Research Article

Taxing Executive Processes Does Not Necessarily Increase Impulsive Decision Making

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Abstract. A link has been established between impulsivity in real-world situations and impulsive decision making in laboratory tasks in brain-damaged patients and individuals with substance abuse. Whether or not this link exists for all individuals is less clear. We conducted an experiment to determine whether taxing central executive processes with a demanding cognitive load task results in impulsive decision making in a normal sample. Participants (n = 53) completed a delay discounting task under the presence (load condition) and absence (control condition) of a demanding generation task. Results indicated that taxing working memory is neither necessary nor sufficient to produce impulsive decision making; instead, the demanding generation task resulted in an increase in the number of inconsistent choices.

Keywords: impulsivity, cognitive load, decision making, executive processes

In everyday situations, we often have to choose between a smaller immediate reward and a larger reward available after some time. For example, deciding whether to spend money now versus waiting to receive a larger financial reward by investing in a retirement account. Generally, as the length of time increases (e.g., from 1 to 10 years), people tend to discount the larger reward delayed in time in favor of a smaller immediate reward (Green & Myerson, 2004). This phenomenon, known as *temporal* or *delay discounting,* has been demonstrated in real-world settings (cf. Loewenstein & Thaler, 1997) and laboratory studies (Green & Myerson, 2004; Kirby & Marakovic, 1995; Rachlin, Raineri, & Cross, 1991). Individuals who demonstrate a proclivity for smaller immediate rewards are often classified as more *impulsive* than those who choose to wait for the larger reward (Dixon, Marley, & Jacobs, 2003; Kirby & Petry, 2004).

Impulsivity and Delay Discounting

A link exists between impulsivity in real-world situations and impulsive decision making in research settings. In laboratory studies of delay discounting, participants make a series of choices between an immediate reward and a larger reward delayed in time (e.g., $250 now or $500 in 1 year). Self-reported measures of impulsivity are correlated with the degree of discounting ($r \sim .20$; Kirby & Petry, 2004). Individuals who engage in real-world impulsive behavior such as pathological gamblers (Dixon et al., 2003; Petry, 2001), drug abusers (heroin & cocaine; Kirby & Petry, 2004; Kirby, Petry, & Bickel, 1999), alcoholics (Dom, D'haene, Hilstijn, & Sabbe, 2006), and smokers (Bickel, Odum, & Madden, 1999; Reynolds, Richards, Horn, & Karraker, 2004) tend to have higher rates of discounting than controls. Additionally, higher rates of discounting are associated with the frequency and co-occurrences of real-world impulsive behaviors (Bickel et al., 1999; Petry, 2001; Reynolds, 2004; Vuchinich & Simpson, 1998). Although some studies have failed to find the link between discounting and impulsive behaviors (Ohmura, Takashashi, & Kitamura, 2005; Ortner, MacDonald, & Olmstead, 2003), most research supports a connection between real-world impulsive behaviors and "impulsive" decision making in laboratory tasks.

The connection between impulsivity and decision making is supported by neurological evidence. The orbitofrontal cortex has been linked to self-reported and behavioral measures of impulsivity (Berlin, Rolls, & Kischka, 2004) as well as responses to hypothetical rewards and punishments in decision tasks (O'Doherty, 2004; O'Doherty, Kringelbach, Hornak, & Andrews, 2001). Patients with prefrontal lobe damage exhibited compromised decision making in a gambling task (Bechara, 2005). More importantly, Bechara and colleagues (Bechara, 2005; Bechara & Martin, 2004) noted that individuals with substance dependence demonstrated similar decision-making deficits and poor working memory task performance as patients with prefrontal damage. The executive processes of working memory rely on frontal lobe functioning (Andres, 2003; Baddeley, Della Sala, Popgagno, & Spinnler, 1997; Smith & Jonides, 1999; Stuss & Alexander, 2000). These processes control higher-level cognitive functions such as decision making and operate

Experimental Psychology 2010; Vol. 57(3):193–201
DOI: 10.1027/1618-3169/a000024

as a limited-capacity mechanism of attentional control (Baddeley, 2002; Baddeley & Hitch, 1974). Consequently, when the executive processes are sufficiently taxed, task performance is usually impaired (Baddeley, 1996, 2002; Gilhooly, Logie, & Wynn, 2002).

