

## 부정적 미래 상상과 그에 따른 부정성의 지연중성화 감소

Imagining Negative Futures to Reduce the Delay Neutralization of Negativity

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### Abstract

Procrastination is an irrational choice to delay high-priority work in order to avoid its unpleasantness, despite the fact that the negativity will not cease if the work still remains undone. We hypothesized that (1) people underestimate the future negativity (i.e., delay neutralization) and (2) in order to complete work in a timely manner, one should project oneself into the future so as to recognize that the negativity associated with an activity does not diminish over time. Especially, negative future thinking that is unrelated to the consequence was hypothesized to reduce delay neutralization of negativity. In the present study, undergraduate students made a series of choices between delayed-but-longer and immediate-but-shorter assignment by employing an inter-temporal choice paradigm. We tracked how positive and negative episodic future thinking influenced the degree to which negativity is neutralized over time (Experiment 1). Following this, we confined the experimental condition to negative thinking about the future (Experiment 2). Participants neutralized negativity involved in assignment as a function of time, suggesting that procrastination arises from the delay neutralization of the negativity. Critically, such neutralization was significantly reduced when participants imagined a negative future event, but this did not occur when they imagined a positive future event (Experiment 1), or when participants did not think about the future (Experiment 1, 2). Our findings suggest that, prior to making a decision between work and indulgence, imagining negative future events can be an effective way to reduce the neutralization of delayed negativity and, in turn, procrastination.

**Key words:** Inter-temporal choice, Decision-making, Episodic future thinking, Procrastination

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## 1. Introduction

When faced with works that require immediate attention, many people still find themselves procrastinating. A task is likely to feel less onerous at a later time, while everything else seems relatively more engaging in the present. Avoiding their responsibilities, people often resort to other activities: socializing with friends, browsing the internet, daydreaming, or sometimes even pursuing arduous and unrewarding activities. Procrastination is a prevalent phenomenon according to substantial body of research (Ferrari, O'Callaghan, & Newbegin, 2005; Harriott & Joseph, 1996; Steel, 2007). This pervasiveness is especially problematic because procrastination is detrimental to diverse life domains such as academic performance, financial security, health, and so on. (O'donoghue & Rabin, 1999; Sirois, Melia-Gordon, & Pychyl, 2003; Steel, 2007). For instance, procrastination is negatively correlated with GPA results in academic settings, and if taxes are not paid on time, it can precipitate an exponential loss of money (Steel, 2007). Considering these negative consequences of procrastination, it is necessary to elucidate the underlying mechanisms and to find a way to reduce it.

Procrastination is a time-inconsistent decision to leave work for a future self, which involves a discounting of delayed values (McClure, Laibson, Loewenstein, & Cohen, 2004; O'donoghue & Rabin, 1999). If the negativity of the assigned task and the positivity of other activities stay the same across all times, it would be of no use procrastinating. On the other hand, if the task's negativity and other activities' positivity are asymptotic to neutral valence, there is clear motivation to postpone the task. Like other types of self-control failure (Mischel, Shoda, & Rodriguez, 1989), procrastination is also likely to come from this discrepancy between subjective estimation of immediate and that of future value. Even though procrastination is not a one-time decision to put off one's work but rather successive deferment of high-priority work, it should still be understood as value estimation process in a temporal horizon first because the temporal horizon is renewed whenever making a decision

and thus inter-temporal difference remains. That is, every moment people decide between a task and other activities, they may always find a task in the future less aversive than one in the present and end up procrastinating. It is important to bear in mind, however, that such subjective discounting of values is still irrational, since neither the objective negative value of task nor the objective positive value of leisure activities diminishes over time. That is, the amount of values that we actually experience when the time comes is the same for today and tomorrow, although they may feel different at the moment of decision-making.

