of affective forecasting. In conclusion, we propose the following hypothesis: analytic thinking would reduce the intensity of affective forecasting, and thus reduce the impact bias.

In order to test the hypothesis of the study, three experiments are included in this paper. Experiment 1 (with visual priming) and experiment 2 (with verbal fluency task) examined the influence of analytic thinking on impact bias, and the mediating effect of affective forecasting intensity. In experiment 3, the effect was investigated through real deci-

sion-making (having a second child as an example).

2 Experiment 1: Ultimatum game task

In experiment 1, a pre-experiment was conducted to test the effectiveness of visual priming on analytic thinking.

2.1 Pretest: The effectiveness of visual priming on analytic thinking

2.1.1 Participants

A total of 64 undergraduates were recruited from a university, including 10 males and 54 females, with an average age of 18.08 years and a standard deviation of 3.87 years. According to the calculation of G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007), under the premise of statistical test force $1 - \beta = 0.80$, bilateral test $\alpha = 0.05$, and effect size $d = 0.8$, the number of subjects for independent sample t test should be set to 52.

2.1.2 Experimental design

According to Gervais et al. (2012), we used Rodin's classic "The Thinker" pictures to prime analytic thinking. We took four images of "The Thinker", each with a time of 3000ms. The subjects were asked to watch carefully and answer questions. In order to make sure that the subjects looked at the pictures carefully, they were asked to answer two questions: First, which hand did The Thinker use to raise his face; and second, what was the facial expression of the sculpture in the picture. The control group was asked to look at 4 geometric pictures.

Analytic thinking is measured by the cognitive reflection test (CRT) (Frederick, 2005). The answers given by intuition in CRT tasks are wrong, and will only be correct if analytic thinking prevails over intuitive thinking, so CRT scores can be used to represent analytic thinking. We chose two of the questions: (1) A bat and a ball cost \$1.10 in total. The bat costs \$1.00 more than the ball. How much does the ball cost? (2) If it takes 5 machines 5 min to make 5 widgets, how long would it take 100 machines to make 100 widgets? Correct answers count for 1, and wrong answers count for 0, with scores ranging from 0 to 2. Previous research has shown that this task is effective to measure analytic thinking (Gervais & Norenzayan, 2012; Yilmaz et al., 2016; Stagnaro et al., 2019).

2.1.3 Experimental procedure

The experiment was all completed on a computer, presented by E-prime. Participants were randomly assigned to either the analytic thinking group or the control group, and then given a cognitive response test after viewing the pictures.

2.1.4 Results

The independent sample t test showed that subjects in the visual priming group ($M_{\text{priming}} = 1.56$, $SD_{\text{priming}} = 0.50$) scored higher in the cognitive response test than those in the control group ($M_{\text{control}} = 1.00$, $SD_{\text{control}} = 0.83$), $t(62) = 3.30$, $p = 0.002$, 95% confidence interval [0.22, 0.90], $d = 0.82$. This showed that picture of *The Thinker* could effectively initiate analytic thinking.

2.2 Experiment 1

2.2.1 Participants

A total of 240 students were recruited from a university, of which 92 were male and 148 were female. The mean age was 21.96 years and the standard deviation was 1.73 years. The experimental group and control group each have 120 participants. According to calculations by G*Power 3.1 (Faul et al., 2007), the number of participants required for the two-factor

inter-subject analysis of variance was 158, based on previous studies with a statistical power of $1 - \beta = 0.80$, $\alpha = 0.05$, and a moderate effect of $f = 0.25$. In this study, there was no significant difference in the impact bias between male ($M_{\text{male}} = 0.79$, $SD_{\text{male}} = 0.91$) and female ($M_{\text{female}} = 0.72$, $SD_{\text{female}} = 0.61$), $t(238) = 0.71$, $p = 0.48$, 95% confidence interval [-0.12, 0.40].

