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Individual Differences in Temporal Perspective May Influence Cognitive Control Strategies



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# Individual Differences in Temporal Perspective May Influence Cognitive Control Strategies

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by

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ABSTRACT

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Research accumulating over the past 50+ years indicates that individuals who are future-oriented (FO) make wiser health decisions, have greater academic achievement, and have overall higher levels of well-being than individuals who are present- or past-oriented. The present study focuses on the cognitive differences in temporal perspective as a trait by addressing the hypothesis that high-FO individuals have increased cognitive control as compared to low-FO individuals. While a number of studies have examined the traits that influence cognitive control strategies—e.g. reward-sensitivity, threat-sensitivity, anxiety—none have addressed temporal perspective. Using recognition memory decision-making strategies as a medium for addressing cognitive control differences, the present study is able to address the recognition memory literature on individual differences in criterion shifting as well. The first hypothesis was that high-FO participants adopt an overall more conservative criterion in a recognition memory test than low-FO participants. The results revealed no correlation between temporal orientation and criterion placement. The second hypothesis was that high-FO participants will perform better than low-FO participants on the Recent-Probes task, a working memory task known to engage a proactive control strategy. No significant differences were found due to ceiling effects, therefore it remains unclear whether there is an inherent difference between high-FO and low-FO individuals in regards to working memory.

## Introduction

Research accumulating over the past 50+ years indicates that individuals who are future-oriented (FO) make wiser health decisions, have greater academic achievement (Cottle, 1969; Goldrich, 1967; Raynor, 1970; De Voider & Lens, 1982), make wiser health decisions (Rothspan & Read, 1996; Kees, 2007; Henson, Carey, Carey & Maisto, 2006; Daughterty & Base, 2010) and have overall higher levels of well-being than individuals who are present- or past-oriented (Melges, 1982; Rothspan & Read, 1996; Strathman, Gleicher, Boninger & Edwards, 1994; Holman & Silver, 1998). Most research on temporal perspective as a personality trait has used social psychological methods to examine temporal orientation in relation to physical and mental health behavior. However, it is less clear what is going on at the cognitive level. The present study explores the possibility that high-FO individuals have increased cognitive control as compared to low-FO individuals. The evidence that already exists addresses the link between temporal perspective and delayed gratification such that FO individuals are better at delaying gratification than present-oriented (Stolarski, Bitner, & Zimbardo, 2011; Wittman & Paulus, 2008;). While a number of studies have examined the traits that influence cognitive control strategies (Braver, 2012)—e.g. reward-sensitivity, threat-sensitivity, and anxiety—there is a lack of research on the cognitive aspects of temporal perspective.

Cognitive control strategies have been studied in the context of recognition memory decision-making (Miller, Guerin & Wolford, 2011; Aminoff et al., 2012). It has been proposed that a key function of memory is to plan future events (Klein, Robertson & Delton, 2011). The more accurately one remembers the past, the more effective that person may be in simulating the future. Some of the cognitive processes that may be underlying temporal perspective may also be underlying differences in memory decision strategies. The link between FO thinking and memory decision strategies is valuable due to information we have on the cognitive processes that lead to accurate or false memory decisions. It may also shed light on factors that contribute to individual differences in criterion placement in recognition memory decision-making, which has important implications for the recognition-memory literature, as well as eyewitness testimony and any important decisions made based on recognition memory. Higher levels of cognitive control have been shown to reduce false alarms (Miller, Guerin &Wolford, 2011). Future-orientation may similarly require cognitive control as in delayed gratification.

Before discussing the goal of the current study, it important to elaborate on the link between temporal perspective, cognitive control, and recognition memory decision-making strategies. First, I will attempt to establish the link between temporal perspective and cognitive control, then I will establish the link between cognitive control and recognition memory decision-making strategies. In exploring these links, it should become clear that individual differences in temporal perspective has the potential to significantly contribute to the literatures on recognition memory decision-making strategies and overall cognitive control.