Executive Processes and Decision Making

Although recent research has identified an association between executive processes, impulsivity, and poor decision making in brain-damaged patients and individuals with addiction (Bechara 2005), the degree to which this relationship exists in *normal* individuals (those without brain damage or addiction) is less clear. Some researchers have proposed that taxing the executive processes in working memory, by having participants complete a cognitive load task, increases impulsive decision making (Hinson, Jameson, & Whitney, 2003; Whitney, Jameson, & Hinson, 2004). These researchers proposed that the ability to inhibit impulsive decisions is reduced when attentional resources are allocated elsewhere. Hinson et al. (2003) tested this supposition by having participants engage in a digit-memory task as a cognitive load while completing a delay discounting decision task. Although the decision task consisted of 729 possible trials (all possible combinations: immediate reward values: \$100 increments from \$100 to \$1,000; delayed reward values: \$100 increments from \$1,200 to \$2,000; coupled with nine possible delay times: 1 week to 24 months) between immediate and delayed rewards, each participant received a random subset of 80 decision trials. The discounting of delayed rewards where an individual's subjective value for the delayed reward decreases as time increases is assessed by examining decision trial choices using a hyperbolic function:

$$V = \frac{A}{(1 + kD)}, \tag{1}$$

where V refers to the value, A represents the monetary amount in the choice option, k is the discounting rate, and D is the amount of the delay (Green & Myerson, 2004; Kirby & Marakovic, 1995; Rachlin et al., 1991). The free parameter k is sometimes considered as an impulsiveness parameter for it reflects one's propensity to select smaller immediate reward over larger delayed rewards (Kirby et al., 1999). Larger values of k indicate a faster rate at which the delayed reward is disregarded. Hinson et al. found that the rate of discounting increased under cognitive load ($k = .646$) when compared to the control condition ($k = .301$) and interpreted these results as evidence that additional cognitive demands on the executive processes during the decision task increased impulsivity.

However, in a reanalysis of Hinson et al.'s data, Franco-Watkins, Pashler, and Rickard (2006) demonstrated that the apparent increase in k was limited to a few outliers who appeared to be most affected by the cognitive load. Removing the three outliers (of 44 participants) reduced k for the cognitive load condition ($k = .422$, $SD = 0.544$) with a negligible effect on the control condition ($k = .300$, $SD = 0.397$) resulting in a nonsignificant difference between the two conditions, $t(40) = 1.54$, $p = .13$, $d = .27$. Moreover, the pattern of results obtained in the original experiment could be explained by supposing that the cognitive load provoked random responding (i.e., inconsistent responses) in the decision task rather than increasing impulsivity. An increase in the number of inconsistent choices is sufficient to produce an increase in k if an initial preference exists (i.e., a propensity to select one type of reward over the other type). Figure 1a presents a summary of the proportion of time the immediate option was chosen during the control and load conditions in Hinson's original dataset.[1] Note that the immediate option was selected less often than the delayed option except for the latter two delays. On average, the immediate option was selected 25% of the time in the control condition. Consequently, if cognitive load produces the slightest inconsistency, choices will tend to shift toward the immediate reward, thereby increasing the average value of k without requiring a consistent shift in decision making toward the immediate "impulsive" choice.

Pilot Study

To examine whether correcting for an initial preference by modifying the decision task would reduce the number of "impulsive choices" under cognitive load, we conducted a pilot study. Thirty-one University of California, San Diego undergraduate students participated in the study in exchange for course credit. The decision task included immediate reward values ranging from \$1 to \$500 (nine possible values: \$1, \$50, \$100, \$150, \$250, \$350, \$400, \$450, and \$500) paired with delay reward values ranging from \$501 to \$999 (nine possible values: \$501, \$550, \$600, \$650, \$750, \$850, \$900, \$950, and \$999) coupled with six possible delay times (1 month, 6 months, 1 year, 3 years, 5 years, and 10 years). Similar to Hinson et al.'s procedure, the decision trials were random subsets of all possible trials. Participants completed the decision task twice: once under a cognitive load and once without the load (control). Figure 1b presents a summary of the proportion of time the immediate option was chosen during the control and load conditions. Participants selected the immediate option approximately half of the time in both the control ($M = .45$, $SD = 0.21$) and load ($M = .43$, $SD = 0.21$) conditions, $t(30) = -1.03$, $p = .31$, $d = .10$. Thus, we were successful in eliminating an initial preference for one reward over another reward. No significant differences in discounting emerged between the load ($k = .309$, $SD = 0.570$) and control ($k = .329$, $SD = 0.570$) conditions, $t(30) = -0.44$,

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[1] Note that the graph is based on the average data across all trials for all participants. Because each participant in Hinson et al.'s Experiment 1 received a unique random set of 80 trials for the control and another set for the load condition, direct comparisons within and across participants per condition are tenuous because reward magnitudes and time delays were not held constant.