2.2.2 Experimental design

The experiment was designed with 2 (analytic thinking vs. control group) \times 2 (acceptance vs. rejection conditions). The subjects in the control group watched four pictures of *The Thinker*, while the subjects in the control group watched geometric pictures, with the same material as in the pretest experiment. In the ultimatum game, participants were asked to allocate 100 Yuan to themselves and another participant. The participant first proposed a distribution plan, and only had one chance to propose it. If the respondent agreed to the plan, then they were assigned according it; if respondents rejected the plan, neither proposers nor respondents would receive any reward (Zhang, 2005). In fact, the experimenter randomly gave feedback of acceptance or rejection.

The dependent variables are affective forecasting and affective experience. Based on the practice of Gilbert et al. (1998), a self-developed questionnaire was adopted. Participants were asked to predict the emotions (e.g. happiness, pleasant) would be experienced after the proposal was accepted or rejected in the ultimatum game, using a 5-point scale, in which 1 is very unhappy and 5 is very happy; the higher the score, the stronger the positive emotion; the lower the score, the stronger the negative emotion. After being told that the respondent had accepted or refused, the participants then rated how they had actually experienced the emotion. In this study, the internal consistency of the affective forecasting questionnaire $\alpha = 0.91$, and the internal consistency of the affective experience questionnaire $\alpha = 0.96$.

2.2.3 Experimental procedure

The ultimatum game were first introduced to the participants, and then subjects were asked to predict how they would feel if the assignment was accepted or rejected. Participants in the experimental group were presented with a picture of *The Thinker* before making the affective prediction, while those in the control group were presented with a "geometric" picture. Finally, the experimenter gave participants a random feedback of acceptance or rejection and asked them to rate their emotional experience at the time. Under the condition of acceptance, subtracting the affective experience of acceptance conditions from the affective forecasting of acceptance conditions was used as the index of impact bias, and under the condition of rejection, subtracting the affective experience of rejection conditions from the affective forecasting of rejection conditions was used as the index of impact bias.

2.2.4 Results

(1) The influence of analytic thinking on affective forecasting intensity.

2(priming analytic thinking/ control group) \times 2(acceptance condition/ rejection condition) ANOVA found that the main effect of priming analysis was significant, $F(1, 239) = 10.18$, $p = 0.002$, $\eta^2 = 0.04$; the main effect of accepting or rejecting proposals was significant, $F(1, 239) = 554.34$, $p = 0.001$, $\eta^2 = 0.70$; affective forecasting under acceptance ($M_{\text{acceptance}} = 4.33$, $SD_{\text{acceptance}} = 0.71$) was significantly higher than that under rejection ($M_{\text{rejection}} = 2.15$, $SD_{\text{rejection}} = 0.85$), $t(238) = 21.71$, p

= 0.001, 95% confidence interval [1.99, 2.39]. The interaction between the two is significant, $F(1, 239) = 43.58, p = 0.001, \eta^2 = 0.16$.

Furthermore, a simple effect analysis showed that participants who primed to analytic thinking ($M_{\text{priming}} = 4.19, SD_{\text{priming}} = 0.81$) predicted less positive emotions than participants of control group ($M_{\text{control}} = 4.50, SD_{\text{control}} = 0.55$), $t(126) = 2.54, p = 0.012, d = 0.45$, 95% confidence interval [0.07, 0.56]; under rejection conditions, subjects of analytic thinking ($M_{\text{priming}} = 2.63, SD_{\text{priming}} = 0.70$) were better than those of control group ($M_{\text{control}} = 1.73, SD_{\text{control}} = 0.74$), and predicted fewer negative emotions, $t(110) = -6.57, p = 0.001, d = -1.25$, 95% confidence interval [-1.17, -0.63].

(2) The influence of analytic thinking on impact bias.

In order to further investigate the influence of analytic thinking on affective forecasting bias, we take the absolute value of the mean difference between affective forecasting and affective experience as impact bias, then we examined the effect of analytic thinking on impact bias under the condition of acceptance/rejection. 2(priming analytic thinking/control group) \times 2(acceptance condition/rejection condition) ANOVA found that the main effect of priming analysis was significant, $F(1, 236) = 111.11, p = 0.001$. The impact bias in analytic thinking group ($M_{\text{priming}} = 0.34, SD_{\text{priming}} = 0.44$) was significantly lower than that in the control group ($M_{\text{control}} = 1.15, SD_{\text{control}} = 0.75$). The main effect of feedback was significant, $F(1, 236) = 34.49, p = 0.001$. The impact bias under the rejection condition ($M_{\text{rejection}} = 1.01, SD_{\text{rejection}} = 0.83$) was significantly higher than that under the acceptance condition ($M_{\text{acceptance}} = 0.51, SD_{\text{acceptance}} = 0.55$). The interaction between the two was not significant, $F(1, 236) = 0.91, p = 0.34$ (Fig. 1). Whether the proposal was accepted or rejected, the analytic thinking group had less impact bias than the control group.