*Temporal Perspective and Cognitive Control*

Braver (2012) defines cognitive control as “the ability to regulate thoughts and actions in accordance with internally represented behavioral goals” (p. 106). In this review article, Braver provides evidence for the claim that inter-individual variability is a fundamental aspect of cognitive control. He focuses on the inter-individual differences of the natural tendencies to engage in proactive and reactive control. *Proactive control* "reflects the sustained and anticipatory maintenance of goal-relevant information within lateral prefrontal cortex (PFC) to enable optimal cognitive performance." *Reactive control* "reflects transient stimulus-driven goal reactivation that recruits lateral PFC (plus a wider brain network) based on interference demands or episodic associations" (Braver, 2012, p. 106). On a surface level, two things related to temporal perspective are apparent: (1) the ability to regulate thoughts and actions in accordance with internally represented behavioral goals might be influenced by individual differences, and (2) Proactive control involves *anticipatory maintenance* of goal-relevant information, and reactive control involves *transient stimulus-driven* goal reactivation. To elaborate on (1), Braver (2012) mentions a number of traits, but temporal perspective, which has been shown to be a reliable trait over and above the big 5 and other measures of stable traits (Zimbardo & Boyd, 1999; Strathman, Gleicher, Boninger & Edwards, 1994) seems to be inherently related to "regulating thoughts and actions in accordance with internally represented behavioral goals." If one is FO, she is likely to have relatively more distal future goals, and is likely to regulate her thoughts and actions (consciously or not) in accordance with these distal future goals. On the other hand, if one is present-oriented, she is likely to have relatively more proximal future goals, and is likely to regulate her thoughts and actions in accordance with these proximal future goals. To elaborate on (2), *anticipatory maintenance* of goal-relevant information seems to be inherent to maintaining distal goals. The assumption is that high-FO individuals are more likely to engage in proactive control, considering distal future goals involve maintaining goal-relevant information and quelling goal-irrelevant information/behaviors. There is already some evidence that engaging in goal-directed future thinking engages similar executive regions that proactive control engages. Specifically, Gerlach, Spreng, Gilmore & Schacter (2011) found that goal-directed future simulation engages the dorsolateral prefrontal cortex and other executive regions. A task in which proactive control is an optimal strategy is the working memory task known as the Recent-probes task (RPT) (Jonides, 1998).

*Temporal Perspective and Strategies for Recognition Memory*

In a pivotal study on false memories, Miller and Wolford (1999) applied signal detection theory (SDT) to explain the high false alarm rate seen in unstudied words that are highly related to lists of words in the study phase of the Deese-Roediger-McDermott paradigm (Roediger & McDermott, 1995). Whereas Roediger and McDermott explained the high false alarm rate of critical lures in terms of spreading activation during the time of encoding, Miller and Wolford emphasized a liberal criterion placement shifts for related words (including the critical lure) and a conservative placement shift for unrelated words at the time of retrieval. For example, participants are very likely to falsely respond "old" to *sleep* and *dream* when participants study *bed, rest, awake, tired*, etc. among a larger list of words in a study phase. They are less likely to falsely respond "old" to *money* if there are no words that relate to *money* in the study phase than if related words were presented. In SDT, the hit rate (proportion of hits/total "old" words) and the false alarm rate (proportion of false alarms/total "new" words) depend on two factors: (1) *Difficulty of task*: in an easy task, a high hit rate and low false alarm rate are observed (signal distribution and noise distribution are further apart and do not overlap much).