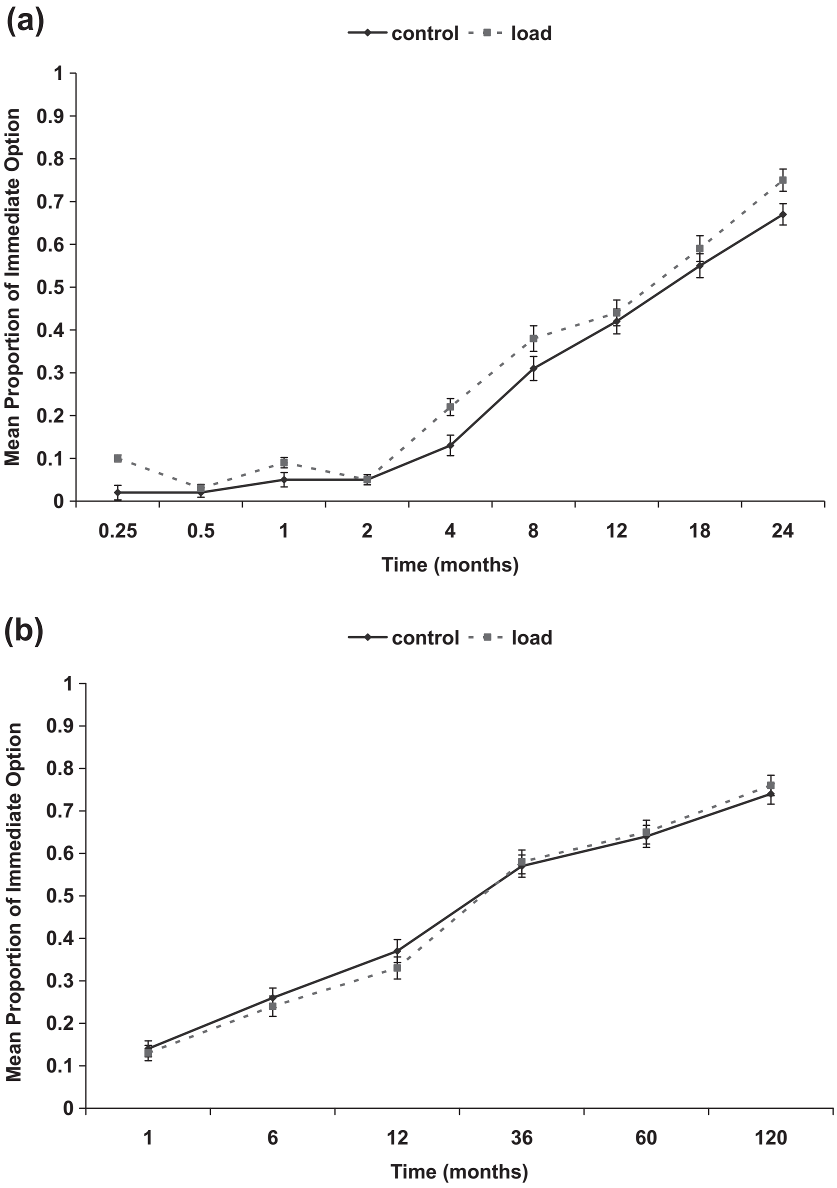

Figure 1. Mean proportion of selecting immediate choice (a) for Hinson et al.'s (2003) Experiment 1 and (b) in pilot study.

