Time-Construal Associations and Functional Outcomes: Examining the Relationship between Time-Construal Associations, Well-Being, Self-Control, and Time Travel

THESIS

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Abstract

This research examines if associations between temporal distance/high-level construal can have functional outcomes. Construal-Level Theory (CLT; Trope & Liberman, 2010) suggests that people think about distant time abstractly. This means that people think about the essential, prototypical features of a distant event. People are able to draw upon the representations they have developed from past experiences to form general expectations for a future event. This is functional because it enables people to prepare for an event even without specific details. When people repeatedly use high-level construal to think about distant time, an association between temporal distance and high-level construal forms. Thus, time-construal associations should be indicative of people’s tendency to think about distant time in a high-level way. This association between temporal distance and high-level construal should form when people think about both the past and the future. We examine if the strength of association between high-level construal/temporal distance varies for past vs. future time in both of our experiments. In both experiments, there was no difference for past vs. future in association strength when using a reaction time-based measure of association strength. However, the association between high-level construal and temporal distance was stronger in the future when using an error-based measure of association strength.

We also suggest that if people are able to think about distant time, they should be able to plan for their goals. This suggested self-regulatory function should help people to
attain high well-being. When people are able to plan for their goals, they should be more likely to achieve them and feel hopeful and satisfied with their lives. When people successfully reach their goals, they should experience an increase in self-efficacy and better well-being. When people are unable to achieve their goals, they are likely to ruminate on their failures and develop depression. Time-construal associations should also be related to self-control to the extent that people mental time travel to pursue their long-term goals and resist short term temptations. Lastly, time-construal associations should be related to the tendency to directly think about distant time.

We test these hypotheses in two experiments. In Experiment 1, we found that time-construal associations (as assessed by a reaction time-based measure of association strength) were related to decreased depression and rumination, but increased hope and life satisfaction. When we used an error-based measure of association strength, we found that the association between temporal distance/high-level construal was related to reduced depression. In Experiment 2, the reaction time-based measure of association strength was related to an increased ability to consider future consequences and a decreased present time orientation. We did not find the well-being relationships with association strength in Experiment 1. When we used the error-based measure of association strength, we found that the association between temporal distance/high-level construal was related to reduced hope and the association between temporal proximity/low-level construal was related to increased rumination. We have preliminary evidence from Experiment 1 that time-construal associations are functional, but future research is needed on this topic.
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Time-Construal Associations and Functional Outcomes: Examining the Relationship Between Time-Construal Association, Well-being, Self-Control, and Time Travel

People often report engaging in mental time-travel. We broadly define mental time-travel as the act of orienting oneself towards the past or future by removing oneself from the present to think about distant time. When people are deciding which activities to pursue, they often consider their future goals. For example, thinking about the future can help people to achieve their goals by planning for the future (Oettingen, Pak, & Schnetter, 2001). Oettingen and colleagues found that when people thought about a desired future state, they felt moderate goal commitment as assessed by increased cognitive effort (e.g. making plans to achieve the goal), affective responses to the goal (e.g. feeling disappointed if they believed they did not achieve the goal), and behavioral measures of working towards the goal (e.g. immediacy of acting to achieve the goal). Similarly, Brown, MacLeod, Tata, and Goddard (2002) found that when women imagined a positive future scenario, they felt that the positive outcome was more likely and they felt less worry. When people think about negative events from the past, they tend to distance themselves from their past experiences so that they can maintain positive self-regard. When they think of past events that were positive, however, people tend to think that these events are subjectively closer. This is particularly true of people with
high self-esteem (Ross & Wilson, 2002). Other research demonstrates that mental time-
travel can improve self-regulation (Daniel, Stanton, & Epstein, 2013; Hershfield, et al.,
2011; Maglio, Trope, & Liberman, 2013; Peters & Buchel, 2010). Clearly, there are
positive outcomes to thinking about the past and future.

**Mechanism**

Although research suggests that it is beneficial to think about the past and future,
the mechanism that enables people to mental time-travel has remained a topic of interest
over the years. Some researchers have suggested that people will use their past
experiences to construct representations of future events (Schacter & Addis, 2007).
Specifically, Schacter and Addis say that people have an ability to construct episodic
memories so that they can draw on their past memories to think about the future. The
constructive nature of episodic memories allows people to think about the future in a
flexible way by drawing on the most important elements of past experiences, rather than
an exact memory of the past. As such, people can simulate a future event using their
representations of their past experiences. Similarly, Gilbert and Wilson (2007) began to
examine how people engage in future-directed thought. These researchers discussed how
humans are able to predict hedonic rewards by simulating events in their minds. This is a
uniquely human ability because humans can simulate future events but experience
hedonic reactions to those hypothetical events in the present. Although animals can learn
reward contingencies, they cannot pre-experience a hedonic experience. These
researchers suggest that while it is sensible to use the past to think about the future, it is a
fallible process. We suggest that Construal-Level Theory, a theory on psychological
distance, (CLT; Trope & Liberman, 2010), may provide some insight into how people engage in mental time-travel.

**Construal Level Theory**

Construal-level theory examines the relationship between psychological distance and cognitive representation or construal (Liberman & Trope, 2008; 2014; Trope & Liberman, 2003; 2010). Psychological distance is the removal of an event from direct experience. There are four main kinds of psychological distance. Temporal distance is the distance between now and then or now and later. Spatial distance is the difference between here and there. Social distance can be explained as the distance between me and you or us and them. Lastly, hypothetical distance is the distance between what is real and what is only hypothetical. When an event is psychologically proximal, people are readily able to use information from their direct experience, such as the idiosyncratic details about their environment, to form detailed representations. However, when people want to think about an object or event that is psychologically removed from their present experience, they must find a way to use their stored representations to imagine this psychologically distant situation.

Because people cannot possibly know all of the details about psychologically distant events, they will think about the broad, generalized features of those events. This enables people to plan for an event even when they do not know all of the specific details. For example, when thinking about a vacation in a year, a person may picture sitting on a beach, but the person would be unable to know specific details about the vacation that far into the future. However, if this person is thinking about a vacation destination that he or
she is traveling to later that day, he or she would have more idiosyncratic details to construct his or her representation of the event. This is functional because people can update their knowledge to be as accurate and best-prepared as possible for the situation at hand. For example, the person may know what the weather forecast is like so that he or she can pack the appropriate clothing. This way of thinking about proximal events in idiosyncratic ways is called low-level construal. Because Construal-Level Theory provides us insight into how psychological distance and high-level construal are connected, it may provide us with a starting point to determine how people mentally time-travel.

A great deal of research has shown that people use high-level construal to represent distant events (Liberman & Trope, 2014; Trope & Liberman, 2010). For instance, people are more likely to categorize events that are distant into fewer, broader categories than proximal events (Liberman, Sagristano, & Trope, 2002). Additionally, people tend to identify behaviors as superordinate ends (“why”) instead of subordinate means (“how”) when they think about psychologically distant events (Liberman & Trope, 1998). Because high-level construal allows people to think about the essential, invariant elements of a distant event when they do not know specific details, it is thought to be functional for thinking about distance because it enables people to plan for an event but update their knowledge as more information comes available.

One finding from the CLT literature that showcases the relationship between distance and high-level construal is that people associate distance and construal level (Bar-Anan, Liberman, & Trope, 2006). This means that people tend to use high-level
construal when they think about distant time, but low-level construal when they think about near time. When people repeatedly pair two concepts (e.g. high-level construal and distance), an association develops. The more frequently that the concepts are paired, the stronger the association. In a series of studies, Bar-Anan and colleagues tested if people associate distance and high-level construal with the Implicit Association Test (IAT; Greenwald, Nosek, & Banaji, 2003). The IAT assesses the association strength between two concepts. When two concepts are paired, participants should be quicker and more accurate to respond when the responses are mapped onto the same key. Bar-Anan and colleagues asked participants to sort near time, distant time, abstract, and concrete stimulus words) into the appropriate categories (abstract vs. concrete and near vs. distant time) for the IAT. The researchers predicted that when distant time and abstract were mapped onto the same key, participants would be faster and more accurate to sort a given stimulus word. Bar-Anan and colleagues found that people possess time-construal associations whereby they associate distance with high-level construal and proximity with low-level construal.