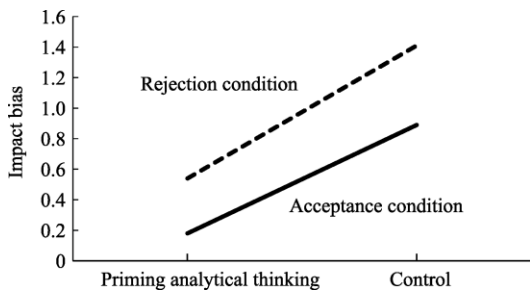


Figure 1. The effect of priming analytic thinking on impact bias under the condition of acceptance/rejection

(3) The mediating role of affective forecasting intensity in reducing the impact bias.

To further examine whether affective forecast intensity plays a mediating role in the relationship between analytic thinking priming and impact bias, the Bootstrap method was used according to Hayes (2013). The results showed that: (1) under the acceptance condition, the mediating effect of affective forecasting intensity was significant, and the indirect effect size is -0.09 , with 95% confidence interval [-0.19, -0.03] without 0 (Fig. 2), showing that intensity of affective forecast mediated the effect of priming an alytic thinking on the bias of acceptance; (2) in rejection condition, the indirect effect size was 0.77 , with 95% confidence interval [0.46, 1.21] without 0 (Fig. 3), which showed that intensity of affective forecasting

mediated the effect of priming analytic thinking on the impact bias under rejection.

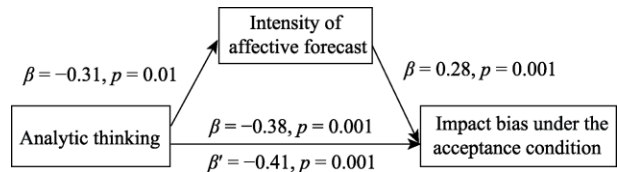


Figure 2. The mediating role of the intensity of affective forecast under acceptance condition.

Note. 0 = control group, 1 = priming group.

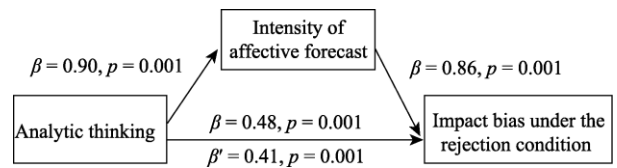


Figure 3. The mediating role of the intensity of affective forecast under rejection condition.

Note. 0 = control group, 1 = priming group.

In addition, we analyzed the mediating effects of emotional experience. According to Hayes (2013), the Bootstrap method was used. The results showed that: (1) under the acceptance condition, the mediating effect of emotional experience was not significant, and the indirect effect was -0.09 , with 95% confidence interval [-0.20, 0.03] including 0, which showed that affective experience had no mediating effect under the condition of acceptance, (2) the mediating effect of affective experience was not significant under the condition of rejection, and the indirect effect was 0.26 , with 95% confidence interval [-0.03, 0.60] containing 0, which showed that emotional experience had no mediating effect under the condition of rejection.

2.2.5 Discussion

Experiment 1 found, whether the proposed assignment was accepted or rejected, the analytic thinking group had a lower intensity of affective prediction and a smaller impact bias than the control group, supporting the hypothesis. The results showed that priming analytic thinking could reduce the intensity of affective forecasting and impact bias. In addition, the mediating effect analysis showed that affective forecasting intensity played an mediating role in reducing the impact bias, while affective experience played no mediating role in reducing the impact bias, which showed that the priming of analytic thinking could reduce the impact bias by reducing the intensity of affective forecasting. In experiment 2, different priming methods were used to test the effect of analytic thinking priming on impact bias.