Conversely, in a difficult task, a low hit rate and high false alarm rate are observed (signal and noise distributions are closely aligned and overlap greatly). This parameter, d', is measured by calculating the signal to "noise" ratio. A higher d' on a task reflects that the test-taker was more accurate than if she had a lower d'. (2) *Strategy of test taker*: if a test-taker tends to respond with "new" to an item when she is uncertain whether the item was presented in the study phase or not, she is using a conservative criterion, i.e., she will have a low false alarm rate and low hit rate (assuming her memory is not perfect). If a test taker tends to respond with "old" to an item when she is uncertain if the item was presented in the study phase or not, she is using a liberal criterion, i.e., she will have a high false alarm rate and a high hit rate (Abdi 2007). The parameter, C, is calculated to determine the test-taker's strategy using the hit rate and false alarm rate.

Using SDT, we can measure the conservativeness of one's criterion in a given recognition memory task by calculating C. It has been shown that adopting a conservative criterion requires more strategic control than adopting a liberal criterion (Miller, Guerin & Wolford 2011). If FO individuals engage in more cognitive control, it is possible that they are more likely to adopt an overall conservative criterion when engaging in a recognition memory task. Aminoff et al. (2012) show that there are individual differences in the strategies used in placing criterion in recognition memory tasks. Considering other individual differences (e.g., age, sleep, cognitive style, personality) have been shown to predict strategies used in shifting criterion, it is plausible to explore temporal perspective as an individual difference that predictions criterion placement.

The goal of this study is to take the first step towards developing a model of temporal perspective that elucidates potential differences in cognitive strategies (i.e., recognition memory decision making and cognitive control) that underlie the observed behavioral differences (i.e., academic achievement, health, overall well-being) between high-FO and low-FO individuals. The present study hypothesizes that high-FO participants will adopt an overall more conservative criterion in Miller & Wolford's (1999) version of the DRM paradigm than low-FO participants. Following the recognition memory test, the link between temporal perspective and cognitive control will be further addressed by having participants perform the RPT, a working memory task that involves storage limitation due to proactive interference. I hypothesize that high-FO participants will perform better (higher proportion correct and quicker reaction time (RT)) on the RPT task than low-FO participants.

## Methods

### Participants

The seventy-nine participants were recruited from University of California, Santa Barbara. All participants received credit to fulfill a requirement of a psychology course. 48 were female, 31 were male. Participants' ages range from 18 to 23, with mean age of 19.37, and SD of 1.12.

### Design

The current study uses a correlational design. Participants' temporal orientation is measured in order to assess the relationship between temporal orientation and cognitive control. Criterion placement is measured in Miller & Wolford's (1999) version of the DRM paradigm and cognitive control is measured in the reaction time and proportion correct in the RPT.

**Procedure**

Participants first took a premeasure to assess participants' temporal orientation, focusing only on future orientation. The premeasure consisted of questions from the Zimbardo Temporal Perspective Inventory (ZTPI) (future subscales only) (Zimbardo & Boyd, 1999) and the Consideration of Future Consequences (CFC) scale (Strathman et al., 1994). These scales were chosen to measure temporal perspective due to their statistical validity and their popularity. Following the premeasure, participants were given Miller & Wolford's (1999) version of the DRM paradigm to address susceptibility to false memory decisions. Participants were instructed to study the words presented on the screen for a memory test. Following the study phase, participants were given a 2-minute break without any specified task. Once the break was over, they were told they were taking a memory test on the words they just studied and were instructed to respond with either "old" or "new" to each item presented on the test phase. To confirm the relationship between conservative criterion and increased cognitive control, participants were given the RPT outlined by Jonides (1998).

**Materials**

*Temporal Perspective Premeasure:*

The premeasure consisted of questions from the ZTPI future subscale and the CFC scales. Participants responded to the question "How characteristic or true is this of you?" for each statement using a 5-point Likert scale, with anchors "Very Untrue" and "Very True." Example statements from the ZTPI include, "I believe that a person's day should be planned ahead each morning" and "I complete projects on time by making steady progress." Example statements from the CFC scale include, "I am willing to sacrifice my immediate happiness or well-being in order to achieve future outcomes" and "Since my day to day work has specific outcomes, it is more important to me than behavior that has distant outcomes" (reverse-coded). The two scales were treated as a single measure.

