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Has Anybody Asked How People Change Their Minds? Pre-crastination and Its Underlying Basis in Decision-Making

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ABSTRACT

Procrastination is much too familiar to us, a derogatory term taught to students as something to avoid, which, to teachers' despair, counterproductively encourages students to take up procrastination as a challenge. The opposite of procrastination, pre-crastination describes the likelihood of completing tasks early at the expense of extra effort, and may be a phenomenon as common as procrastination (Rosenbaum et al., 2014). We hypothesize that fundamentally, pre-crastination is cognitively driven, given that participants offload cognitive tasks before determining the course of action. This study took place over three experiments. Our pool of UCR undergraduate participants (N=89) made two forced yes/no responses pertaining to the same stimulus in each trial. The stimuli in the first experiment was determining chronology of number sequences while the stimuli in the subsequent two experiments was determining digit-matching. The most significant alteration was made in the third experiment, in which the second response was changed from a yes/no to a confirm/disconfirm submission. This innovative testing strategy, coined double-response in our lab, allows us to correlate response time to decision-making bases. Largely, participants exhibited a significantly longer reaction time in submitting their first response. This outcome supports our cognitive hypothesis which predicts that action-planning occurs through longer first-response times, going against the behavioral hypothesis which predicts that action is taken prematurely through shorter first-response times. Ultimately, this double-response method better helps us understand the dynamics of decision-making through pre-crastination.

KEYWORDS: pre-crastination, double-response, procrastination, decision-making, planning

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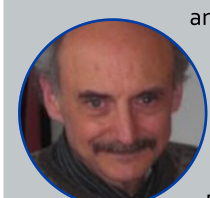

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Has Anybody Asked How People Change Their Minds? Pre-crastination and Its Underlying Basis in Decision-Making

INTRODUCTION

The process of 2-step decision-making first established by Francis Donders was paramount in establishing that decisions are made in stages: early stages of decision-making are automatic while later stages are more calculated (1868; Rosenbaum et al., 2022 (in press)). Donders' groundbreaking study demonstrates that decision-making is a cognitively complex process that takes into account reaction times, and it has since been further studied using various methods. In leading experiments building off of reaction times in decision-making, studies involving choice reaction tasks are particularly significant in demonstrating that actions (i.e. behavioral response) are not always the final product of cognition; reaching trajectories can have multiple competing targets (Hillyard & Kutas, 1983; Luck et al., 1990; Hillyard, 1990; Song & Nakayama, 2009). For example, you may find yourself automatically reaching for a commonly used object due to muscle memory, but may correct yourself upon realizing you intended to reach for something else.

These trailblazing methods in integrating reaction time greatly influenced our lab's basis of choice reaction time (RT), more particularly the 2-choice RT strategy – introducing two possible stimuli under two responses (Rosenbaum et al., 2022 (in press)). Existing experimental RT has suggested that people continue to think even after a response has been made in their decision-making process, and furthermore, RT has been found to be longer after an error has been made compared to that of non-error trials (Danielmeier & Ullsperger, 2011; Rosenbaum et al., 2022 (in press)). This brand-new method of studying decision-making required two responses, which our participants were told could be non-identical. This procedure allowed participants the possibility to rethink their final answer before moving on to the next trial and was consequently a new variation of psychological experimentation based on choice RT in decision making, coined by our lab as the double-response method.

PRE-CRASTINATION

Pre-crastination, the hastening of tasks at the cost of additional effort, was the key discovery that gave rise to our invention of the double-response method for observing response times in our experiments. Our lab first observed the phenomenon of pre-crastination through a 2014 experiment, in which UCR undergraduates chose to pick up one of two buckets – one spaced closer to the starting point and the other further from the starting point – to carry to the finish line (Rosenbaum et al., 2014). In the experimental group, the bucket closest to the starting point is lighter in weight, whereas the bucket placed closest to the finish line is heavier; in the control group, the buckets are spaced in the same manner, but they remain empty and therefore are the same weight. Contrary to our lab's expectation, the results of both the experimental group and the control group show that a majority of participants choose to carry the bucket closer to the starting point rather than the bucket further from the starting point. Thus, participants consistently opt for the bucket that must be carried a farther distance.