3 Experiment 2: Memory Test Task

In experiment 2, verbal fluency task was used to prime analytic thinking, and pre-experiment was conducted to test whether the verbal fluency task could prime analytic thinking effectively.

3.1 Pre-experiment: Effectiveness of verbal fluency task on priming analytic thinking

3.1.1 Participants

A total of 55 undergraduates were recruited from a university, including 5 males and 50 females. The mean age was 20.05

years, and the standard deviation was 1.01 years. 28 was in the analytic thinking group and 27 was in the control group. According to the calculations of G*Power 3.1 (Faul et al., 2007), the number of participants required for the independent sample t test was 52, with statistical power $1 - \beta = 0.80$, bilateral test $\alpha = 0.05$, and effect quantity $d = 0.8$.

3.1.2 Experimental design

Using the method of Gervais et al. (2012), the participants were asked to rephrase 10 randomly scrambled words by using the verbal fluency task. Each group had five words, and participants were asked to eliminate one word and then put the remaining four words into a sentence. Under the condition of analytic thinking, there are 10 sentences, among which 5 sentences contain the words, such as “analysis” and “reasoning”, and the other 5 sentences have nothing to do with analytic thinking. All 10 sentences in the control group were not related to analytic thinking. At the end of the verbal fluency task, the cognitive response test was performed. In order to eliminate the influence of verbal fluency task difficulty on the priming effect, subjects were asked to evaluate the task difficulty on a 5-point scale, with 1 being very easy and 5 being very difficult.

3.1.3 Experimental procedure

The experiment was all completed on a computer, presented by E-prime. The participants were randomly assigned to the analytic thinking group or the control group. After completing the verbal fluency task, they were tested for cognitive response and task difficulty.

3.1.4 Results

The independent sample t test showed that the subjects in the analytic thinking group ($M_{\text{priming}} = 1.50$, $SD_{\text{priming}} = 0.69$) had higher scores in the cognitive response test than those in the control group ($M_{\text{control}} = 1.00$, $SD_{\text{control}} = 0.83$), $t(53) = 2.42$, $p = 0.02$, the 95% confidence interval [0.09, 0.91], $d = 0.66$. In addition, the results showed that there was no significant difference in verbal fluency task difficulty between the priming group ($M_{\text{priming}} = 1.93$, $SD_{\text{priming}} = 1.05$) and the control group ($M_{\text{control}} = 1.96$, $SD_{\text{control}} = 1.13$), $t(53) = -0.12$, $p = 0.91$, the 95% confidence interval [-0.62, 0.55]. Therefore, the verbal fluency task in this experiment can effectively prime analytic thinking.

3.2 Experiment 2

3.2.1 Participants

A total of 52 undergraduates were recruited from a university, including 9 males and 43 females, with an average age of 19.23 years and a standard deviation of 0.99 years. There were 26 in the analytic thinking group and 26 in the control group. According to the calculations of GPower 3.1 (Faul et al., 2007), the number of participants required for the independent sample t test was 52 with statistical power $1 - \beta = 0.80$, bilateral test $\alpha = 0.05$, and effect size $d = 0.8$. In this study, there was no significant difference in the impact bias between males ($M_{\text{male}} = 0.74$, $SD_{\text{male}} = 1.21$) and females ($M_{\text{female}} = 0.42$,

$SD_{\text{female}} = 0.65$), $t(50) = 1.14$, $p = 0.26$, 95% confidence interval [-0.24, 0.89].

3.2.2 Experimental design

The participants were asked to complete a memory test consisting of three meaningless syllables of English letters. It was divided into two stages: recognition and test. The task was to determine whether a meaningless syllable was a new word or an old word. The subjects were told that this was a classic memory test that accurately reflected their ability of remembering. If the correct rate of judgment reaches 90% or above, you can get a cash reward of 15 Yuan. If the correct rate is below 90%, there is no cash reward. In fact, the average correct rate was 71.56%, and none of the subjects got the correct rate above 90%.