Classic investigations of self-control and procrastination have primarily focused on establishing their relationship to temporal progress of reward values (Steel, 2007) and found that as reward is delayed, subjective value of the reward decreases over time (Kirby & Herrnstein, 1995; McClure, Laibson, Loewenstein, & Cohen, 2004; Mischel, Shoda, & Rodriguez, 1989; O'donoghue & Rabin 1999). However, the understanding is yet incomplete if the delayed negativity is not considered. The negativity is especially critical because procrastination, by definition, involves postponing a negatively-valenced unwanted task. Supporting this explanation, a meta-analysis showed that procrastination has a positive correlation with task-aversiveness (Steel, 2007), and the negativity associated with performing a task is found to be the core feature of procrastination (Blunt & Pychyl, 2000). Given that, it is necessary to investigate procrastination in terms of negativity of the task. Thus, in this study, we examined negative valence and how it is underestimated as time is delayed. Similar to delay discounting of value, it is underestimation of emotional valence that we investigated.

However, the term discounting may insufficiently capture the point that the value can actually increase (not decrease) if a stimulus feels less negative, so it would be more appropriate to refer it as delay neutralization of valence. We aimed to examine if this delay neutralization process occurs in procrastination. Two predictions are possible for delay neutralization of negativity. First, negative valence may not approach

neutral state even though time passes. For example, a research by Berns and colleagues (2006) had participants choose between immediate and delayed pain. They found that people prefer overcoming an adverse outcome (i.e., pain) to delaying it, because delay causes prolonged dread. If this decision-making pattern is generalizable to procrastination, deferment of a task would not neutralize subjective negativity, and thus delay neutralization would not be able to account for procrastination. Nevertheless, it may not be generalizable to procrastination because the works over which people usually procrastinate entail much milder negativity with low arousal level: writing a paper, paying taxes, seeing a dentist, doing house chores, and so on. For this type of negativity, negative valence of assigned task can approach neutral valence when the event is delayed, just as positive valence of rewarding event approaches neutral valence over time. If this is the case, delay neutralization can be an underlying mechanism that motivates procrastination.

We also sought to examine how short-sighted decision-making can be reduced in terms of delay neutralization of negativity. Previous research has found that temporal discounting of reward values can be reduced when episodic future thinking precedes decision-making (Benoit, Gilbert, & Burgess, 2011; Peters & Büchel, 2010). In a study of Peters and Büchel (2010), participants were asked to choose between smaller immediate rewards and larger delayed rewards. In a future thinking condition, they imagined a future event that may happen to them at the delayed time point before they made a decision between the two reward options. Participants made more far-sighted decision to wait for the larger reward in a future thinking condition, compared to a control condition without the future thinking process. Their finding suggests that thinking about future helps more rational and future-oriented decision-making.

So far, however, questions regarding negative valence remains unanswered. When it comes to delay neutralization of negativity rather than delayed gratification of positive stimuli, it is necessary to investigate the possibility that valence of future events asymmetrically influences temporal progress of valences.

Future thinking with different valences could influence delay neutralization of task's negativity to an unequal extent depending on whether valence of imagined episodes and valence of stimuli (e.g., assignment) are congruent. As a result, it is possible that negative future thinking reduces delay neutralization of negativity than positive future thinking does, even though the episodes are unrelated to the consequence of procrastination. The present study aims to elucidate the relationship between valence of future thoughts preceding decision-making and the degree to which delayed negativity is underestimated. We posit that imagining task-irrelevant negative future events will prevent people from being short-sighted and deferring high-priority work.

Two experiments were conducted to test our hypotheses that delayed negativity is underestimated and that decision to procrastinate can be reduced with thinking about future in a negative way. In order to increase ecological validity, undergraduate students were made to believe that there was an assignment for class, and asked to choose whether they would defer the due date of the assignment taking the cost of increased length. Experiment 1 compared the effect of positive and negative future thinking that precedes the inter-temporal choice of deferment. In Experiment 2, we tested the effects of negative future thinking on the delay neutralization of negativity.

## 2. Experiment 1

In Experiment 1, we examined delay neutralization process and the effect of future thinking valence on it in a realistic context of class assignment. We expected delay neutralization of negativity and hypothesized that task-irrelevant negative future thinking would decrease the degree to which delayed negativity is neutralized over time. To test the hypothesis, we had participants choose their own assignment length and deadline in an inter-temporal choice task. Importantly, future cues were provided before they made decisions. To compare the effect of future thinking valence, we created three experimental conditions (negative future thinking condition, positive future thinking condition, and a

control condition without future thinking) and neutralization rates for the three conditions were compared.