**Construal-Level Theory and Functional Outcomes**

Other research has investigated if using high-level vs. low-level construal to think about the distant vs. near future and/or past is functional. Fujita, Darwent, Lazarus, and Cheavens (2015) tested whether time-construal associations might be able to predict maladaptive self-regulatory outcomes. In an initial test of this hypothesis, they examined whether these time-construal associations could predict depression, a disorder that some have suggested is rooted in poor self-regulation (Strauman, 2002). To the extent that
high-level construal is adaptive for mental time travel, not using high-level construal for these purposes may lead to poor planning and other self-regulation challenges, which in turn might promote goal failure and depression. Indeed, the researchers found that weaker associations between distance and high-level construal were related to an increased number of depressive symptoms. Moreover, they found that it was specifically the association between temporal distance and high-level construal, rather than the association between temporal proximity and low-level construal, that predicted depressive symptoms. From this, one might infer that people with depression may struggle to think about events in the distant past or future, or that when they do, the manner in which they think about these events is quite different from healthy individuals. This research was the first test of the idea that using high-level construal to think about the future has an impact on well-being.

Although this work began to test the functionality of time-construal associations, there are some issues that have yet to be addressed. One question that has been raised by this research is whether people think about the past more concretely than they think about the future. Some people may claim that people would think about the past more concretely relative to the future because they have specific details about their past experiences. However, no one has yet tested if the strength of association between high-level construal/temporal distance varies between the past and the future. All of the research that has been conducted on time-construal associations has used the Bar-Anan et al. (2006) IAT, which uses presents stimuli about both past and future to represent temporal distance vs. proximity. Adapting this paradigm so that temporal stimuli
represent exclusively the past vs. future may allow for more nuanced insight into the role of construal level in mental time travel both into the past and future.

Another question that comes up with this research is if time-construal associations are related to well-being outcomes beyond depression. Positive well-being may be the result of good self-regulation because people are able to think about, plan for, and achieve their goals. However, poor well-being may be a result of a failure to self-regulate, and thus a failure to achieve one’s goals. When a person continuously fails, he or she may develop depression or other poor well-being outcomes. Similarly, it is important to assess individual differences in self-regulation outcomes. This is important because if the researchers assessed these individual differences in self-regulation outcomes, they would be able to make stronger conclusions about how using high-level construal to think about distant events is functional. Lastly, it is important to assess individual differences in time travel.

The Present Research

In the present work, we have four main goals. First, we want to determine if people think about the past and future equally abstractly, or if they think of one dimension more abstractly than the other. Some researchers may predict that people would think about the future more abstractly because people lived through the past, but they have yet to experience the future. However, one could also predict that people would not think about the past and future differently because people think about distant time abstractly in general. This is an open question that we are hoping to address with our experiments.
Another goal of this research is to replicate the depression data of Fujita and colleagues (2015). If people have difficulty engaging in mental time-travel, they may not be able to achieve their goals, and thus may become depressed from repeated failure. We want to expand upon these well-being findings by including measures of hope, satisfaction, and rumination because we wanted to examine if time travel promotes good well-being. We are using a population of healthy individuals because we want to examine the time travel strategies of people who are good self-regulators. In this set of studies, we are assessing how associations between temporal distance and high-level construal can lead to positive well-being, such as hope and satisfaction. Similarly, we are examining how engaging in high-level construal to think about distant time can buffer people against poor well-being outcomes such as depression and rumination.

Additionally, we want to directly examine self-regulation. We hypothesize that time travel enables people to visualize their future goals and plan to achieve them. If this is the case, people should report having better self-control if they associate distance with high-level construal. We thus included two individual difference measures of people’s self-control, one based on self-report and the other on behavioral decisions (i.e., temporal discounting as assessed by intertemporal choice).

Lastly, we want to assess more directly whether time-construal associations helps people with time travel. We included a questionnaire to determine how people orient themselves in time (i.e. if people are present or future oriented). We expect that people who engage in high-level construal to think about the future would report being more future oriented. Similarly, we included a questionnaire to determine if people who use
high-level construal to think about the future would report being able to consider the consequences of their actions.

We test these hypotheses in two experiments. Experiment 1 examines the degree to which people associate temporal distance with high-level construal and temporal proximity with low-level construal with an IAT. We also examine whether these associations differ for the past vs. future. Additionally, Experiment 1 examines whether the use of high-level vs. low-level construal to mental time-travel relates to well-being and self-regulatory success. Experiment 2 also examines the degree to which people associate temporal distance/high-level construal and temporal proximity/low-level construal, but we used different stimuli for the IAT to be able to test whether our effects were specific to the stimuli that we used. Experiment 2 also introduced measures directly assessing people’s ability to mentally time-travel. We predicted that the strength of associations between temporal distance and high-level construal will predict improved well-being, self-regulation, and time-travel.

**Experiment 1**

In Experiment 1, we sought to examine time-construal associations in the past and future by manipulating past vs. future stimuli between-subjects. We used a high-level/low-level construal and distant/near time IAT to test the strength of associations between temporal distance and construal.

Additionally, we sought to test the premise that using high-level construal to think about psychological distance is functional. We hypothesize that using high-level construal to think about the future could be functional because it may help people to self-
regulate more effectively. High-level construal promotes self-control and goal-behavior consistency (Fujita, Trope, Liberman, & Levin-Sagi, 2006). If people are better able to self-regulate, they should be able to achieve their goals and report having more hope and greater life satisfaction on these outcome questionnaires. If people cannot achieve their goals, they will likely fall into a cycle of failure and depression. Similarly, people should be able to behave in ways consistent with their long-term goals. In our research, they should show improved performance on self-control. We use both a self-report and behavioral task to assess self-control. We predict that people who use high-level construal to think about distant time will show better well-being and better self-control.

Method

Participants. One hundred six participants at The Ohio State University participated for partial course credit. Two participants were later excluded for having error rates over 40% on the time-construal IAT (described in further detail below). Approximately 1/3 (N = 36) of participants did not finish the experiment because they were unable to complete the experiment within the allotted thirty minute time frame, so they did not complete gender, age, or ethnicity items. As a result, we do not report that demographic data. Additionally, not all participants were able to complete the well-being questionnaires. The number of participants that completed each questionnaire is reported in the materials and procedure section.

Materials and procedure.

IAT. Participants first completed an IAT that assessed the degree to which participants associate temporal distance and high-level construal (and temporal proximity
with low-level construal). When people repeatedly use high-level construal to think about distant time, an association between temporal distance and high-level construal develops. When participants completed the IAT, they were asked to sort a given stimulus into the appropriate category as quickly and accurately as possible. The IAT consisted of two stages. The first stage consisted of two practice blocks (40 trials each) and 80 critical trials. There were 40 trials that allowed participants to learn the abstract/concrete stimuli (abstract: broad, general, universal, generalized; concrete: specific, detailed, defined, particular) and the mapping of the abstract/concrete category labels. These category labels and specific stimuli were adapted from Bar-Anan and colleagues (2006). There were then 40 trials that allowed participants to learn the near/distant time stimuli (near future: tomorrow, later today, tonight; near past: yesterday, earlier today, last night; distant future: next year, 2025, future; distant past: last year, long ago, 2000) and the mapping of the near/distant time category labels. There were two between-subjects time conditions in our experiment, past vs. future time. Participants in the future condition saw near and distant future time words. The participants in the past condition saw near and distant past time words. We did not include error feedback in the practice trials.

In the subsequent 80 critical trials, both sets of category labels (abstract vs. concrete and near vs. distant time) were presented at the top of the screen and participants were asked to sort all four types of stimuli (abstract, concrete, near time, distant time) into the appropriate categories. We counterbalanced IAT order so that half of the participants saw compatible critical trials in stage 1 (abstract/distant and concrete/near pairings). Half of the participants responded to abstract or distant words using the “F”
key and concrete or near words using the “J” key. The other half of participants responded to abstract or near words using the “F” key and concrete or distant words using the “J” key (incompatible pairing). When the compatible responses are mapped onto the same key, participants should be faster and more accurate when they are asked to sort the stimuli.

Stage 2 of the IAT is similar to stage 1, except that there is one practice block of 40 trials and 80 critical trials. This practice block allowed participants to familiarize themselves with the new key mapping of the near/distant time category. If near time was on the left (right) of the screen in stage 1, it would appear on the right (left) side of the screen in stage 2. The mapping of the abstract/concrete category remained the same, so participants did not practice this category mapping. Participants then completed the final 80 critical trials. If participants completed compatible (incompatible) critical trials in stage 1, they completed incompatible (compatible) critical trials in stage 2.

**Depression (BDI).** Following the IAT, participants completed a series of questionnaires. Participants (N = 100) completed a series of well-being questionnaires to assess their ability to self-regulate. Participants first completed the Beck Depression Inventory to assess depressive symptoms (BDI: α = .88, Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). For this scale, participants were asked to select the statement that best described them. A sample question that participants would be asked is “I do not feel sad, I feel sad, I am sad all the time and I can’t snap out of it.”