This surprising outcome goes against Rosenbaum, Gong, and Potts's expectations in mapping the "biomechanical tradeoffs" analogizing weight and distance, which, in sum, intends to determine the point of indifference within the said tradeoff (2014). This experiment was sparked by an interest in human action planning, a segment of decision-making that posited the investigation into human course of action in correlation to the action's biomechanical costs. Essentially, this experiment was the first instance observed exemplifying pre-crastination and hence initiated our lab's research further into the phenomenon.

Noteworthy in the pioneering experiment run by Rosenbaum et al. (2014) is the restriction that it can only test the behavioral account of pre-crastination, which only emphasizes the completion of a goal at the cost of extra effort. Cardinal subsequent studies carried out by Fournier et al. (2018; 2019) challenge this basis of pre-crastination by arguing that it is actually the start, not completion, of goals rooted in the tendency to pre-crastinate via offloading working memory. In 2018, Fournier carried out two experiments with physical tasks – one experiment requiring lower cognitive demand (bearing no memory load) and the other requiring higher cognitive demand (bearing high memory load) – in order to observe how increasing cognitive demand affected the tendency to pre-crastinate. Fournier's results show that the more cognitively demanding task increases participants' likelihood to plan a course of action, i.e. make a logical decision before taking action. This conclusion contradicts the method of pre-crastination proposed by Rosenbaum et. al. (2014) thus far, which asserts that actions are carried out prior to cognitive decision-making. Thus, a new potential premise for the phenomenon is introduced: the cognitive account.

Understanding the fundamental driving factor of pre-crastination is crucial in understanding its potential reflections in our everyday lives – whether it be answering emails hastily without caution, convicting people without forethought (as magnified within the criminal justice system, particularly regarding the disproportionately incarcerated people of color in American prisons), and in the most extreme case, beginning wars without proper deliberation (with the most current example being the 2022 war on Ukraine). All of these examples have the same limitation as Rosenbaum et al. (2014): they are all under the presumption that pre-crastination operates on a behavioral basis. As such, in order to determine if pre-crastination truly does explain fundamental decision-making in these events, our goal is to establish a conclusive experiment that also examines the potential cognitive basis behind the phenomenon by way of double-response RT methodology.

Behavioral vs. Cognitive Basis

Firstly, examining the driving factor – the behavioral account or cognitive account – of pre-crastinational decision-making is fundamental in building its premise.

The behavioral account describes the phenomenon of acting on impulse and is thus considered idleness aversion: doing something is its own reward (Hsee et al., 2010; Rosenbaum, 2022). Essentially, we define the behavioral basis as "the desire to act upon." For instance, in the present study, a participant would find pressing a button alone in itself rewarding, as they are simply looking to rid themselves of the action (Fournier et al., 2018, 2019; Rosenbaum et al., 2019). Moreover, many studies have demonstrated that there are no intrinsic rewards that result from pre-crastination. As summarized above, picking up the basket in the 2014 study is not rewarding in itself because a basket is always picked up and the same distance is walked (Fournier et al., 2018, 2019; Rosenbaum et al., 2019). As such, there is nothing intrinsically rewarding about picking up a basket earlier or later. Further studies have also shown that early actions reduce external rewards (Rayburn-Reeves et al., 2011; Zhu et al., 2018).

The cognitive basis is defined as the inclination to make a decision before planning a course of action. Having a lesser memory load may enable one to be more prepared to face future challenges, a concept which Wasserman (2018) referred to as the "fierce urgency of now," quoted from Martin Luther King, Jr (Rosenbaum et al., 2022 (in press)). Research has furthermore shown that when memory loads are increased, pre-crastination rates increase. This data is consistent with the postulation that pre-crastination is linked with working memory resources to clear items from a mental to-do list (Fournier et al., 2018; Patterson & Kahan, 2020).

Double-response is henceforth a testing strategy formulated in our experiments as an attempt to discriminate between the behavioral and cognitive accounts studied previously in the field of decision-making. This new tool can bring more awareness and clarity to decision-making, which can subsequently enrich the understanding of this important topic as well.

Double-Response

The double-response method is the driving force for studying whether or not pre-crastination is built upon a behavioral or cognitive basis. In both accounts, the reaction time patterns are key in concluding behavioral or cognitive forces.