## 2.1. Method

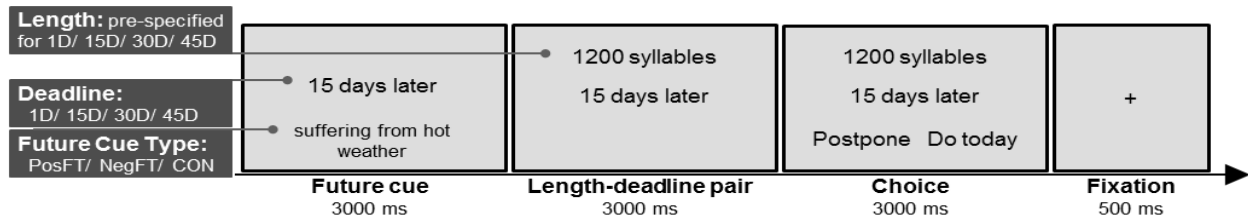
### 2.1.1. Participants

Nineteen undergraduate students (mean age 22.5, 3 males) taking a psychology course participated in the

study as part of their course requirements. They were in the same class, and the class had several short assignments over the course of semester, which made the experimental context realistic to them. Informed consent was obtained in accordance with the guidelines of the Yonsei University Department Review Committee. All participants were debriefed after completing the task. Data from two participants were excluded from the analysis due to failure to following the instruction properly.

- (a) You should write a 1000-syllable response paper as your assignment if you are to submit it today. Estimate the proper amount of assignment as the due date is delayed as below.
- |                             |                |
|-----------------------------|----------------|
|                             | * in syllables |
| Tomorrow:                   | <u>1200</u>    |
| A week later:               | <u>1500</u>    |
| A half month later:         | <u>1800</u>    |
| A month later:              | <u>2500</u>    |
| One and a half month later: | <u>2700</u>    |
- (b) Imagine and write down positive events that may happen to you at the below time points (e.g., getting a present from a friend).
- |                             |   |
|-----------------------------|---|
| Tomorrow:                   | <u>getting a free movie ticket</u>      |
| A week later:               | <u>getting money back from a friend</u> |
| A half month later:         | <u>getting a surprise present</u>       |
| A month later:              | <u>finding a class cancelled</u>        |
| One and a half month later: | <u>mom buying me a clothes</u>          |
- (c) Imagine and write down negative events that may happen to you at the below time points (e.g., not bringing an umbrella on a rainy day).
- |                             |  |
|-----------------------------|--|
| Tomorrow:                   | <u>missing a bus</u>                                     |
| A week later:               | <u>finding a school festival boring</u>                  |
| A half month later:         | <u>suffering from hot weather</u>                        |
| A month later:              | <u>getting sick</u>                                      |
| One and a half month later: | <u>having trouble with studying during the dead week</u> |

**Figure 1. Examples of Subject-specific Stimuli.** Participants first reported the assignment length they regarded proper for deadlines (a). Another survey asked them to provide possible positive (b) and negative (c) future events that may happen to them on specified time points.



**Figure 2. Experimental procedure.** A future cue (or nonsense letters in the control condition) and a time point were presented for 3000ms, followed by a length-deadline pair for another 3000ms. While the pair remains on a screen, participants made a choice between “Postpone,” and (2) “Do today,” in a 3000ms choice phase. After a 500ms fixation cross screen, the next trial began.

### 2.1.2. Stimuli

Subject-specific future episodes and assignment length-deadline pairs were obtained and used as personalized future cues and decision options. In order to obtain subject-specific length stimuli, participants first were asked to answer a short survey before the main experiment, under a cover story that instructor needed to know assignment paper length and due date that the students regard reasonable. The default length was established at one thousand syllables (approximately a half page) if submitted immediately within the day. The survey asked participants to estimate length of assignment that feels appropriate to them as the deadline is extended (see Fig. 1a for example). Specifically, they answered how many syllables (in Korean) an assignment length should be for each of five given time points (tomorrow, a week later, a half month later, a month later, and one and a half months later).