**Rumination (SRSQ).** We assessed rumination in our studies in addition to depression because rumination may be linked to time travel. Specifically, rumination may
be a sign of poor planning and not effectively considering alternative possibilities. When people are not able to plan, they may not able to achieve their goals, which in turn may promote rumination. As a measure of rumination, participants \(N = 68\) then completed the Short Response Styles Questionnaire (SRSQ; \(\alpha = .92\), Nolen-Hoeksema & Morrow, 1991), which asked participants to rate their agreement with statements such as “I think about a recent situation wishing it had gone better.”

**Satisfaction with life.** Participants \(N = 72\) also completed the Satisfaction with Life scale \(\alpha = .89\), Diener, Emmons, Larsen, & Griffin, 1985). This scale asks participants to rate their agreement on various statements such as “On the whole, I am satisfied with my life right now.”

**Hope.** Similarly, participants \(N = 93\) completed the State Hope Scale \(\alpha = .86\), Snyder, Sympson, Ybasco, Borders, Babyak, & Higgins, 1996) which assesses participants’ beliefs about their ability to achieve their goals in the future (agency) and their ability to generate work around obstacles and challenges (pathways). They rated their agreement to statements such as “If I should find myself in a jam, I could think of many ways to get out of it.”

**Self-control.** Finally, participants completed two self-control measures. Participants completed a temporal discounting task as a measure of self-control (Kirby, Petry, & Bickel, 1999), which assessed preferences for prefer $30 now or some larger amount one month from now. The dollar amount that participants were asked if they would prefer a month from now increased by $5 increments starting at $30 and went up to $100 \(N = 62\). Another measure that participants \(N = 81\) completed to assess self-
control was the Rosenbaum Self-Control Schedule ($\alpha = .87$, Rosenbaum, 1980). A sample question on this scale is “When I do a boring job, I think about the less boring parts of the job and about the reward I will receive when I finish.” After completing these questionnaires, participants filled out demographic information and were fully debriefed.

**Results**

**Evidence of associations based on reaction times.** We first computed the strength of participants’ associations between temporal distance and construal by using the improved D-scoring algorithm for the IAT (Greenwald, Nosek, & Banaji, 2003). We used a 600 ms penalty for incorrect responses. To determine if our participants have associations between temporal distance and high-level construal (vs. temporal proximity and low-level construal) as hypothesized, we conducted a one-sample t-test to examine whether these D-scores significantly differed from 0. We found that this was the case, $t(103) = 5.40, p < 0.001$ ($M = 0.22, SD = 0.41$). This result demonstrates that people do have time-construal associations, replicating Bar-Anan and colleagues (2006).

Additionally, to test whether these time-construal associations were stronger in the past vs. the future condition, we conducted a 2 (order: incongruent vs. congruent critical trial first) X 2 (time: past vs. future) between-subjects ANOVA with the D-scores as the dependent variable. We observed a typical order effect, $F(1, 100) = 20.36, p < 0.001$, such that participants in the congruent critical block first condition ($M = 0.38, SD = 0.37$) had stronger associations than participants in the incongruent critical block first condition ($M = 0.04, SD = 0.37$). The main effect of time was not significant $F(1, 100) = 0.31, p = 0.58$ (see Table 1). This suggests that associations between temporal distance
and high-level construal (vs. temporal proximity and low-level construal) are symmetrical in the past and future. We also did not find an interaction between time and IAT order $F(1, 100) = 0.07, p = 0.79$.

**Well-being and regulatory outcomes (reaction times).** We wanted to test if the strength of time-construal associations was related to well-being and self-regulation. To do this, we used multiple regression and regressed participants’ responses to the various well-being and self-regulation questionnaires on time, D-scores, IAT order, and the interaction between time and D-scores. In what follows, we do not report the effects of time, IAT order, or the interaction of these variables unless they were significant as we did not make any predictions for these effects. See Table 2 for a summary of the simple effects of D-scores on well-being and regulatory outcomes. See Table 3 for a summary of the correlations between the outcome measures.

**Depression (BDI).** We did not find the predicted effect of D-scores on depression as assessed by the BDI, $b = -3.04, SE = 2.07, t(95) = 1.47, p = 0.14$. The direction of this finding, however, is consistent with past research that participants with stronger time-construal associations report fewer depressive symptoms (Fujita et al., 2015).

**Rumination (SRSQ).** We found a marginally significant effect of D-scores on rumination tendencies as assessed by the Short Response Styles Questionnaire, $b = -0.44, SE = 0.24, t(63) = 1.81, p = 0.08$. Mirroring our findings with depression, participants with stronger time-construal associations reported fewer ruminative tendencies.
**Life satisfaction.** We also found an effect of D-scores on life satisfaction, $b = 0.97$, $SE = 0.46$, $t(67) = 2.09$, $p = 0.04$, such that participants with stronger time-construal associations reported greater life satisfaction. This finding is consistent with our hypothesis that people with the ability to mental time-travel should be able to plan for and achieve their goals, thus feeling more satisfied with their lives overall.

**Hope.** Consistent with the findings above, we also found an effect of D-scores on hope, $b = 0.87$, $SE = 0.32$, $t(88) = 2.72$, $p = 0.01$, such that participants with stronger time-construal associations reported feeling more hope. Surprisingly, there was a significant time by D-scores interaction, $b = -0.62$, $SE = 0.29$, $t(88) = 2.09$, $p = 0.04$. This interaction is shown in Figure 1. We probed the interaction to examine the relationship between D-scores and hope within each time condition. The effect of D-scores on hope scores was significant for people who associated the distant (vs. near) past with high-level (vs. low-level) construal, $b = 1.48$, $SE = 0.51$, $t(88) = 2.93$, $p = 0.004$, but not people who associated the distant (vs. near) future with high-level (vs. low-level) construal, $b = 0.25$, $SE = 0.35$, $t(88) = 0.73$, $p = 0.47$. This finding suggests that for the people with strong time-construal associations, only those who associated the distant past with high-level construal reported feeling more hopeful.

When we probed this same interaction looking at the effect of time on hope at plus or minus 1 SD from the mean D-score, we found that there was no effect of time for people 1 SD below the mean $b = 0.22$, $SE = 0.16$, $t(88) = 1.34$, $p = 0.19$. However, there was a marginally significant effect at 1 SD above the mean $b = -0.28$, $SE = 0.17$, $t(88) = 1.71$, $p = 0.09$, such that people with associations between the distant past and high-level construal reported feeling more hopeful.
construal reported more hope than people who associated the distant future with high-
level construal. This finding was unexpected in that we would expect people who
generally think about distant future time abstractly would be more hopeful. We especially
did not expect that people who had strong associations between the distant past and high-
level construal would be more hopeful than people with strong associations between the
distant future and high-level construal. This finding may have occurred because hopeful
people may think abstractly about their past successes and this makes them believe that
they should be hopeful for their futures. We elaborate on this issue in the Discussion.

*Self-control.* To assess the effect of D-scores on self-control, we first had to
calculate discounting rates (Weber, et al., 2007). To calculate these rates, we determine at
what magnitude of the delayed reward people switch from preferring a larger amount of
money they would receive in the distant future to preferring a smaller amount of money
they would receive immediately. The larger the switch number, the less people discount
the value of the dollar. We then put the switch point into a discounting equation, \( \delta = (x_1/x_2)^{(1/(t_2-t_1))} \). \( X_1 \) is the amount of money that a person could receive immediately, and
\( x_2 \) is how much money the person could receive in 3 months. The \( t_1 \) value stands for the
first time point (“now“, so \( t_1=0 \)), and the \( t_2 \) value stands for 3 months from now. The
output from this function is the amount that a future dollar is worth today. For example,
1.00 means that $1 a month from now is worth $1 today and .50 means that $1 a month
from now is worth $0.50 today. This means that higher numbers are good for self-control.
There was no effect of D-scores on discount rates from neither the temporal discounting task nor the Rosenbaum Self-Control Scale. This is surprising because we expected that the ability to mental time-travel would lead to better self-control.

**Error rate analysis (PDP).** We also conducted a process dissociation procedure (PDP; Jacoby, 1991) to analyze error rates on the IAT rather than reaction times. A process dissociation approach suggests that responses in the IAT result from a combination of associative and more task-directed responses – the latter referring to the correct identification of stimuli. PDP allows us to estimate the contribution of each of these responses to participants’ performance (referred to as the A and C parameters, respectively). Estimating the A parameter may provide a cleaner signal with respect to the strength of participants’ time-construal associations in that it isolates the impact of the association from corrective processes. The second benefit of using PDP is that it allows us to estimate to what extent time-construal associations are being driven independently by the association between temporal distance and high-level construal (A-distant parameter estimate) or the association between temporal proximity and low-level construal (A-proximal parameter estimate).