*Recognition Test: Study Phase:*

The lists of words in the study phase were broken down by categories of common words (e.g., Anger, Black, Bread, Chair) with highly related associated words listed in ascending order of relatedness (e.g., Anger: mad, fear, hate; Black: white, dark, cat; Bread: butter, food, eat; Chair: table, sit, legs). Each participant received 12 of the 24 lists originally presented in the DRM paradigm, plus 2 lists of unrelated words, generated from the unseen lists. Each list consisted of 15 words and they were presented at a rate of 1.5s per word. There was a 10s break between lists. The two unrelated lists were always presented in the middle of the study phase. Of the 14 lists presented, there were four lists in which the critical lure (the word that each list item is highly related to (e.g., anger)) was presented, replacing the word in the first position of the list, and four lists in which the critical lure replaced the word in the tenth position. The remaining four lists were presented in its original DRM format.

*Recognition Test: Test Phase:*

The recognition test comprised of 72 words. 36 were presented in the study phase. Of the 36 presented words, 8 were critical lures presented in the first or tenth position, 16 were related list items presented in the first or tenth position, and 12 were unrelated items presented from the two unrelated lists. The remaining 36 words were not presented in the study phase. Of the 36 not-presented words, 4 were critical lures from the other 12 lists in the DRM paradigm, 8 were related list items that were displaced when a critical lure was presented in its position (either first or tenth position), and 24 were unrelated items from the other 12 lists in the DRM paradigm.

*Recent-Probes Task:*

Following the paradigm outlined by Jonides (1998), participants were given 180 trials in which four uppercase letters appear in the center of the screen for 500ms. Following a fixation point presented for 1000ms, a probe is presented for 500ms as a lowercase letter. Any target set contains two letters drawn from the previous trial and two letters not presented in the last two trials. There are four types of probes: recent-positive, recent-negative, non-recent positive, and non-recent negative. Recent-positive probes consistent of a letter that was presented in both the most recent trial and the trial preceding the most recent trial (e.g., 'g' was presented in trial n and trial n-1). Recent-negative probes consistent of a letter that was not presented in the most recent trial but was presented in the trial preceding the most recent trial (e.g., 't' was not presented in trial n, but was presented in trial n-1). Non-recent positive probes consist of a letter that was presented in the most recent trial but was not presented in the trial preceding the most recent (e.g., 'a' was presented in trial n, but was not presented in trial n-1). Non-recent negative probes consist of a letter that is not presented in the most recent trial and is also not presented in the trial preceding the most recent (e.g., 'p' was not presented in trial n or trial n-1).

## Results

Seventy-nine participants' (48 females, 31 males) composite FO scores (consisting of the ZTPI future subscale and the CFC scale) were used to address temporal orientation. The decision to combine the scales was a result of the moderately strong correlation between the two scales ($r=.454$, $p< .001$). Age ranged from 18 to 23 years old ($M = 19.37$; $SD = 1.12$).

A Pearson's r was calculated to address the hypothesis that highly future-oriented participants have a higher C (i.e., more conservative criterion) on the recognition memory test and excel at the RPT compared to participants with lower FO. Results revealed no significant correlations between temporal orientation and C ($r = .137$, $p= .228$), no significant correlations between temporal orientation and d' ($r= .011$, $p = .924$), and no significant correlations between temporal orientation and the proportion of correct responses on the RPT ($r= -.122$, $p= .282$). There was a marginally significant weak correlation between future orientation and reaction time in the RPT ($r= .195$, $p= .085$).

## Discussion

The goal of this study is to elucidate cognitive control differences among high-FO and low-FO individuals. The first hypothesis was that high-FO participants adopt an overall more conservative criterion in a recognition memory test than low-FO participants. The correlational analyses revealed no significant correlations between temporal orientation and criterion placement in the recognition memory.