p = .66, d = .03. The pilot study resulted in eliminating the previous initial preference with no observable effects on the rate of discounting. Thus far, we cannot address whether cognitive load produces more impulsive decision making because in both the pilot study and Hinson's experiment, it appears that the cognitive load task did not affect decision making. One explanation is that perhaps the digit-memory load task might not have sufficiently taxed working memory. Fine-grained studies of load interference show that while mental operations involved in decision making and action planning are subject to a very severe "bottleneck-type" pattern of interference, merely holding onto a memory load usually produces a much smaller and graded form of interference (see Pashler & Johnston, 1998, for review). There are mixed results as to whether or not holding a memory load imposes substantial demands upon the central executive processes. Some research indicates that it does not place substantial demands (Baddeley, 2002; Baddeley & Hitch, 1974), while other research supports that it does place some demands upon central executive processes (Allen, Baddeley, & Hitch, 2006; Jameson, Hinson, & Whitney, 2004). However, a generation task that requires the verbal production of a random letter or number each time a signal is presented does consistently place heavy demands on central executive processes (Baddeley, 1966, 1998; Baddeley, Emslie, Kolodny, & Duncan, 1998; Jahanshahi, Saleem, Ho, Dirnberger, & Fuller, 2006). When generation tasks are paired with another task, participants typically experience impaired performance on the primary task (e.g., *syllogistic reasoning* Gilhooly et al., 2002; *mental rotation task* Logie & Salway, 1990; *proposition reasoning* Meiser, Klauer, & Naumer, 2001; and *problem solving* Phillips, Gilhooly, Logie, Della Sala, & Wynn, 2004). If one assumes that assessing the relative value of immediate and delay rewards in a delay discounting task requires controlled, deliberative processing, then placing additional demands upon the decision maker should impact their decision making. Although researchers agree that decision making is compromised when the executive processes are taxed, the question remains as to whether or not it leads to impulsive decision making for all individuals.

Overview of Experiment

We conducted an experiment to determine whether taxing central executive processes with a more demanding cognitive load task results in impulsive decision making in a *normal* sample. Specifically, participants completed a delay discounting decision task in the presence and absence of a demanding generation task. One possible effect of the demanding cognitive load task is that participants opt to use a strategy that favors one specific type of option more often without fully evaluating both options. There are two possible approaches that one could use in this situation: (1) an *impulsive strategy* where the immediate option is consistently selected more often thereby *increasing* the rate of discounting or (2) a *conservative strategy* where the delay option is consistently selected more often thereby *decreasing* the rate of discounting. A conservative strategy is possible because participants could opt to select the reward with the largest monetary value under cognitive load and the delay reward is always larger than the immediate reward. However, another possible effect of taxing one's central executive processes might be to simply increase the number of inconsistent responses. The latter is plausible given the increased difficulty to evaluate options and/or recall previous preferences while having additional attentional demands placed on working memory processes.

All three possibilities (impulsive, conservative, and inconsistent) rely on the assumption that performing a cognitive load task sufficiently taxes executive processing such that decision making is modified compared to conditions where no additional cognitive demands are present, however, they differ on how decision making is compromised under additional cognitive demands.

Experiment

Method

Participants

Fifty-six undergraduate students at the University of California, San Diego participated in the experiment as partial fulfillment toward course credit. Each person completed the experiment alone in a sound-attenuated booth.

Design

We used a within-participants design. Each participant completed the same decision task twice: once alone (control condition) and once paired with the generation task (load condition). Conditions were counterbalanced across participants. Eighty identical decision trials were used for each condition.

Materials

The experiment was programmed in Visual Basic 6.0 and run on PCs using Windows XP.

Decision Task

The delay discounting decision task involved two options presented in the center of the computer screen: An immediate reward presented on the left side and a delay presented on the right side of the screen. A total of 80 trials (40 trials with a fixed $500 delay reward and 40 trials with a fixed $10,000 delay reward) were used in the decision task. The immediate option contained five possible values. Immediate values of $50, $150, $250, $350, and $450 were paired with the $500 fixed delay option and immediate values of $1,000, $3,000, $5,000, $7,000, and $9,000 were paired with the $10,000 fixed delay option. For each fixed delay value ($500 and $10,000), the time associated with the delay option varied: 1 month, 6 months, 9 months, 1 year, 3 years, 5 years, 8 years, or 10 years. Thus, five immediate values were paired with 8 delay times resulting in 40 trials per fixed delay value. Note that the decision task corresponds to the standard delay discounting task where a staircase method is used to ascertain the degree of discounting by asking participants to choose between a fixed delay reward (e.g., $500) and an immediate reward of progressively increasing (or decreasing) step values. Rather than present step values in consecutive order and discontinue steps when a preference reversal occurs, all possible decision trials were presented in a random order to increase the likelihood that participants evaluated both options and did not simply wait for a specific predetermined value to appear on the screen (possible with an ordered presentation). Note that all participants received all steps (trials) in the sequence; thus, it is possible to compare performance within and across participants as well as across conditions.

Letter Generation Task

Participants responded vocally (into a microphone) with a letter from the alphabet each time the 190 ms tone was heard over headphones (every 1 s).