Highlighting the benefits of PDP procedures, Fujita et al. (2015) not only found that the A parameters of a time-construal IAT were correlated with more traditional D-scores, but that it was the A-distant parameter estimate (temporal distance/high-level construal association) that predicted depressive symptoms, not the A-proximal parameter estimate (temporal proximity/low-level construal association). To see if such effects were replicated in the present work, we calculated C parameters by subtracting the probability
of obtaining an incorrect response on an incompatible trial from the probability of obtaining a correct response on a compatible trial. The A parameters are calculated by dividing the probability of getting a response incorrect on an incompatible trial by the C parameters. We calculated the A-proximal parameter estimate by dividing the probability of obtaining an incorrect response on an incompatible trial (temporal proximity mapped with high-level construal) by the C-proximal parameter. We calculated the A-distant parameter estimate by dividing the probability of obtaining an incorrect response on an incompatible trial (temporal distance mapped with low-level construal) by the C-distant parameter.

On the basis of past research (Fujita et al., 2015), we predicted that the A-distant parameter estimate would be negatively correlated with depression and rumination, but positively correlated with hope, satisfaction, self-control, and temporal discounting. It was less clear what to expect for the A-proximal parameter estimate, but we decided to include it in our analyses in case the associations were being driven by near time and low-level construal.

We found that the A-proximal parameter estimate significantly correlated with the D-scores, \( r = 0.27 \), \( p = 0.01 \). The A-distant parameter estimate also significantly correlated with D-scores, \( r = 0.22, p = 0.03 \). These results suggest that the reaction time-based measure of association strength is related to the error-based method of association strength. When we compared the A-distant parameter estimate against .50 (chance probability), we found that the A-distant parameter estimate was significantly higher than .50, \( t(105) = 3.61, p < 0.001 \) (\( M = 0.57, SD = 0.19 \)). When we compared the A-proximal
parameter estimate against .50, we found that the A-proximal parameter estimate was significantly higher than .50, $t(105) = 2.52, p = 0.01 (M = 0.55, SD = 0.22)$. This means that participants had associations between temporal distance/high-level construal and temporal proximity/low-level construal, and these associations were stronger than would be predicted by chance. Additionally, we compared the A-proximal parameter estimate and A-distant parameter estimate against each other as a function of time to see if the strength of associations for the past vs. the future differed from one another. We find that associations are marginally stronger in the future than in the past, $F(1, 99) = 3.44, p = 0.07$ (see Table 1).

We regressed participants’ responses to the various well-being and self-regulation questionnaires on time, A-distant parameter estimate scores, IAT order, and the interaction between time and A-distant parameter estimate scores. We conducted parallel analyses regressing participants’ responses to the various well-being and self-regulation questionnaires on time, A-proximal parameter estimate scores, IAT order, and the interaction between time and A-proximal parameter estimate scores. We do not report time, IAT order, or interaction effects unless they are significant since we do not make any predictions for these variables. See Table 2 for a summary of simple effects of A-parameter estimates on well-being, self-control, and time travel measures.

**Depression (BDI).** When examining the BDI as an assessment of depression, we found a marginally significant effect of A distant parameter estimate, $b = -7.36, SE = 4.40, t(92) = 1.83, p = 0.07$ on depression. This finding is consistent with past research (Fujita et al., 2015) demonstrating that participants who have strong associations between
temporal distance and high-level construal report fewer depressive symptoms. It also parallels our findings with D-scores. We did not find an effect of A-proximal parameter estimate, \( b = 0.49, SE = 3.63, t(92) = 0.14, p = 0.89 \).

Surprisingly, we also found a marginally significant interaction between A-proximal parameter estimate and time, \( b = 6.07, SE = 3.34, t(92) = 1.82, p = 0.07 \). This interaction is shown in Figure 2. We probed the interaction to examine the relationship between the A-proximal parameter estimate and depression within each time condition. The effect of A-proximal parameter estimate was weaker when people associated the near past with low-level construal, \( b = -5.58, SE = 4.89, t(92) = 1.14, p = 0.26 \), than when people associated the near future with low-level construal, \( b = 6.56, SE = 4.98, t(92) = 1.32, p = 0.19 \). This finding suggests that for the people with strong low-level construal/proximity associations, those who associated the near future with low-level construal reported feeling more depressed than people with weak temporal proximity/low-level construal associations. Additionally, when we probed the interaction at plus or minus 1 \( SD \) from the mean A-proximal parameter estimate, we found that there was no effect of time for people 1 \( SD \) below the mean \( b = -0.42, SE = 1.05, t(92) = 0.40, p = 0.69 \), but a marginally significant effect for people 1 \( SD \) above the mean \( b = -2.30, SE = 1.07, t(92) = 2.15, p = 0.04 \), such that people who associated near future with low-level construal reported more depression than people with weak near time/low-level construal associations. Perhaps thinking about the near future in a low-level way may be related to depression because people may think that their future will be no better than the present.
**Rumination (SRSQ).** There was no effect of A-distant parameter estimate or A-proximal parameter estimate on rumination tendencies as assessed by the Short Response Styles Questionnaire. These findings do not support our hypothesis because we were expecting A-distant parameter estimate to be negatively related to rumination. Additionally, these findings do not parallel those we found when we examined D-scores.

**Life satisfaction.** There was no effect of A-distant parameter estimate or A-proximal parameter estimate on satisfaction. These findings are not consistent with our hypotheses, nor do they replicate our D-score results.

**Hope.** There was no effect of A-distant parameter estimate or A-proximal parameter estimate on hope. These findings are not consistent with our hypothesis because we expected that people who have strong distance-high-level construal associations would report greater well-being as assessed by the hope scale than people with weak associations. Similarly, these findings do not parallel what we found when we looked at D-scores.

Surprisingly, there was a significant time by A-proximal parameter estimate interaction, $b = -1.48$, $SE = 0.54$, $t(85) = 2.74$, $p = 0.01$. This interaction is shown in Figure 3. We probed the interaction to examine the relationship between the A-proximal parameter estimate and depression within each time condition. The effect of low-level construal/proximity associations on hope scores was significant when participants associated the near past with low-level construal, $b = 1.54$, $SE = 0.79$, $t(85) = 1.96$, $p = 0.05$, but weaker (and in the opposite direction) when participants associated the near future with low-level construal, $b = -1.42$, $SE = 0.80$, $t(85) = 1.78$, $p = 0.08$. This finding
suggests that for the people with strong low-level construal/proximity associations, those who associated temporal proximity with low-level construal in the past, felt more hopeful than people who associated temporal proximity with low-level construal in the future. Additionally, when we probed the interaction at plus or minus 1 $SD$ from the mean of the A-proximal parameter estimate, we found that there was a significant effect of time for people 1 $SD$ above the mean, $b = -0.37, SE = 0.17, t(85) = 2.20, p = 0.03$, but a marginally significant effect for people 1 $SD$ below the mean $b = 0.29, SE = 0.17, t(85) = 1.72, p = 0.09$, such that people with strong low-level construal/proximity associations felt more hope when they associated the near past with low-level construal and people with weak low-level construal/proximity associations felt more hope when they associated the near future with low-level construal. Speculatively, people who have strong associations between the near past and low-level construal may be more hopeful than people with weak associations because these people may be able to vividly re-experience their past successes, which in turn may make them feel more hopeful.

**Self-control.** There was no effect of time, A-distant parameter estimate, A-proximal parameter estimate, or the 2-way interactions on the temporal discounting task. Lastly, we did not find an effect of time, A-distant parameter estimate, A-proximal parameter estimate, nor the 2-way interactions on the Rosenbaum Self-Control Scale. The lack of any significant relationships between time-construal associations and self-regulation outcomes when the former is assessed by errors parallels the lack of any relationships when the associations are assessed by reaction times (D-scores). This was unexpected, and elaborated upon further in the Discussion.
Discussion

In Experiment 1, we found that people do associate temporal distance and high-level construal, replicating Bar-Anan and colleagues (2006). Specifically, we found that people associate distant time with high-level construal and proximal time with low-level construal. We also found that these associations do not seem to vary between past and future time when examining the reaction time-based measure of association strength. This means that people do not have stronger associations between the distant future and high-level construal than between the distant past and high-level construal. There was a marginal difference of time when examining the error-based measure of association strength such that associations between temporal distance and high-level construal were marginally stronger for the future vs. past.