Subject-specific episodic future cues were also obtained beforehand. Participants were given a cover story that this survey is part of course lecture material for understanding an online survey system. They were asked to write down events that may happen to them at six future time points (tomorrow, one week later, two weeks later, a month later, one and a half month later, and two months later). Critically, they wrote about both positive and negative future events (see Fig. 1b and Fig. 1c for illustration). These future episodes were used as future cues for positive and negative future thinking conditions respectively, whereas a string of nonsense letters (i.e., ‘#####’) substituted for the cue in a

control condition. It is important to note that the episodes were provided before the main experiment, and at that point, they were unaware of what they would perform later. Thus the future cues did not include the consequence of procrastination. Moreover, in order to obviate potential influence of the degree to which the events consume time, we asked participants to provide events that do not take up much time (e.g., not bringing an umbrella on a rainy day).

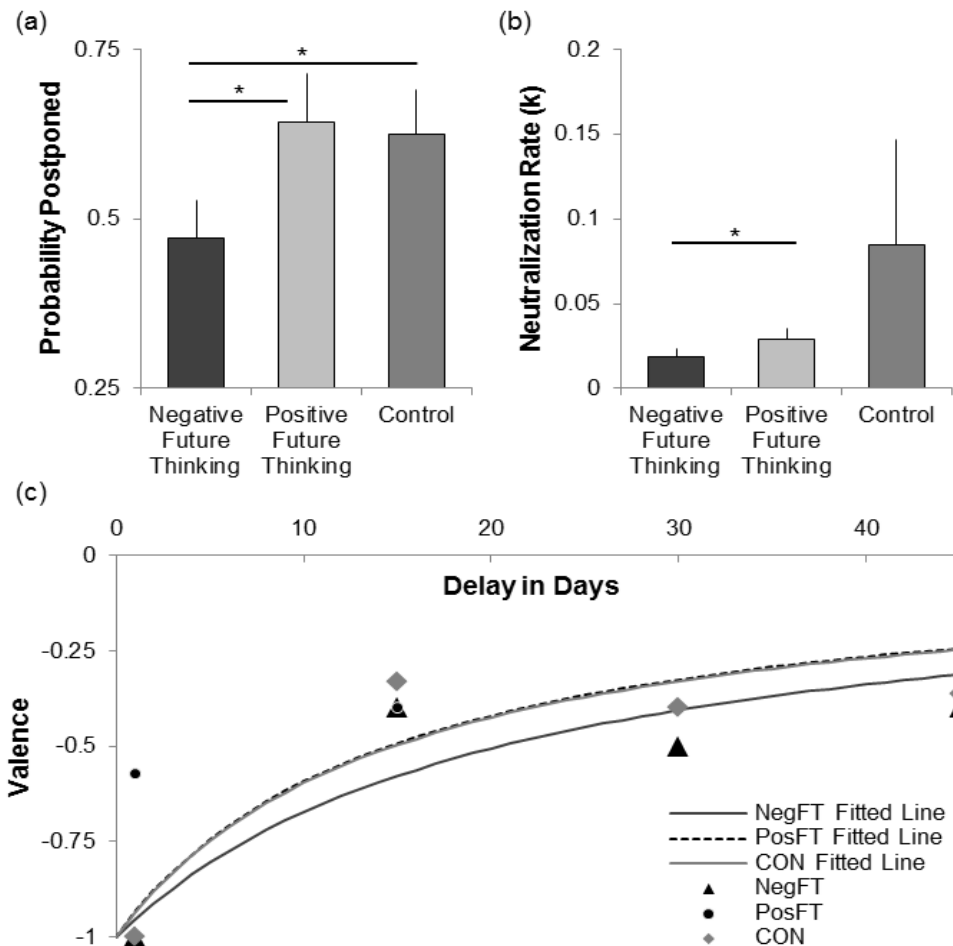
Participants wrote about positive (e.g., “being able to wear clothes that had not fit before”, “boyfriend getting me a pair of shoes that I wanted”) and negative (e.g., “awkward make-up for yearbook photo shoots”, “spilling a bowl of soup while eating it”) events. After being provided with these personal future events, we prepared subject-specific length-deadline pairs for the main experiment. Because the main experiment took place after preparation of stimuli, in order to avoid mismatch between time and event, only four time points (tomorrow, two weeks later, one month later, and one and a half month later) were used in the main experiment. Each length options were paired with all four deadlines, which resulted in sixteen pairs in total.