Procedure

Participants were randomly assigned to one of the two counterbalancing conditions where they completed either the control or load condition first. The experimenter briefly described the tasks and indicated that each task would be completed once alone and once combined together. The experimenter emphasized that performing both tasks together might be challenging, but participants should try their best. Participants were informed that their keyboard responses and vocal responses would be recorded. They read detailed instructions presented on the computer screen prior to the commencement of a task. The decision task instructions informed participants that they should press the "1" key for the left option and the "2" key for the right option to indicate their preference. Furthermore, instructions stated that there was no right or wrong answer and participants should try to be consistent in their choices. Reaction times and choices were recorded for each trial in the decision task.

In the letter generation task, instructions stated that each time a tone was played participants should respond with a letter from the alphabet (A through Z). They were instructed not to use consecutive letters (e.g., A, B, and C) or letters spelling a word (e.g., M, I, L, and K) and to try to generate unsystematic letters. Vocal responses were recorded onto a sound file.

Participants completed a brief practice session of five trials of the decision task and 20 trials of the letter generation task before starting the experiment. The decision task was self-paced in both conditions. Participants completed all 80 trials in one condition before completing the 80 trials for the next condition. During the load condition, the letter generation task was presented simultaneously with the decision task and ended when the participant had completed all trials.

Results

Three participants were excluded from subsequent analyses: One failed to generate letters in the generation task; one completed the decision trials rapidly (< 400 ms: insufficient time to read options); and one chose the delay option for all trials in both conditions. Analyses are based on 53 participants. Because differences exist in discounting rates for \$500 and \$10,000 rewards (Green, Myerson, & Ostaszewski, 1999), separate analyses were conducted for each delay reward. Smaller delay rewards (\$500) are discounted at a faster rate than larger delay rewards (\$10,000) because the indifference point (where the immediate and delay rewards have the same subjective value) occurs sooner for smaller delay rewards.

Choices

The mean proportion of selecting the immediate option during the control and load conditions is presented in Figure 2a for the \$500 reward and in Figure 2b for the \$10,000 reward. Consistent with previous delay discounting findings, the immediate option is chosen more often as time increases for both the \$500, $F(7, 46) = 55.25$, $p < .001$ and \$10,000, $F(7, 46) = 59.95$, $p < .001$, rewards. Although differences exist between the control and load conditions in immediate option selection, \$500: $F(1, 52) = 13.90$, $p < .001$ and \$10,000: $F(1, 52) = 4.49$, $p = .04$, of greater interest is the significant interaction between delay time and condition. The load condition begins at a slightly higher rate of selecting the immediate option and crosses the control condition at ~ 6 months (see Figure 2a) but then never matches the control condition at longer delay times, resulting in a significant interaction for the \$500 reward, $F(7, 46) = 9.19$, $p < .001$. The \$10,000 reward resulted in a similar interaction pattern (see Figure 2b), however, the crossover occurs at 36 months, $F(7, 46) = 12.81$, $p < .001$.

The hypothetical consequences of an inconsistent response strategy are depicted in the solid horizontal line at 50% (equally likely to select the immediate or delayed option) in Figure 2a and b. It appears that engaging in the generation task resulted in regressing choice responses toward an inconsistent response strategy. A regression slope was calculated per participant for each condition and delay reward to examine the linear trend of selecting the immediate option across time. The control condition ($M = .39$, $SD = 0.26$) had a larger slope than the load condition ($M = .24$, $SD = 0.26$), $t(52) = 4.71$, $p < .001$, $d = .58$ in the \$500 reward. The same pattern occurred for the \$10,000 reward with a larger slope for the control condition ($M = .48$, $SD = 0.31$) than the load condition ($M = .26$, $SD = 0.28$), $t(52) = 5.71$, $p < .001$, $d = .75$. The observed pattern does not suggest that people become more impulsive in their decision making under cognitive load. To support an impulsivity interpretation, we would expect to see the immediate option being selected more often across time for the load condition compared to control condition. In this case, we might see similar slopes for both conditions, but the mean proportion of immediate choices should be greater in the load condition than the control condition across time.

We measured choice consistency by examining the number of intransitive choices. A participant would be intransitive if they preferred \$50 now compared to \$500 in 1 month, but preferred the delay reward when presented with \$150 now compared to \$500 in 1 month. Figure 3a and b present the mean number of intransitive choices for each condition. An ANOVA revealed a main effect of condition on the number of intransitivities for both the \$500 and \$10,000 rewards, $F(1, 52) = 18.94$ and $F(1, 52) = 27.59$, ps < .001, respectively. The load condition produced more intransitivities than the control condition. There was no main effect of delay time on the number of intransitivities for the \$500, $F(6.3, 41.4) = 1.48$, $p = .18$, and the \$10,000, $F(6.58, 43.24) = 1.68$, $p = .12$, rewards. Additionally, the interaction between condition and delay time was not significant for the \$500, $F(6.23, 40.94) = 0.82$, $p = .56$, and the \$10,000, $F(6.51, 42.78) = .56$, $p = .77$, rewards. The increase in the number of intransitivities in the load condition provides additional support that the presence of a demanding cognitive load might be to increase inconsistency.