The second hypothesis was that high-FO participants would perform better (higher proportion correct and quicker reaction time) on the RPT than low-FO participants. No significant differences were found in the proportion correct. This is likely due to the ease of the task employed in the experiment; therefore it remains unclear whether there is an inherent difference between high-FO and low-FO individuals on this task. This is a serious limitation of the present study, considering the overwhelming majority of participants performed at 90% accuracy or higher (median= .93, mean = .92, SD= .065). Ways to increase the difficulty of the task include degrading the stimuli so it's harder to see and decreasing the stimuli presentation time. These measures should be taken in future experiments related to the present study. Considering that previous studies have demonstrated a link between future-oriented thinking and increases in working memory capacity I think it is reasonable to re-run the RPT controlling for ceiling effects. Baird, Smallwood & Schooler (2011) found a moderately strong correlation between participants who engage in future-oriented mind wandering and working memory capacity using the Operation span task. In the present study there was, however, a marginally significant weak correlation between temporal orientation and reaction time in the RPT, such that those who were higher in FO had a slower reaction time in the task. I am skeptical to speculate the meaning of these results because the effect is very weak to begin with (r= .195).

A follow up to the present study can address whether high-FO individuals flexibility adapt their criterion placement based on context more so than low-FO individuals. This phenomenon, known as criterion shifting, involves becoming more conservative or liberal in response to the shifting of the likelihood of new items presented on a recognition memory test. Criterion shifting has been a source of debate due to mixed results in the recognition memory literature. Inherent differences in individuals that lead some to shift more than others may explain the mixed results (Hockley, 2011). Aminoff et al., (2012) identify a number of characteristics, including cognitive style, personality, age and sleep, which strongly influence the tendency to shift criterion in correspondence with cues that signal whether it is optimal to have a conservative or liberal criterion. Temporal perspective may contribute to understanding the differences in criterion placement and criterion shifting in the recognition memory literature. Future studies can implement the criterion shifting paradigm outlined in Aminoff et al. (2012) to assess whether temporal perspective is a significant contributing factor to individual differences in criterion shifting. This may inspire new methods for reducing false memory decisions in situations that rely on recognition memory, e.g., eyewitness testimonies.

In addition to addressing optimal criterion shifting, temporal perspective can be explored as a contributing factor to predicting whether an individual optimally shifts between proactive and reactive control strategies. One way to address this is to administer the RPT with blocks of trials that allow for strategic control (i.e., optimal shift between proactive and reactive control). Jonides (2006) outlines this task, in which blocks of trials are separated such that every other block is a low interference condition and the other half is a high interference condition. A low interference condition consists of 20% recent negatives probes and 80% non-recent negative probes, and 80% recent positive probes and 20% non-recent positive probes. The high interference condition has the reverse distribution of positive and negative probes. Exploring the relationship between individual differences in temporal perspective and optimally shifting cognitive control strategies may broaden the domain of Braver's dual mechanism of control (DMC) framework, which proposes that intrinsic variability in cognitive control might be a result of “qualitative distinctions in temporal dynamics between proactive and reactive control” (2012, p. 106). In his consideration of individual variation in cognitive control, Braver addresses research on reward-sensitivity, threat-sensitivity and trait anxiety. Temporal perspective may be an important contribution to the individual differences component of this model, particularly considering nearly every decision a person makes involves consideration of the proximal or distal future.

In conclusion, although no significant results were derived from the present study, trending results provide reason to continue exploring the differences in criterion placement in recognition memory decision-making and overall differences in cognitive control among individuals who are future-oriented and those who are not.

*Figures*

| Composite FO | RPT % correct | RPT RT | c | d' |
|---|---|---|---|---|
| Pearson Correlation | -0.122 | 0.195 | 0.137 | 0.011 |
| Sig. | 0.282 | 0.085 | 0.228 | 0.924 |
| N | 79 | 79 | 79 | 79 |

Table 1: Results of Pearson's r correlation between future orientation and cognitive control measures

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