### 2.1.3. Procedure

Participants were first informed that they should submit a short report paper as part of regular class assignments. In order to make the procedure feel more realistic, the cover story was given that the experiment was to choose assignment length and deadline for the paper. The length of the assignment was one thousand

syllables in Korean (approximately a half page) if they turn in the paper on that day; however, they could postpone the due date by choosing alternative options. The experiment provided a series of length-deadline options which they could choose during the experiment, and final length and deadline for their own paper would be selected from the choices they made. Importantly, there were three conditions: the negative future thinking condition (NegFT) in which participants imagined negative future events with subject-specific episodic cues, the positive future thinking condition (PosFT) in which they imagined positive future events with cues, and the

control condition (CON) where they were instructed not to think about future events. Importantly, these future cues were independent of assignment, because they did not know about the experiment when they provided the cues. For example, it could not include the consequence of procrastination such as “feeling rushed to finish the paper.” The three conditions were used in order to examine both the effect of future thinking and the difference of future thinking’s valence. All three conditions were intermixed in a randomized order.



**Figure 3. Results of Experiment 1.** Probability of postponing the assignment was significantly low in Negative future thinking condition (a). Neutralization rate was also lowest in Negative future thinking condition (b). An individual sample graph illustrates that valence of paper assignment neutralizes over time at different rates depending on future thinking condition (c).

Error bars represent  $\pm 1$  SEM

Participants were first presented with a future cue (or nonsense letters in the control condition) and a time point for 3000ms, where they were asked to think about the cue event. It was followed by a length-deadline pair for another 3000ms, and they were requested to consider the option in this phase. While the pair remains on a screen, participants made a decision between the alternative options of (1) “Postpone,” meaning that they would defer the assignment at the cost of increasing its length, and (2) “Do today,” meaning that they would submit a one-thousand-syllable paper on that day, in a 3000ms choice phase. After a 500ms fixation cross screen, the next trial began. Experimental procedure is depicted in Fig. 2. Responses were made by pressing the ‘,’ and ‘.’ keys that were pre-assigned to the “Postpone” and “Do today” options, respectively.

After the inter-temporal choice task is completed, participants provided valence, arousal, and vividness of the episodic cues in a 7-point Likert scale. After all procedure ended, they were debriefed and assured that they did not have to turn in the paper hypothesized in the experiment.

#### 2.1.4. Analysis

For analyzing the effect of future thinking valence on decreasing neutralization, we employed inversed hyperbolic function to derive neutralization rate, which is a time-sensitive index. Hyperbolic function (Mazur, 1987) is well supported in a great body of inter-temporal decision literature, especially in that this function explains the empirical finding of preference reversal well while other functions cannot (for a review, see Green & Myerson, 2004). To reflect that neutralization of negativity starts from negative value, we inversed the function. The neutralization rate was then estimated with inversed hyperbolic function  $SV = -1/(1+kD)$ , where  $SV$  denotes Subjective Valence,  $k$  is the neutralization rate, and  $D$  is the delay in days. Subject-specific  $k$  values were obtained by fitting each participant’s chosen length-deadline pair to the function, using the least square curve fitting function of the MATLAB Statistics toolbox (The Mathworks, Natick, MA).

## 2.2. Results and Discussion

To test the hypothesis that negativity neutralizes as a function of time, we first estimated the neutralization rate of negativity from the subject report of each deadline’s appropriate assignment length. Derived neutralization rate was compared to

the null hypothesis of zero discounting rate. As no experimental manipulation was involved in getting this neutralization rate, it is each subject’s baseline neutralization rate. One sample t-test revealed a significant neutralization of negativity (mean  $k = .07$ ,  $t(16) = 2.19$ ,  $p < .05$ ), supporting our prediction. That is, participants increased their assignment lengths as due dates were delayed, with no manipulation on future thinking.