We also found that our reaction time measure of association strength (D-scores) was related to well-being. We found that when people had strong associations between temporal distance and high-level construal, they showed less rumination and less depression. This finding replicates Fujita and colleagues’ (2015) work. Similarly, we found that strong associations between temporal distance and high-level construal were associated with more hope and life satisfaction. These findings helped us to expand upon the work done by researchers on the linkage between time-construal associations and well-being. Unexpectedly, we found an interaction between time and D-scores on hope such that for people with strong time-construal associations, only those who associated the past with high-level construal reported feeling more hopeful.
However, we did not find a relationship between D-scores and self-control measures in this experiment. This may be because self-control may represent a particularly unique type of self-regulation challenge. In a self-control conflict, people are presented with a proximal temptation that interferes with the pursuit of a distal goal. The proximity of the temptation evokes low-level construal, yet successful self-control may require instead high-level construal (Fujita & Carnevale, 2012). Thus, having strong temporal distance/high-level construal associations may hurt some in that it “locks” people into low-level construal when presented with proximal temptations. By contrast, these same strong associations may help others in their self-control efforts in that when they think about their distal goals, they engage in high-level construal. More research may be necessary to unpack the relationship between time-construal associations and self-control outcomes.

We did not find that PDP scores related to many of the well-being and self-regulation outcomes that D-score associations were related to. The only predicted effect we found was that the A-distant parameter estimate parameter estimate was related to reduced depressive symptoms. This finding is consistent with our hypothesis and Fujita and colleagues’ (2015) work. There was no effect of A-distant parameter estimate or A-proximal parameter estimate on hope, rumination, or life satisfaction.

We also found a number of unexpected interactions between time and A-proximal parameter estimate when we looked at our depression and hope questionnaires. For example, we found that when people have strong low-level construal/proximity associations in the past, they report feeling less depressed, but this is not the case when
people have weak low-level construal-near time associations. Additionally, we found that people with strong low-level/proximity associations, those who associated the near past with low-level construal, felt more hopeful than people who associated the near future with low-level construal. We did not predict these interactions, and we especially did not expect that these well-being outcomes would be related to the tendency to associate proximity with low-level construal.

It is important to note we did not find many parallels D-scores and PDP. For example, we did not find that the A-distant parameter estimate was related to rumination, hope, or life satisfaction, although D-scores were. We did find that the association between temporal distance and high-level construal was related to lower levels of depressive symptomology. This finding replicates the work of Fujita and colleagues (2015). We also found an interaction between D-scores and time on hope and between the A-proximal parameter estimate and time on hope. We find that people with strong D-scores report more hope when they associate the distant past vs. distant future with high-level construal, and people with weak A-near parameters report more hope when they associate the near past vs. near future with low-level construal. These findings appear consistent in that people who associate the distant past with high-level construal either directly or by having weak associations with the near past and low-level construal have more hope. One reason for the lack of consistency between D-score and PDP analyses, and the appearance of unexpected interactions between the parameter estimates and time conditions, may be due to poor reliability of the PDP estimates. When completing the IAT, people may not have made systematic errors to incompatible vs. compatible trials,
but rather made errors of miscomprehension. That is, analysis of error rates during our practice trials suggested that some participants may have simply had trouble categorizing stimuli into the appropriate categories because they did not know what stimuli were abstract and what stimuli were concrete. Supporting this assertion, the data revealed that participants more errors when they were asked to categorize stimuli as abstract or concrete (average error rate was 16%) than when they were asked to categorize stimuli as near or distant time (average error rate was 8%). This type of error would be less impactful on a reaction time-based measure of association strength, but it would change the way that we interpret an error-based measure of association strength.

In Experiment 2, we sought to replicate the findings of Experiment 1 by using another version of the IAT. Specifically, we are going to use a category/exemplar IAT as another way to assess high-level vs. low-level construal. Having people think about broad, superordinate categories makes them engage in high-level construal, whereas having them think about specific exemplar makes them engage in low-level construal. Using a new version of a time-construal IAT would allow us to reduce the likelihood that participants make errors from not understanding the stimuli. Instead, errors should be driven by their associations.

Another issue in Experiment 1 was that approximately one third of participants were unable to answer outcome questionnaires, self-control measures, and demographic questions due to time constraints. This is important to address because we may not have had enough statistical power to detect if time-construal associations impacted well-being and self-regulation. With a larger sample, we may be able to more convincingly
demonstrate that time-construal associations are related to well-being and self-regulation. We extended the length of the experiment to ensure that participants had enough time to complete the self-report questionnaires following the IAT.

We also doubled the size of the blocks for the IAT to gather more data points. We thought that we may find stronger D-scores if we included more data points. Specifically, adding more trials would help us with the reliability and precision of the association strength. This is important because if we are able to reduce random noise in our data, we may be able to find a stronger impact of time-construal associations on well-being and self-regulation. Lastly, we included new time travel measures, and we predicted that time-construal associations would be positively related to the ability to mental time-travel.

**Experiment 2**

We conducted Experiment 2 as a follow up to Experiment 1 using the category/exemplar IAT. Additionally, we wanted to test more directly the ability to mental time-travel using questionnaires directly related to thinking about the future. Specifically, we included a measure to assess participants’ orientation in time (i.e. if they are oriented toward the present or the future). We also included a measure to assess participants’ likelihood of considering the future consequences of their actions. We predict that we will replicate our findings with the well-being and self-regulation questionnaires from Experiment 1, and that the new time-travel questionnaires will be positively correlated with time-construal associations.

**Method**
Participants. Two hundred forty-five participants at The Ohio State University participated for partial course credit. Participants ranged in age from 18 to 49 ($M = 19.16$, $SD = 2.25$). There were 119 males, 125 females, and 1 participant who preferred not to answer this question. There were 187 White/Caucasian participants, 8 African-American participants, 9 Hispanic/Latino participants, 3 Middle-Eastern participants, 35 Asian participants, and 3 participants who identified as “Other”.

Materials and procedure. Participants first completed a time-construal IAT. We again manipulated time past vs. future as in Experiment 1. We also used the same time words as in Experiment 1. However, we changed the high-level vs. low-level stimuli. To assess high-level construal, we used category-level stimuli (vegetables, animals, clothes, food, furniture), and to assess low-level construal we used exemplar-level stimuli (beet, Poodle, belt, Sprite, hammer). Bar-Anan and colleagues (2006) similarly used category and exemplar stimuli in their test of time-construal associations. We also changed the time-construal IAT from Experiment 1 by doubling the number of trials in every practice and critical block from 40 to 80 and every critical block from 80 to 160.

Following the IAT, participants again completed a series of questionnaires. Participants completed the same well-being and self-regulation questionnaires that were used in Experiment 1. We also added additional questionnaires to more directly assess the relation between time-construal associations and temporal distance travel. Participants completed the Stanford Time Perspective Inventory-Short Form. The Stanford Time Perspective Inventory-Short Form ($\alpha = .60$, D'alessio, Guarino, De Pascalis, & Zimbardo, 2003) determines how people are oriented in time, for example if people are focused on
future rewards or enjoying the present moment. There are two subscales in the short form, a present orientation subscale and a future orientation subscale. A sample question on the present orientation subscale is “I try to live my life as fully as possible, one day at a time.” A sample question on the future orientation subscale is “Meeting tomorrow's deadlines and doing other necessary work come before tonight's play.” They also completed the Consideration of Future Consequences scale (α = .82, Strathman, Gleicher, Boninger, & Edwards, 1994), which shows the degree to which participants are able to consider the outcomes of their decisions and actions. For example, participants would be asked to rate their agreement on a statement such as “I consider how things might be in the future, and try to influence those things with my day to day behavior”. After completing these questionnaires, participants filled out demographic information and were fully debriefed.

**Results**

**Evidence of associations based on reaction times.** To determine if our participants have associations between temporal distance and high-level construal, we conducted a one-sample t-test on calculated D-scores to examine if participants’ associations were significantly different from 0. We found that this was the case, \( t(244) = 7.24, p < 0.001 \) (\( M = 0.15, SD = 0.32 \)). Additionally, we were interested to see if these time-construal associations as assessed by D-scores were stronger in either the past vs. the future. We conducted a 2(order: incongruent vs. congruent critical trial first) X 2(time: past vs. future) ANOVA with the D-scores as the dependent variable. There was a significant order effect as is often seen in IAT experiments, \( F(1, 241) = 74.57, p < 0.001, \)
such that participants in the congruent critical block first condition had stronger associations \((M = 0.28, SD = 0.29)\) than participants in the incongruent critical block first condition \((M = -0.03, SD = 0.26)\). The main effect of time was not significant, \(F(1, 241) = 1.19, p = 0.28\), replicating our finding that associations for the past and future are symmetrical (see Table 4). The interaction between time and IAT order was also not significant, \(F(1, 174) = 0.28, p = 0.60\).