Before the memory test, participants were asked to predict either the positive emotions (e.g., happy, pleasant) after reaching 90% of the test score or the negative emotions (e.g., unhappy, unpleasant) after not reaching 90% of the test score, using a five-point scale, in which one is not at all and five is very strong. When the participants were told that the correct rate was not reaching 90%, they immediately rated the negative emotion they experienced at the time and scored on a 5-point scale. The difference between the affective prediction and the affective experience represents the index of impact bias. The internal consistency of the negative emotion prediction questionnaire was 0.91 and that of the negative emotion experience questionnaire was 0.92.

3.2.3 Experimental procedure

The experiment was all completed on a computer using E-prime. After the participants came to the laboratory, the memory test task were first introduced to them and then they practice. After that, they performed the verbal fluency task. We had the participants predict their emotions after the memory test with correct rate is above 90% or below 90%. Finally, they completed the memory task and evaluated the emotional experience as soon as they got the feedback.

3.2.4 Results

(1) The effect of analytic thinking on affective forecasting and impact bias.

We compared the negative emotion prediction, emotional experience, and impact bias in the analytic thinking group and the control group, respectively. The results of independent sample t test are shown in Table 1. It is found that the affective forecast intensity and impact bias of the priming group were significantly lower than that of the control group.

(2) The mediating role of affective forecasting intensity in reducing the impact bias.

According to Hayes (2013), Bootstrap method was used. Model 4 was selected, and bootstrap sample size was set at 5000. The results showed that the mediating effect of affective forecasting intensity was significant. The indirect effect size is -0.23, and 95% confidence interval [-0.61, -0.04] was without 0 (Fig. 4), which showed that intensity of affective forecast

Table 1

Independent sample t-test of negative emotion prediction, emotion experience and impact bias under different experimental conditions

Dependent variables	Priming group	Control group	t	df	p	95% CI	d
Affective forecasting	2.19 ± 0.81	2.78 ± 0.99	-2.36	50	0.02	[-1.09, -0.87]	0.65
Emotional experience	1.94 ± 0.54	2.09 ± 1.09	-0.65	50	0.52	[-0.63, 0.33]	0.17
Impact bias	0.26 ± 0.65	0.69 ± 0.83	-2.11	50	0.04	[-0.85, -0.02]	0.58

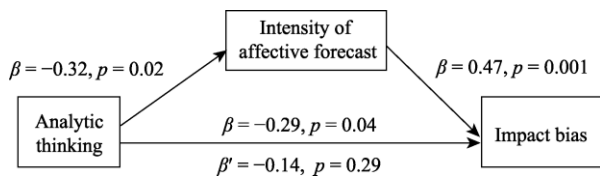


Figure 4. The mediating role of the intensity of affective forecast in the influence of analytic thinking on impact bias
Note. 0 = control group, 1 = priming group.

mediated the effect of priming analytic thinking on impact bias.

In addition, we examined whether affective experience played a mediating role. According to Hayes (2013) we used the bootstrap method, and model 4 was selected. The results showed that the mediating effect of emotional experience was not significant, and the indirect effect was 0.05, with 95% confidence interval $[-0.06, 0.27]$ containing 0, which showed that there was no mediating effect of affective experience in the effect of analytic thinking on impact bias.

3.2.5 Discussion

In experiment 2, we found that the priming of analytic thinking can significantly reduce the participants' affective forecasting intensity of the failure in the memory test, and then reduce the impact bias. The analysis of mediation showed that the intensity of affective forecast mediated the effect of priming analytic thinking on impact bias, while affective experience did not. This was consistent with the results of experiment 1, which reconfirmed the hypothesis. Experiment 3 further examined whether priming with analytic thinking reduced affective forecasting intensity in real life.

4 Experiment 3: The second child decision

4.1 Participants

In public places where mothers often congregate, such as primary school gates and Xinhua bookstore, 111 married women with only one child (mean age 1.40, standard deviation 0.49) were recruited. The mean age was 34.77 years and the standard deviation was 5.02 years. There are 51 in the control group and 57 in the priming group. According to calculations by GPower 3.1 (Faul et al., 2007), the number of subjects required for a t test between subjects is 52 on the assumption of the statistical power $1 - \beta = 0.80$, the bilateral test $\alpha = 0.05$, and the effect size $d=0.80$.