Next we went on to examine how negative and positive future thinking can affect the delay neutralization of negativity. The probability of postponing the deadline, despite the increase in paper length, was determined as the number of postponed options divided by the number of total offered options in the relevant condition. The postponement probability was significantly differed across conditions,  $F(2,15) = 6.19$ ,  $p < .01$ ,  $\eta p^2 = .28$  (Fig. 3a). Planned contrasts revealed a significantly lower probability of postponement for the negative future thinking condition (mean probability = .47) than the positive future thinking condition (mean probability = .64),  $F(1,16) = 8.84$ ,  $p < .01$ ,  $\eta p^2 = .36$ . Additionally, the control condition had a significantly higher probability of postponement than the negative prospection condition,  $F(1,16) = 8.3$ ,  $p < .05$ ,  $\eta p^2 = .34$ . However, positive future thinking did not have a significant abatement effect compared to the control condition,  $F(1,16) = .13$ ,  $p = .72$ ,  $\eta p^2 = .01$ . The result suggests that negative future thinking has the greatest effect in reducing postponement (i.e., a decision to procrastinate), even though the content of future thinking did not include the bad consequence of procrastination.

To further test if the difference comes from the inherent characteristics of future events, we compared the levels of vividness and arousal produced by the positive and negative future events. Wilcoxon tests showed that

there was no significant difference in positive and negative events in terms of vividness (mean vividness, PosFT = 5.22, NegFT = 4.91,  $z = 1.17$ ,  $p = .24$ ) or arousal (mean arousal, PosFT = 5.51, NegFT = 5.62,  $z = .14$ ,  $p = .89$ ), but there was significant difference across valences in terms of positivity (mean positivity, PosFT = 6.35, NegFT = 1.82,  $z = 3.64$ ,  $p < .01$ ). Thus, the difference is not attributable to dissimilar levels of vividness or arousal.

Critically, the difference between imagining positive and negative future events was then tested with a temporal neutralization rate ( $k$ ), a more temporally sensitive index. Although the difference in neutralization rate across all conditions, including CON, did not reach statistical significance ( $F(2,15) = 1.03$ ,  $p = .37$ ), planned contrast of PosFT and NegFT showed that the neutralization rate was significantly lower for NegFT (mean  $k$  value, PosFT = .029, NegFT = .018),  $F(1,16) = 6.54$ ,  $p < .05$ ,  $\eta^2 = .29$  (Fig. 3b). Fig. 3c shows an individual's sample graph of different neutralization rate for three valence conditions. However, due to the great variance in CON (mean  $k$  value = 0.08, S.E.M. = .06), NegFT and CON did not differ significantly ( $F(1,16) = 1.2$ ,  $p = .29$ ). We speculated that the variance comes from intermixed conditions with separate presentation of future cue and decision options, because the time in-between cue and options may weaken the direct effect of future thinking. Thus, to clarify the results of Experiment 1, we proceeded to Experiment 2.

### 3. Experiment 2

Experiment 2 directly compared the negative future thinking condition (NegFT) to the condition where future thinking is absent (CON), with future cue remaining present until length-deadline pair appeared. In addition, more future time points were used in order to fit data more neatly into the inversed hyperbolic function, as the use of more data points enhances the least square curve fitting.