**Well-being and regulatory outcomes (D-scores).** We regressed participants’ responses to the various well-being questionnaires on time, D-scores, IAT order, and the interaction between time and D-scores. We do not report time, IAT order, or interaction effects unless they are significant since we do not make any predictions for these variables. See Table 5 for a summary of simple effects of D-scores on well-being, self-control, and time travel measures. See Table 6 for a summary of the correlations between the outcome measures.

**Depression (BDI).** Although directionally consistent, we did not find any significant effects of D-scores, \(b = -0.20, SE = 1.54, t(240) = 0.13, p = 0.90\) with BDI scores. These findings did not replicate the findings from Experiment 1 and are not consistent with our hypothesis that people with strong time-construal associations should report fewer depressive symptoms as a result of their tendency to mental time-travel.

**Rumination (SRSQ).** We did not find any significant effects D-scores, \(b = 0.06, SE = 0.15, t(239) = 0.42, p = 0.68\) on rumination. These findings are not consistent with our previous findings or our hypothesis. We were expecting that people who had strong time-construal associations to report less rumination.
**Life satisfaction.** We did not find any significant effects of D-scores, $b = 0.40$, $SE = 0.28$, $t(239) = 1.44$, $p = 0.15$, on life satisfaction. These findings did not replicate our findings from Experiment 1. We hypothesized that people who have strong time-construal associations would feel greater life satisfaction because their ability to mental time-travel should help them to achieve their goals and feel more satisfied with their lives.

**Hope.** We did not find any significant effects of D-scores, $b = 0.33$, $SE = 0.27$, $t(240) = 1.20$, $p = 0.23$, on hope. There was, however, a significant interaction, $b = -0.52$, $SE = 0.24$, $t(240) = 2.16$, $p = 0.03$. This interaction is shown in Figure 4. We probed the interaction to look at the effects D-scores on hope in each time condition. As in Experiment 1, the effect of D-scores on hope scores was significant when people associated the distant (vs. near) past with high-level (vs. low-level) construal, $b = 0.84$, $SE = 0.35$, $t(240) = 2.43$, $p = 0.02$, but not when people associated the distant (vs. near) future with high-level (vs. low-level) construal, $b = -0.19$, $SE = 0.38$, $t(240) = 0.50$, $p = 0.62$. This finding suggests that using high-level construal to travel back in time appears to promote hope. Unexpectedly, this was not true of mental time travel into the future. Additionally, when we probed the interaction at plus or minus 1 SD from the mean, we found that time had an effect for people 1 SD below the mean, $b = 0.22$, $SE = 0.11$, $t(240) = 2.04$, $p = 0.04$, but not for people 1 SD above the mean, $b = -0.11$, $SE = 0.11$, $t(240) = -1.01$, $p = 0.31$. This pattern suggests that people with strong time-construal associations feel less hopeful than people with weak associations when they associate the distant future with high-level construal. These findings were not in line with
our predictions, but it does replicate our past findings. We predicted a simple effect such that people with strong time-construal associations would report feeling more hope than people with weak time-construal associations.

**Self-control.** We did not find an effect of D-scores, $b = 0.05, SE = 0.14, t(239) = 0.34, p = 0.74$, on self-control. Unexpectedly, however, we found a marginally significant effect of time on self-control scores as assessed by Rosenbaum’s (1980) scale, $b = -0.07, SE = 0.04, t(239) = 1.73, p = 0.08$, such that participants reported having better self-control in the past vs. future condition. It is not immediately apparent why exposure to words related to the past vs. future in an IAT would promote self-reports of self-control.

We did not find the predicted effect of D-scores on temporal discounting, $b = 0.06, SE = 0.07, t(240) = 0.93, p = 0.35$. There was, however, a significant interaction between time and D-scores, $b = 0.13, SE = 0.06, t(240) = 2.16, p = 0.03$. This interaction is shown in Figure 5. We probed the interaction to find the effect of D-scores on temporal discounting in each time condition. The effect of D-scores on temporal discounting scores was not significant when people associated the distant (vs. proximal) past with high-level (vs. low-level) construal, $b = -0.07, SE = 0.09, t(240) = 0.75, p = 0.45$, but it was significant when people associated the distant (vs. proximal) future with high-level (vs. low-level) construal, $b = 0.20, SE = 0.10, t(240) = 2.04, p = 0.04$. This finding suggests that it is associating the distant future with high-level construal that is associated with enhanced self-control. Additionally, when we probed the interaction at plus or minus 1 $SD$ from the mean, we found that time had an effect for people 1 $SD$ above the
mean, $b = 0.07$, $SE = 0.03$, $t(240) = 2.39$, $p = 0.02$, but not for people 1 SD below the mean, $b = -0.02$, $SE = 0.03$, $t(240) = -0.67$, $p = 0.53$. We did not expect the interaction to emerge. In the future condition, D-scores predict discounting. Although these data are not exactly what we predicted, they are not necessarily inconsistent. People with strong associations between distant future time and high-level construal may be the people who often think about their long term goals. If these people continuously think about and plan to achieve their goals, it makes sense that they would perform better on a self-control task relative to people with weak distant future/high-level construal associations.

**Time perspective.** We did not find any significant effects of D-scores, $b = 0.02$, $SE = 0.14$, $t(239) = 0.15$, $p = 0.88$, on the future-time orientation subscale of the time perspective inventory scale. We were expecting to find an effect of D-scores such that people with strong time-construal associations reported increased future time perspective.

Unexpectedly, we found an effect of time on present-time orientation, $b = 0.10$, $SE = 0.04$, $t(239) = 2.36$, $p = 0.02$, such that people who were in the future condition reported being more present time oriented. More consistent with predictions, we found a marginally significant effect of D-scores, $b = -0.28$, $SE = 0.15$, $t(239) = 1.84$, $p = 0.07$, such that stronger D-scores were associated with reduced present time orientation.

**Consideration of future consequences.** Additionally, we found a significant effect of D-scores on consideration of future consequences, $b = 0.41$, $SE = 0.15$, $t(239) =
2.76, \( p = 0.01 \), indicating that people with stronger time-construal associations report greater consideration of future consequences. This is in line with our predictions.

**Error rate analysis (PDP).** As in Experiment 1, we calculated A and C parameters (for both distant/high-level and near/low-level associations) using PDP. We found that the D-scores correlate significantly with A-near parameter estimate, \( r = 0.27 \ p < 0.001 \), and with A-far parameter estimate, \( r = 0.13, \ p = 0.05 \). This finding suggests that our reaction time-based measure of association strength is related to our error-based measure of association strength. When we compared the A-distant parameter estimate against \( .50 \) (chance probability), we found that the A-distant parameter estimate was significantly higher than \( .50, \ t(241) = 4.48, \ p < 0.001 \) \( (M = 0.55, \ SD = 0.18) \). When we compared the A-proximal parameter estimate against \( .50 \), we found that the A-proximal parameter estimate was significantly higher than \( .50, \ t(241) = 5.23, \ p < 0.001 \) \( (M = 0.57, \ SD = 0.21) \). Additionally, we compared the A-proximal parameter estimate and A-distant parameter estimate parameters against each other as a function of time to see if the strength of associations for the past vs. the future differed from one another. Contrary to our D-score findings, a 2 (within-subjects: A-distant parameter estimate vs. A-proximal parameter estimate) X 2 (between subjects: past time condition vs. future time condition) mixed ANOVA demonstrated that the time-construal associations were stronger in the future than in the past, \( F(1, 240) = 5.59, \ p = 0.02 \) (see Table 4).

We regressed participants’ responses to the various well-being questionnaires on time, A-distant parameter estimate scores, IAT order, and the interaction between time and A-distant parameter estimate scores. We also regressed participants’ responses to the
various well-being questionnaires on time, A-proximal parameter estimate scores, IAT order, and the interaction between time and A-proximal parameter estimate scores. We do not report time, IAT order, or interaction effects unless they are significant since we do not make any predictions for these variables. See Table 5 for a summary of simple effects of A-parameter estimates on well-being, self-control, and time travel measures.

**Depression (BDI).** When examining the BDI as an assessment of depression, we found no effect of A-distant parameter estimate or A-proximal parameter estimate on depression. These findings are not consistent with previous research (Fujita et al., 2015), nor the results from Experiment 1. This result parallels what we found with the D-score analysis from Experiment 2.

**Rumination (SRSQ).** There was no effect of A-distant parameter estimate on rumination tendencies as assessed by the Short Response Styles Questionnaire, $b = 0.34$, $SE = 0.25$, $t(236) = 1.32$, $p = 0.19$. There was a marginally significant effect of A-proximal parameter estimate on rumination, $b = 0.41$, $SE = 0.21$, $t(236) = 1.92$, $p = 0.06$. These findings suggest that people with strong near time/low-level construal associations ruminate more than people with weak low-level construal/proximity associations. We did not find this effect in our first experiment. Instead, we found that D-scores were related to reduce rumination tendencies. This effect also does not parallel what we found using the D-score analysis in Experiment 2 since we found no effect of D-scores on rumination. This effect may have emerged because when people who are unable to time travel, they are likely to remain immersed in the present. When people cannot think about their future
goals, they cannot plan to achieve these goals. Thus, rumination may be a result of poor time-travel and self-regulation.