Estimation of *k* and Error

A discounting parameter (k), see Equation 1, and the number of erroneous responses were estimated for each participant

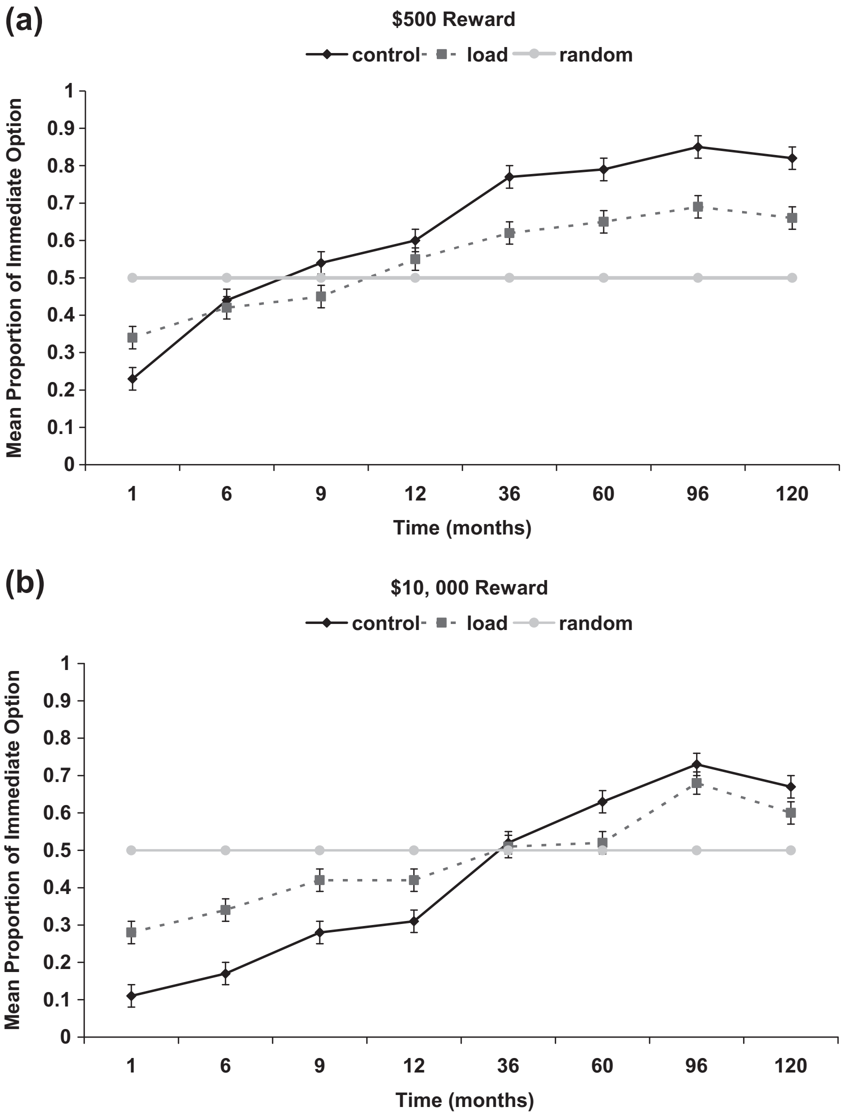

Figure 2. Mean proportion of selecting immediate choice across time for (a) \$500 reward (b) \$10,000 reward.

and condition using Hinson et al.'s method (2003).[2] Erroneous responses refer to the number of choices made in the decision task that differed from the predicted responses based on the participant's best-fitting *k*.