## 3.1. Method

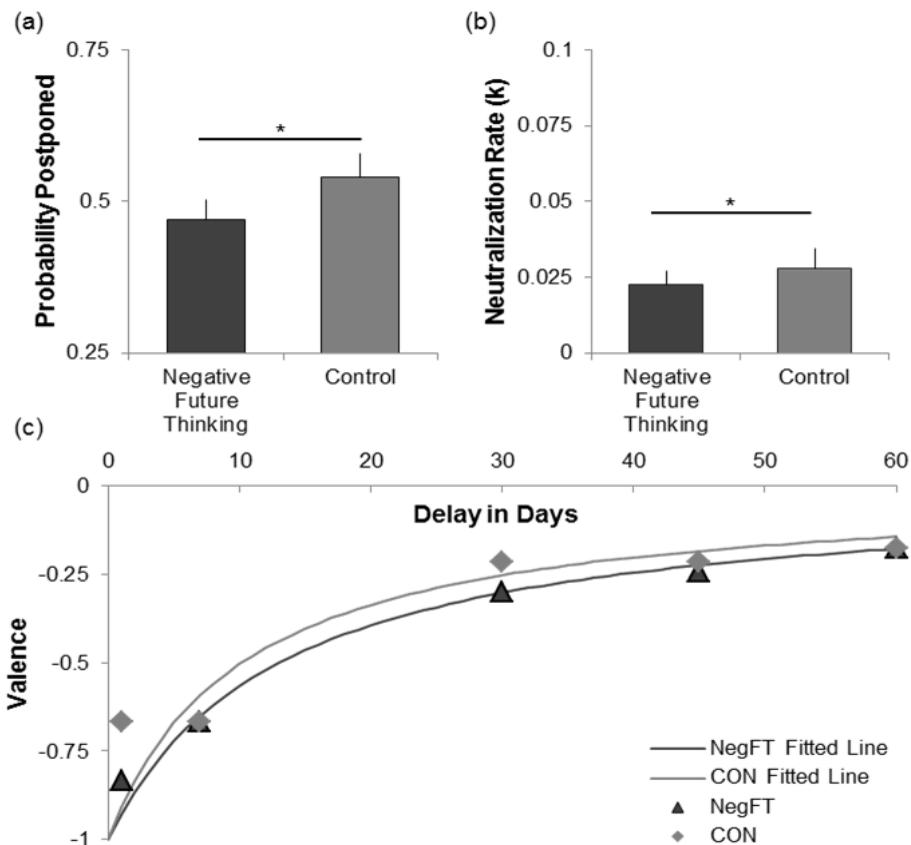
### 3.1.1. Participants

Twenty-eight undergraduate students (mean age = 22.96, 9 males) taking a psychology course participated in the experiment as part of their course requirements. Informed consent was obtained from all participants.

### 3.1.2. Stimuli and Procedure

The experimental procedure was identical to Experiment 1, except that experimental manipulation was confined to the negative future thinking condition (NegFT) and an increased number of time points were used in order to make it fit better to the inversed hyperbolic function. Participants provided subject-specified assignment lengths (calculated in syllables) for seven time points (tomorrow, one week later, two weeks later, one month later, six weeks later, two months later, and three months later), on the understanding that they should submit a one-thousand-syllable paper if they turn it in that day. Since the main experiment took place after preparation of stimuli, in order to avoid mismatch between time and event, only five time points (tomorrow, one week later, one month later, one and a half month later, and two months later) were used as future time points. They also provided a range of negative future episodes for the seven time points, which were presented as negative future thinking cue in the inter-temporal choice task. The future cues were unrelated to consequence of putting off the assignment, as in Experiment 1. Again, in the control condition (CON), nonsense letters appeared instead of future cues and participants were asked not to think of future events. The two conditions, NegFT and CON, were intermixed in a randomized order.





**Figure 4. Results of Experiment 2.** Probability of postponing the assignment was lower in Negative future thinking condition than control condition (a). Neutralization rate was also lower in Negative future thinking condition (b). An individual sample graph depicts that valence of paper assignment neutralizes over time at different rates depending on future thinking condition (c). Error bars represent  $\pm 1$  SEM

A negative future cue (or nonsense letters for the control condition) was presented along with the time points for 1000ms. To allow more time to process future events, an assignment length for the deadline appeared for a further 5000ms with both cues and the time point remaining present. After being presented with a fixation screen for 500ms, participants were then asked to choose between “Yes,” which meant that they would accept the presented length-deadline option to postpone the task, and “No,” which meant that they would rather choose the immediate, one-thousand-syllable option. The alternative lasted for 2000ms, and was followed by a 500ms fixation screen. Responses were collected by pressing ‘z’ and ‘/’ on a keyboard, which were “Yes” and “No” respectively.

### 3.1.3. Results and Discussion

We first examined the delay neutralization without any influence from future thinking. Replicating the results of Experiment 1, when participants were asked to estimate the proper assignment length in proportion to the amount of time postponed, it was again discovered that the delay neutralization of negativity was significant ( $k = .0567$ ,  $t(27) = 4.14$ ,  $p < .01$ ).

The probability of postponement was next analyzed in order to determine whether negative future thinking reduces the intention to defer the assignment. Participants chose the immediate option significantly more often under the NegFT condition (mean probability of postponement, NegFT = .49, CON = .54,  $F(1,27) = 6.57$ ,  $p$

$< .05$ ,  $\eta p^2 = .20$ ), indicating less short-sighted decision (Fig. 4a).