**Life satisfaction.** There was an effect of A-distant parameter estimate on satisfaction such that stronger associations between temporal distance and high-level construal lead to less life satisfaction, $b = -1.25, SE = 0.46, t(236) = 2.70, p = 0.01$. We did not find an effect of D-scores on life satisfaction. There was also no effect of A-proximal parameter estimate on satisfaction, $b = -0.32, SE = 0.38, t(236) = 0.79, p = 0.43$. These findings are not consistent with our hypotheses, and are in the opposite direction of some of the findings in Experiment 1 in which we found a positive impact of D-scores on life satisfaction.

**Hope.** There was an effect of A-distant parameter estimate on the hope scale in the opposite direction of what we predicted, $b = -1.49, SE = 0.46, t(237) = 3.23, p = 0.001$, such that people with strong associations between temporal distance and high-level construal reported feeling less hopeful than people with weak associations. We did not find any effect of D-scores on hope, so this finding does not parallel those results. There was also no effect of A-proximal parameter estimate on hope, $b = 0.03, SE = 0.39, t(237) = 0.07, p = 0.95$. These findings are not consistent with our findings in Experiment 1 in which we found an effect of D-scores on hope. They are also not consistent with our hypothesis because we expected that people who have strong temporal distance/high-level construal associations would report more hope than people with weak associations.
**Self-control.** As with our D-score analyses, we found an unexpected marginally significant effect of time on self-control scores as assessed by Rosenbaum’s (1980) scale, $b = -0.07$, $SE = 0.04$, $t(236) = 1.73$, $p = 0.09$, such that participants reported having better self-control in the past vs. future condition. As we speculated in Experiment 1, perhaps the past condition reminded people of their prior self-control successes, thus contributing to this unexpected finding. Critically, we did not find an effect of A-distant parameter estimate nor A-proximal parameter estimate on self-control. This replicates the non-significant findings from our D-score analyses in the present experiment, as well as in Experiment 1.

We also did not find an effect of A-distant parameter estimate nor A-proximal parameter estimate on temporal discounting. We predicted that people with strong time-construal associations would be able to mentally time-travel and understand that the value of a dollar in the future is not worth less than the value of a dollar in the present. Our findings were not consistent with this prediction, but they were consistent with our results from Experiment 1, in which we did not find an impact of association strength on self-control when we used D-scores or PDP to assess association strength.

**Time perspective.** We did not find any significant effect of A-distant parameter estimate nor A-proximal parameter estimate on the future-time orientation subscale of the time perspective inventory scale. We were expecting to find an effect of time-construal associations such that people with strong temporal distance/high-level construal associations reported increased future time perspective. We also did not find an effect of A-distant parameter estimate nor A-proximal parameter estimate on present-time
orientation. Oddly, we did find an effect of time such that people who were in the future condition reported being more present time oriented, $b = 0.09, SE = 0.04, t(236) = 2.18, p = 0.03$. It is somewhat unclear how to interpret these findings.

**Consideration of future consequences.** We did not find a significant effect of A-distant parameter estimate nor A-proximal parameter estimate on consideration of future consequences. These are inconsistent with our D-scores findings, which suggested that these associations were related to an improved ability to consider future consequences.

**Discussion**

As in Experiment 1, regardless of whether the data were analyzed in terms of reactions times or error rates, Experiment 2 found evidence that people associate cognitive high-level construal with psychological distance. This again replicates the findings of Bar-Anan and colleagues (2006). Analysis of reaction times suggested that the strength of associations between past and future appeared to be symmetrical, replicating results from Experiment 1. However, unexpectedly, analysis of error rates suggested that the distant future (relative to the distant past) is associated more strongly with high-level construal.

We did not, however, replicate the relationship between these associations and measures of well-being and regulatory outcomes as in Experiment 1. Unlike Experiment 1, participants with strong associations between psychological distance and high-level construal as assessed by reaction times did not report any less rumination, less depression, more satisfaction with life, or more hope. We did find, however, that participants with strong time-construal associations (again, as assessed by D-scores) were
more likely to report that they considered the future consequences of their actions, and that they were less present-oriented. These findings are consistent with our hypothesis that people with strong time-construal associations should be better able to mental time travel and orient themselves toward the future. There was also a suggestion that these associations, at least when they were about the future rather than the past, predicted enhanced self-control, as assessed by temporal discounting.

These findings, however, were not replicated in our analyses of error rates. Indeed, many of the findings from the PDP analyses were difficult to interpret, and in some cases, opposite of what we might have predicted. We are somewhat hesitant to draw strong conclusions from the error rate analysis. Some of the unexpected findings and inconsistencies in data patterns may result from very low error rates. We designed Experiment 2 to reduce errors based on misclassifications of what represents high-level vs. low-level construal stimuli. However, we may have been too successful. Approximately 43% of participants (N = 108) made 5% errors or fewer. In Experiment 1, participants made 12% errors on average, but they only made 7% errors on average in Experiment 2. PDP requires that people make errors on each of the different types of trials (e.g. compatible category, incompatible category, etc.), but some of our participants did not made any errors on certain types of trials. This low error rate may have made it difficult for PDP, which is based on systematic errors, to assess association strength, leading to unreliable estimates.

Perhaps one way to reconcile the discrepant findings between Experiments 1 and 2 is the assessment of the time-construal associations. There were two notable changes.
First, we changed the stimuli representing high-level vs. low-level construal. Note that in Experiment 2, strength of association between temporal distance and construal was weaker relative to Experiment 1. The smaller effect size may have made it more difficult to find reliable relationships between the time-construal associations and our well-being and self-regulation measures. Second, in an attempt to increase the precision of our estimate, we increased the number of trials, making the IAT significantly longer in Experiment 2. This increased duration may have led to greater boredom and disengagement not only in the IAT itself, but also on subsequent measures in the experiment. This lack of engagement in turn may have led to less reliable measurement of our key variables.

**General Discussion**

Construal-Level Theory suggests that it is functional for people to think about distant events when using high-level construal. This is because specific details of the future are unknowable, but people can use abstract representations to plan for future events. Past research (Bar-Anan et al., 2006; Fujita et al., 2015) has shown an association between temporal distance and high-level construal. We replicated these findings in our present work. We found evidence for these associations in the two experiments we conducted, finding evidence for them across reaction time analysis and error rate analyses.

One goal of the present work was to examine whether these time-construal associations differ as a function of whether they refer to the past vs. future. In the two studies reported here, we generally found no differences in association strength between
past and future time. In Experiment 1 and Experiment 2, we find no differences in association strength between the past and future when associations are assessed via reaction time performance. The data were more mixed, however, when we assessed the associations using errors. In Experiment 1, we find a marginal difference in time using the PDP analysis and a significant difference in time in Experiment 2 such that people think of the future more abstractly than the past. This appears to be a systematic finding. Our participants are equally fast at associating distant past vs. future words with high-level construal, but they appear to be more accurate when they associate high-level construal with the distant future compared to the distant past. Future work should eliminate the speed-accuracy tradeoff to determine if people are more accurate when they associate the distant future vs. distant past with high-level construal.

Over two studies, we found mixed evidence that time-construal associations were related to well-being outcomes. In Experiment 1, we found that stronger time-construal associations were related to lower depression scores, less rumination, more hope, and more life satisfaction. Critically, we replicate Fujita et al.’s (2015) finding that a stronger association between temporal distance and high-level construal, not low-level construal and near time, was related to fewer depressive symptoms.

In Experiment 2, however, we do not replicate these well-being findings. We encountered some general issues in trying to assess the relationship between these associations and well-being outcomes. For example, one issue we faced whether to focus on reaction times vs. error rates when looking at association strength. Another issue was ensuring appropriate comprehension of the stimulus categories.
A third goal we had in these studies was to assess if the tendency to associate distant time with high-level construal was related to improved self-control. We hypothesized that people who think about distant time would be able to visualize their long-term goals. As a result, we hypothesized that people would be able to plan to achieve their long-term goals and this ability to self-regulate would help people to resist short-term temptations. However, we did not find that associations between temporal distance and high-level construal were related to self-control in any of our studies. One reason for this finding is that perhaps having strong time-construal associations are a double-edged sword. Although high-level construal may help us think about distant future events, strong associations between near-future and low-level construal may “lock” in a tendency to think about immediate temptations in low-level terms. The latter may render people vulnerable to self-control failure (e.g., Fujita & Carnevale, 2012). With strong associations, people may have a hard time thinking about their long-term goals in the immediate presence of temptations. That these results could have gone in either direction may explain the null results.