The discounting rate did not differ between the load (k = .437, *SD* = 1.32) and control (k = .360, *SD* = 0.55) conditions for the \$500 reward, $t(52)$ = .50, p = .62, d = .08, nor between the load (k = .281, *SD* = 0.53) and control (k = .250, *SD* = 0.98) conditions for the \$10,000 reward, $t(52)$ = .27, p = .79, d = .04. The observed differences in *k* for the different delay reward values are expected because smaller rewards are typically discounted at a higher rate than larger rewards. We did not find support that taxing the executive processes leads to higher discounting rates. To examine whether cognitive load produced larger proactive interference effects on later trials (Hinson & Whitney, 2006), we divided the 80 decision trials into four blocks (e.g., Block 1 = trials 1–20, Block 2 = trials 21–40, etc.) per condition. Paired comparisons revealed no significant differences in *k* across blocks in either condition, *p*s > .05. Perhaps, the interference associated with the cognitive load task placed greater demands on decision making above and beyond proactive interference.

Next, we computed two difference scores per participant: (1) *k* difference score subtracting *k* in the control condition from the load condition and (2) an error difference score subtracting the number of "erroneous" responses in the control condition from the load condition. A significant negative

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[2] Values for Equation 1 were determined for the immediate and delayed options by varying *k* values in incremental steps of .005 for a total of 2,000 iterations. An error occurred when the participant's choice disagreed with the estimated higher value option. For all errors, the sum of squared error was calculated between the two values. The *k* yielding the smallest total sum of squared errors resulted in the estimated *k* for each participant. Separate *k* estimations were computed for control and load conditions.

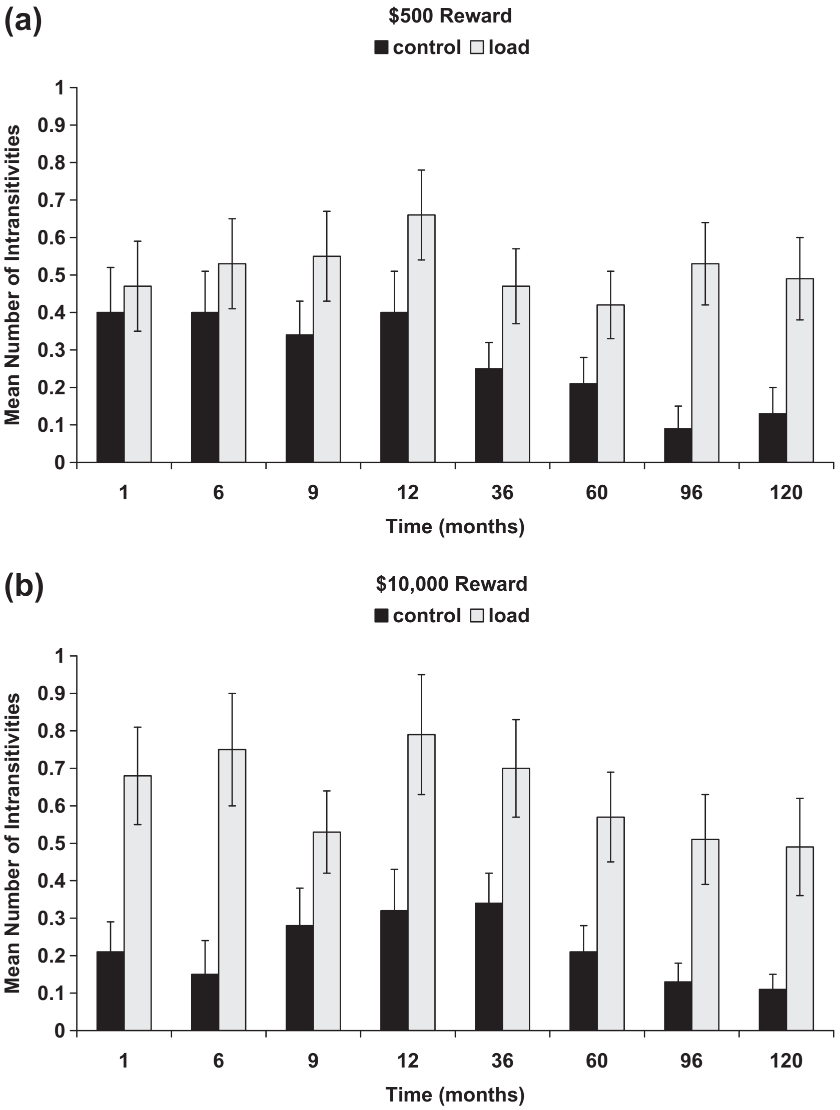

Figure 3. Mean number of intransitive choices for (a) $500 reward (b) $10,000 reward.