To test the hypothesis that negative future thinking reduces the delay neutralization of negativity, the neutralization rate was estimated from the inversed hyperbolic function. The neutralization rate was significantly lower for the NegFT (mean  $k$  parameter, NegFT = .024, CON = .029,  $F(1, 27) = 5.10$ ,  $p < .05$ ,  $\eta p^2 = .16$ ), which indicates a more rational choice with negative future thinking (Fig. 4b). For illustration, Fig. 4c shows an individual subject's neutralization function with and without negative future thinking. This result supports the hypothesis that negative future thinking is a way to reduce the neutralization of delayed negativity, thereby strengthening the findings of Experiment 1.

#### 4. General Discussion

In the present study, we examined the neutralization of negativity as a function of time and explored how negative future thinking can lessen this neutralization process, leading to more far-sighted decision-making. Experiment 1 showed that negative future thinking has a greater abatement effect over positive future thinking. In Experiment 2, we confined experimental conditions to negative future thinking condition and control condition and found further evidence that a decision following negative future thinking was more far-sighted than one following no future thinking.

Our finding shows that the negativity of ordinary tasks associated with procrastination are likely to follow an inversed hyperbolic function, although other negative values, such as life-threatening fear, may not decrease even when imagined as future events (Berns et al., 2006). This finding gives a plausible explanation of how procrastination can arise due to the subjective experience of neutralizing delayed negativity. Thus, to be rational so as to complete high-priority work in a timely manner, one should less neutralize subjective negativity, because objective negativity of the work does not diminish over time. Simulating negative future events was suggested as a way to attenuate the degree to which negativity is neutralized and thus defeat procrastination. Albeit

unassociated with the consequences, the future simulation of negative episodes was found to have a greater effect on abatement, compared to that of positive episodes.

It is worth noting that future thinking in this study does not involve the consequence of decision. In a motivational sense, it would be important to investigate future thinking in terms of consequences. However, regardless of the content, episodic future thinking does seem to have influence on far-sighted decision making (Peters & Büchel, 2010), as our finding supported.

Although this study found negative future thinking's role in reducing underestimation of negativity in the future, our study is limited in that we did not measure actual procrastination behavior. Thus, it is further requested to investigate if negative future thinking leads to true behavioral change, as defeating procrastination requires the effect to be sustained until the work is done. Previous findings on fading affect bias showed that episodic memory and simulations with different valences fade at dissimilar rates (Szpunar, Addis, & Schacter, 2012; Walker, Skowronski, & Thompson, 2003). Interestingly, the memory of negative simulations faded faster than that of positive future simulations. If negative simulations indeed fade away faster, the effect of negative prospective memory might also become insignificant as time passes, resulting in relatively less behavioral change. The question of negative simulation's long-term effect should be addressed further with actual measurement of procrastination behavior.

Moreover, individual difference can modulate how negative simulation affects decision-making and self-control. Supporting the possibility, dysphoria was found to modulate the fading affect bias, as dysphoric people showed less fading affect bias (Walker, Skowronski, Gibbons, Vogl, & Thompson, 2003). This relationship between mild depression and negative episodic simulation implies that an effective measure of procrastination would also depend on individual differences.

Besides investigating an effective way to reduce the degree of delay neutralization of negativity, the present study also brings up a question of whether the congruency of the valence that is neutralized over time

and the valence being imagined is pivotal in reducing temporal neutralization. Our results have shown that positive future thinking had no significant difference from the absence of future thinking at all. It is rather surprising that we did not observe a difference. There are two possibilities. If it is congruency that matters, the gratification of delayed rewards should benefit more from positive future thinking compared to negative thinking. However, it is possible that the negative valence of future thinking itself has a stronger effect, regardless of what is being neutralized. The congruency issue would be an interesting topic for a future study to explore with factorial design, based on the results of the present study.

In addition, as our study did not directly compare future thinking condition to no future thinking condition with the same valence, it is possible the mood that arose from future thinking may have played a role. It is worth investigating further if manipulation of mood alone can have similar effects. In a similar vein, a control condition with neutral future thinking would also help to explain the results further.

Nonetheless, the current study has demonstrated that the neutralization of delayed negativity can be an underlying mechanism of procrastination and that thinking about negative future events can prevent short-sighted decisions to put off high-priority work.

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