On a related note, our measure of association strength does not provide us insight into how people may flexibly construe their environments. Perhaps people who are good at self-control can readily see present temptations in a high-level, abstract way. That is, having more flexible time-construal associations may be most important for successful self-control. Perhaps self-control is the one exception to the self-regulation benefits of strong time-construal associations.
A final aim of our studies was to determine if associating temporal distance with high-level construal helps people to think about the future. In Experiment 2, we included measures that directly assessed people’s ability to think about the future. Consistent with our predictions, we found that strong associations between temporal distance and high-level construal were related to the ability to think about the future consequences of one’s actions. Participants were also less likely to be present oriented when they had strong time-construal associations. The latter finding, however, is somewhat difficult to interpret as these same participants did not report being more or less future oriented. In general, Experiment 2 failed to replicate many of the findings in Experiment 1, as well as past research with regards to depression. Thus, our results suggest that Experiment 2 was generally a flop.

**Future Directions**

One enduring problem in this work is the apparent lack of consistency in findings across reaction time and error analyses. In general, we found more significant relations between association strength and our outcome measures when we examined the reaction time analysis of association strength. There may not have been enough variance in error rates to use this as a method of calculating association strength. As such, associations measured by error rates may not have been as predictive of our outcome measures.

Future work should address this inconsistency. Given that Experiment 1 replicated previous research (e.g., Fujita et al., 2015), we might suggest modeling the procedures of any future research on its materials and procedures. To resolve apparent discrepancies between reaction time (D-score) and error rate (PDP) analyses, we might
propose instituting a response window. This should effectively eliminate any differences in reaction time, leading error rates to be a much more sensitive measure of participants’ time-construal associations. We might also encourage providing error feedback in the practice trials to ensure participants correctly learned the categorization of stimuli. This should reduce mistaken categorization as a source of error.

**Implications for Understanding Well-Being**

While there are inconsistencies in findings across our studies, our research may have some important implications. For example, people with good well-being (those who are satisfied with their lives and feel hopeful) may use different strategies for thinking about the distant past and future. People who are hopeful and satisfied with their lives may be able to mental time-travel in a more functional way, which enables them to think about their long-term goals. These people then may be able to plan to achieve their goals and feel happy when they succeed. Although we are not entirely sure how people who are unhappy and depressed mental time travel, we do know that they do not use high-level construal to think about distant time the same way that healthy individuals do. It is also possible that people with poor well-being, particularly depression, may not be sensitive to time when planning and making judgments. Future research should examine this issue.

If researchers can determine how people with high well-being vs. those with poor well-being mental time-travel, they may be able to create interventions for people with poor well-being. A cognitive retraining approach may give people the tools they need to start thinking about, planning for, and achieving their goals. However, it is important to first determine whether the weakened time-construal associations contribute to
depression or whether depression impacts how people think about time, particularly distant time. Research by Watkins and Teasdale (2001) suggests that people with depression tend to have overgeneralized memory. This causes people with depression to recall broad memories of repeated events such as numerous past failures. This would suggest that people are not using high-level construal in a functional way. Our present findings are correlational, so we cannot determine if weak time-construal associations cause people to develop depression or if depression weakens people’s time-construal associations. Future work may be able to address this issue.

**Conclusion**

In this package of experiments, we first wanted to examine if people construe distant future and past time equally abstractly. The majority of our evidence seems to suggest that people do not vary in how abstractly they visualize the distant past vs. future. Additionally, we wanted to explore the functionality of using high-level construal to engage in mental time-travel. Although we examined only a few measures of well-being (depression, rumination, hope, and life satisfaction), our results may provide insight into how mental time-travel aids in self-regulation and positive well-being outcomes. Lastly, we found preliminary evidence that the association between high-level construal and distant time is related to people’s ability to think about the future. Overall, these preliminary findings show that mental time-travel is an important phenomenon for future researchers to examine. Although future work is needed to bolster any conclusion from the present work, mental time travel may help people to think about the future, plan for their goals, and attain positive well-being outcomes.
References


Appendix A: Tables and Figures

Table 1

*Experiment 1 D-score and A-parameter estimates*

<table>
<thead>
<tr>
<th></th>
<th>D-scores</th>
<th>A-proximal estimate</th>
<th>A-distant estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Past</td>
<td>0.24</td>
<td>0.51</td>
<td>0.54</td>
</tr>
<tr>
<td>Future</td>
<td>0.20</td>
<td>0.59</td>
<td>0.59</td>
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</table>

*Note.* This table shows the means of the D-scores and A-parameter estimates. The D-scores are significantly different from 0 and the A-parameter estimates are significantly different from 0.50.
Table 2

*Experiment 1 D-score and A-parameter estimates simple effects*

<table>
<thead>
<tr>
<th>Outcome measures</th>
<th>D-scores</th>
<th>A-proximal</th>
<th>A-distant</th>
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<td>β</td>
<td>SE</td>
<td>β</td>
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<td>Depression</td>
<td>-.17</td>
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<td>Rumination</td>
<td>-.27†</td>
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<td>-.06</td>
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<tr>
<td>Life satisfaction</td>
<td>.30*</td>
<td>0.46</td>
<td>-.07</td>
</tr>
<tr>
<td>Hope</td>
<td>.32*</td>
<td>0.32</td>
<td>.01</td>
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<td>Rosenbaum SCS</td>
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<td>0.21</td>
<td>-.09</td>
</tr>
<tr>
<td>Discounting</td>
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<td>0.12</td>
<td>-.17</td>
</tr>
</tbody>
</table>

*Note.* † = p < .10, * = p < .05, ** = p < .01.
Table 3

*Pearson Product-Moment Correlations of the Measures of Well-being in Experiment 1*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Depression</th>
<th>Rumination</th>
<th>Life Satisfaction</th>
<th>Hope</th>
<th>Self-Control</th>
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</thead>
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<tr>
<td>Depression</td>
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<td>-0.40**</td>
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<td>0.06</td>
<td>0.32**</td>
<td>0.50**</td>
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</tr>
<tr>
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<td>0.02</td>
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<td>0.06</td>
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*Note. p < .01 = ***
Table 4

*Experiment 2 D-score and A-parameter estimates*

<table>
<thead>
<tr>
<th></th>
<th>D-scores</th>
<th>A-proximal estimate</th>
<th>A-distant estimate</th>
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<tr>
<td>Past</td>
<td>0.13</td>
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<td>0.52</td>
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<tr>
<td>Future</td>
<td>0.16</td>
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<td>0.58</td>
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</table>

*Note.* This table shows the means of the D-scores and A-parameter estimates. The D-scores are significantly different from 0 and the A-parameter estimates are significantly different from 0.50.
Table 5

*Experiment 2 D-score and A-parameter estimates simple effects*

<table>
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<tr>
<th>Outcome measures</th>
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<td>β</td>
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<td>0.46</td>
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<td>0.23</td>
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<tr>
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<td>-.02</td>
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<tr>
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*Note.* † = p < .10, * = p < .05, ** = p < .01.
Table 6

*Pearson Product-Moment Correlations of the Measures of Well-being in Experiment 2*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Depression</th>
<th>Rumination</th>
<th>Life Satisfaction</th>
<th>Hope</th>
<th>Self-Control</th>
<th>Future Orientation</th>
<th>Present Orientation</th>
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<td>Depression</td>
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<tr>
<td>Rumination</td>
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<tr>
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<tr>
<td>Hope</td>
<td>-0.58**</td>
<td>-0.48**</td>
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<tr>
<td>Self-Control</td>
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<tr>
<td>Present Orientation</td>
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<td>-0.02</td>
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<td>CFC</td>
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<td>0.45**</td>
<td>-0.44**</td>
</tr>
</tbody>
</table>

*Note.* $p < 0.05 = *$, $p < 0.01 = **$, CFC = Consideration of Future Consequences
Figure 1. Experiment 1 D-score hope interaction. This figure illustrates the interaction between D-scores and time on hope.
Figure 2. Experiment 1 A-proximal depression interaction. This figure illustrates the interaction between the A-proximal parameter estimate and time on depression.
Figure 3. Experiment 1 A-proximal hope interaction. This figure illustrates the interaction between the A-proximal parameter estimate and time on hope.
Figure 4. Experiment 2 D-scores hope interaction. This figure illustrates the interaction between D-scores and time on hope.
Figure 5. Experiment 2 D-scores discounting interaction. This figure illustrates the interaction between D-scores and time on discounting scores.