correlation ($r_s = -.40$, $p > .001$) emerged between k and error difference scores in the $500 reward, but not in the $10,000 reward ($r_s = -.18$, $p = .19$). A relationship between k *and* error difference scores was not expected because a shift toward an impulsive or conservative strategy should not be associated with an increased number of errors and conversely, an inconsistent response strategy should increase the number of errors without an associated increase or decrease in k. However, negative k difference scores can occur if there is a slightly higher proportion of selecting the immediate option in the control condition which occurred for the $500 reward (*GM* = .63, *SD* = 0.24), but not for the $10,000 reward (*GM* = .43, *SD* = 0.25). These differences are expected because of the higher rates of discounting for smaller rewards (Green et al., 1999). During load conditions, the rate of selecting the immediate option approached 50% for both the $500 (*GM* = .55, *SD* = 0.27) and $10,000 (*GM* = .47, *SD* = 0.27) rewards. Thus, if under cognitive load, participants shift toward more inconsistent responses, then the delayed option would be selected more often resulting in a negative relationship between k and error difference scores.

Letter Generation Task

As a manipulation check to ensure that participants completed the cognitive load task, generation response rates were calculated per participant by computing the number of letters generated over the total number of possible generations during the decision task. Participants generated letters on average 79.85% of the time (*SD* = 20.63 range 30–100%). Seven of 53 participants generated less than 50% of the letters demanded. Because of the dual-task nature of the experiment, increased demands associated with completing both tasks, response omissions are expected. Response rates did not correlate with discounting rates ($500: $r = .08$, $p = .55$ and $10,000: $r = -.11$, $p = .42$) nor with the number of intransitive choices ($500: $r = .09$, $p = .54$ and $10,000: $r = -.07$, $p = .61$). It appears that rate of generation did not impact the choice strategy, but that generating letters, in general, was sufficient to produce changes in choice consistency.

General Discussion

Because decision making, impulsivity, and central executive processes in working memory rely on frontal lobe functioning, researchers have posited whether or not occupying the executive processes in working memory is sufficient to produce impulsivity. Indeed, impulsive decision making and working memory deficits have been observed in both brain-damaged patients and addicts (Bechara, 2005; Bechara & Martin, 2004; Dixon et al., 2003; Kirby & Petry, 2004). However, most decision tasks used with brain-damaged patients involved a learning component (e.g., Iowa Gambling Task) or required one to inhibit responses to specific stimuli in the decision task. Fellows and Farah (2004) used a delay discounting task with shorter delay times and found no differences in discounting rates between patients with nonfrontal and frontal lobe damage. Although a relationship exists between impulsivity and addiction, this relationship is correlational. It is difficult to ascertain a causal relationship between the variables: Do deficits in working memory result in more impulsive decisions leading to addiction or do more impulsive decisions lead to potential substance-abuse problems which in turn affect working memory processes? The exact causal nature of this relationship is still under investigation.

We found little evidence to support that taxing the central executive processes in a *normal* sample results in more impulsive decisions. Placing additional demands on central executive resources with a demanding generation task increases the number of inconsistent choices. It is easy to imagine that in the delay discounting task, it might be difficult to fully evaluate multiple pieces of information while performing a demanding load task. If one cannot devote sufficient processing resources to evaluating the options, maintaining consistency in decision making becomes virtually impossible. Our results suggest that taxing working memory is neither necessary nor sufficient to produce impulsivity in a decision task. Furthermore, our results suggest that using k without examining choice consistency might lead to theoretical interpretations that can be misleading.

Although previous research has demonstrated no differences between real and hypothetical decisions using the delay discounting paradigm (Johnson & Bickel, 2002), perhaps in real-life situations when more is at stake people use different decision strategies to ensure consistency. However, in many situations one has to make decisions under less than ideal circumstances (e.g., time pressures, stress, sleep deprivation, and reduced attentional demands; Johnston, Driskell, & Salas, 1997). Some decisions are as trivial as choosing a task-out food order or selecting a detergent, while others, such as voting or deciding whether to pass another car on the road, can have significant and lasting consequences. These types of decisions are sometimes made by people who are distracted or under time pressure. Thus, understanding how attention and executive processes interact with the choices that people make is of substantial importance.

Acknowledgments

The research was supported in parts by Grant R29 MH58202 from NIMH (T. C. Rickard, PI) and Grant R01 MH45584 from NIMH (H. Pashler, PI). We would like to thank David Cun for programming the experiment and Kathrin MacNeil, Anisa Thobhani, Kristina de LaRosa, and Rebecca Eskins for assistance with data collection and letter generation transcriptions.

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Received November 6, 2008
Revision received April 15, 2009
Accepted April 20, 2009

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