4.2 Experimental design

4.2.1 Independent variables

Four pictures of *The Thinker* were shown to the subjects in the priming analytic thinking group, while geometric pictures which were same as that in experiment 1 were shown to the subjects in the control group.

4.2.2 Dependent variables

Affective forecasting. According to the positive and negative emotion words used in Wirtz, Kruger, Scollon, and Diener (2003), the author selected emotive words closely related to the birth of a second child, and participants were asked to predict positive emotions (happy, pleasant, excited) and negative emotions (depressed, painful, tired) after having a second child using a seven-point scale, with 1 = none at all and 7 = very strong. The higher the score, the stronger the affective forecast. In this experiment, the internal consistency of the positive affective forecasting questionnaire was $\alpha = 0.96$, and that of the negative affective forecasting questionnaire was $\alpha = 0.84$.

4.3 Experimental procedure

The experiment was carried out in a quiet room, and it was all completed on a computer with E-prime. Once in the laboratory, pictures of "*The Thinker*" were shown to the participants, while geometry pictures were shown to the control group. And then the subjects predicted the positive and negative emotions that would be experienced after having a second child.

4.4 Results

Independent sample t test results are shown in Table 2. When predicting positive emotions after having a second child, the priming group predicted lower positive emotions than the control group. When predicting negative emotions after having a second child, there was no significant difference between the priming group and the control group.

4.5 Discussion

Experiment 3 found that when predicting the positive emotions of having a second child, the priming analytic thinking group have less intensity of the positive emotions forecasting, consistent with the hypothesis. When people start thinking analytically, they stop focusing on the joy of a new life and start thinking more rationally, and their predictions of positive emotions was reduced. However, there was no significant difference between the control group and the analytic thinking group in predicting negative emotions, which was not consistent with the hypothesis. The effect of analytic thinking on affective forecasting might be influenced by task characteristics. The intensity of negative emotion after having a second child was relatively weak, so the intensity of affective forecast did not decrease significantly after priming analytic thinking; the intensity of positive affective forecast after having a second child was relatively strong, and it decreased significantly after priming analytic thinking. Hong et al. (2016) found similar results. Mindfulness significantly reduced the intensity of the prediction of negative emotions after knowing test scores, but did not significantly reduce the intensity of the prediction of positive emotions after knowing test scores.

Table 2

Independent-sample t -test was used to test the predictive power of analytic thinking on positive and negative emotions

Dependent variables	Analytic Thinking	Affective forecasting	t	df	p	95% CI	d
Positive emotions	Analytic Thinking	4.54 ± 1.63	2.02	106	0.046	[0.01, 1.27]	0.39
	Control Group	5.18 ± 1.66					
Negative emotion	Analytic Thinking	2.98 ± 1.32	-1.01	106	0.314	[-0.86, 0.28]	-0.19
	Control Group	2.69 ± 1.65					

5 General Discussion

Experiment 1 (with visual priming) and experiment 2 (with verbal fluency task) examined the influence of analytic thinking on impact bias and analyzed the mediating effect of intensity of affective forecast. Experiment 3 further investigated the effect of analytic thinking priming on affective forecast through real decision-making (having a second child as an example).

5.1 The role of analytic thinking in affective forecasting

Three experiments found that priming analytic thinking reduced the intensity of people's affective forecast of future events. According to the accessibility model of emotional self-report (Robinson & Clore, 2002), when people make predictions about their future emotions, they intuitively make predictions based on beliefs about future events. In experiment 1, people might intuitively predict how they would feel if a proposal was accepted or rejected, based on beliefs such as "getting more money is happy" or "losing money is unhappy". In experiment 2, people may intuitively make affective forecast about memory test failure, based on beliefs such as "poor memory test scores are very embarrassing or very unhappy". In experiment 3, people may intuitively predict the emotional outcome of having a second child based on such beliefs as "more children, more happiness". Because people's beliefs about future events are abstract, they tend to ignore the emotional impact of events unrelated to future events, which leads people to overestimate the emotional impact of future events. Previous studies have shown that analytic thinking weakens the influence of intuition after it is activated (Evans, 2003; Evans, 2008; Kahneman, 2003). As a result, priming analytic thinking weakens the effect of people's beliefs about future events on affective forecasting, making people less dependent on intuitive beliefs in affective forecast, and more likely to analyze the effect of future events on emotions in a more comprehensive way, and thus reduces the intensity of the affective forecast. This is consistent with previous findings on the effect of analytic thinking on beliefs, which can attenuate the effects of beliefs (Gervais & Norenzayan, 2012; Yilmaz et al., 2016; Stagnaro et al., 2019; Franks & Scherr, 2017).

5.2 The role of analytic thinking in impact bias

In experiment 1 and experiment 2, we found that analytic thinking significantly reduced people's affective forecasting bias, and the intensity of affective forecast played a mediating role in the process of reducing the impact bias by priming analytic thinking, which was consistent with the hypothesis of this study. Previous intervention studies on impact bias have found that a decrease in affective forecast intensity reduces impact bias and improves affective forecast accuracy (Wilson et al., 2000; Eggleston et al., 2015; Hong et al., 2016; Hoerger et al., 2010). As a result, priming the analytic thinking reduces the impact bias by reducing the intensity of affective forecast.

Overall, three experiments showed that priming analytic thinking significantly reduced people's affective forecast intensity of future events, thus reducing impact bias. As proposed in dual-process theory, while System 1 and System 2 can sometimes run in parallel, System 2 often overrides System 1's input when the analytic thinking tends to be activated and cognitive resources are available (Strack & Deutsch, 2004). When people predict the emotions of future events, as they cannot get the specific experiences and situations and

beliefs about future events are more available, people intuitively predict the emotions of future events based on their beliefs about future events. When analytic thinking is primed, the role of System 2 attenuates the role of intuition (Evans, 2003; Evans, 2008; Kahneman, 2003), so that people do not rely on intuitive beliefs about future events for affective forecast. They are more likely to fully analyze the impact of future events on emotions and make more rational predictions, thus reducing the intensity of affective forecasting and impact bias.

5.3 Theoretical contribution

Based on the accessibility model of emotional self-report (Robinson & Clore, 2002), the study suggests that people follow the information availability principle in affective forecasting. They make predictions intuitively on the basis of beliefs about future events, but their actual emotional experiences are based on the immediate emotional experience, which leads to impact bias. At present, few studies shed light on the impact bias of affective forecasting from the perspective of intervention on intuitive belief. From the perspective of dual-process theory (Evans, 2003; Evans, 2008; Kahneman, 2003), this study finds that analytic thinking can reduce people's affective prediction intensity of future events and thus the impact bias, which provides a new research direction for the intervention of impact bias, and further confirms the effect of belief on impact bias. In addition, this study found that priming analytic thinking can reduce the intensity of people's affective forecast of future events, suggesting that System 2 can override or weaken the intuitive processing of System 1 after priming analytic thinking, which provides further evidence for the dual-process theory.

5.4 Practical value

People make decisions in their daily lives. The decision-making often involving affective forecasting. Impact bias will reduce the quality of decision-making, and then affect people's satisfaction and happiness of decision-making. This study shows that priming analytic thinking can significantly reduce impact bias in decision-making. Based on this, we can improve the accuracy of affective forecast and the quality of decision-making by priming analytic thinking.

5.5 Shortcomings and future research

This study examined the effects of analytic thinking on affective forecasting and impact bias through laboratory experiments (experiment 1 and experiment 2) and field experiments (experiment 3). And there are still some shortcomings. In experiment 3, we only examined the effect of analytic thinking on affective prediction in second-child decision-making, but did not follow up the subjects to measure their real emotional experience after having a second child. In the future research, we need to further investigate the effect of analytic thinking priming on affective forecasting bias in real life decision-making. In addition, the future research can use a direct way to examine the impact of analytic thinking on intuitive beliefs.

6 Conclusion

We found that analytic thinking can reduce the impact bias of affective forecasting, and affective forecast intensity played a mediating role in that process.

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