Double-response describes the method in which participants make a yes/no decision in response to one stimulus, and subsequently must also submit a second response echoing or not echoing their initial decision (Rosenbaum et. al. 2022 (in press)). We set these responses, R1, and R2 (the first response and the second response respectively), as the main means by which to build our data of interest. One set of data corresponding to R1 and R2 was the accuracy probabilities P1 and P2, respectively. The other set was the corresponding times, T1 and T2, with regards to R1 and R2 respectively. T1 and T2 were representative of the reaction times, with T1 defined as the time from when participants were first exposed to the stimulus to the time R1 were submitted, and T2 defined as the time period between R1 and R2 submissions. Thus, the total time per trial was defined as T1+T2 (Rosenbaum et. al. 2022 (in press)).

Participants were not given feedback regarding their accuracy or reaction times for the first two experiments. The only prior instructions participants were given were to respond accurately and directly. This procedure allows us to better gauge predictions for our two models of behavioral vs. cognitive bases.

In our prediction concerning the behavioral model, participants are expected to submit R1 rapidly, resulting in a characteristically short T1. This derives short latencies which cause participants to focus their primary decision-making in their R2, consequently producing a longer T2. Based on this strategy, our expected results would exhibit $T1<T2$ and $P1<P2$, mirroring the offloading of action.

Conversely, our prediction regarding the cognitive model would yield a characteristically longer T1 due to their reduction of cognitive load in R1. In their subsequent R2, their T2 would likely be shorter due to the decision largely being rectified in R1. This implies that primary decision-making was made before planning a course of action, thereby participants are more inclined to think the task through before submission of either response. This strategy will give rise to two potential patterns: (1) $T1>T2$, $P1=P2$ if no additional decision-making took place after R1, or (2) $T1>T2$, $P1<P2$ if decision-making was refined after R1. We omitted the hypothesis of $T1=T2$, as although we acknowledge that this outcome was a possibility, it was extremely unlikely and not relevant to our main hypotheses.

Our lab conducted three different experiments in order to test the double-response strategy and apply our cognitive vs. behavioral models of pre-crastination. Each experiment led to the development of the consecutive experiment, with Experiment 1 being the pioneering study utilizing the double-response method. Experiment 2 was thereafter introduced in order to reduce fallacies that may have given rise to biased results in the first experiment and was the primary procedure that Experiment 3 was built upon. Experiment 3 ultimately provided the most conclusive and substantial results for our hypothesis as it was based on the analyses of the previous two experiments.

EXPERIMENTS 1 AND 2

METHODS

In Experiment 1, UCR undergraduate participants (N=15) were asked to make yes/no judgments regarding 2-digit numerical sequences, read from left to right. Participants were told to be as accurate and quick as possible in both R1 and R2. A participant may be given one of these two sequences: (a) 11 12 20 28 33 75 (b) 28 36 **45 35** 78 91. Sequence (a) formed a chronologically increasing pattern because each subsequent 2-digit number was larger than the number before when read left to right. However, (b) was not chronologically increasing because 35 was smaller than 45 and thus disrupted the smallest-to-largest-number pattern.

As per our double-response strategy, participants were told to submit two individual yes/no responses per trial. A "yes" was conveyed by pressing the j key and indicated that the participant observed a chronological sequence, whereas a "no" was conveyed by pressing the f key and indicated that there was not a chronological pattern. Experiment 1 and the subsequent experiments were written and run on MATLAB, a computing platform which automatically calibrated reaction times and accuracy. The program contained six blocks, with 24 trials per block. Half of the trials in each block randomly contained sequences that increased chronologically, while the other half contained a violation of the chronological pattern by one position.

In Experiment 2, UCR undergraduates (N=32) participated for academic credit. None of these participants participated in Experiment 1 and were once again told to be as accurate and as quick as possible in R1 and R2. Rather than showing two digits to be checked for monotonicity as in Experiment 1, participants were instead shown six three-digit numbers to check for repeats in the hundred's column, the tens column, or one's column (see **Table 1**). Participants were instructed to consult the first three-digit number as their reference point to scan for repeats in subsequent three-digit numbers' corresponding columns. If participants found a repeat in the hundreds, tens, or one's columns, they pressed "j" on the keyboard; otherwise, they were to press "f" on the keyboard. As in Experiment 1, participants were given a second response in each trial. They were told that they were being tested on their quickness and precision, but were not given any feedback regarding these two factors.

Digit Array	Repeat Column	Repeat Position
687 293 141 532 779 155	None	None
687 293 641 532 779 155	Hundreds	3
687 293 641 582 779 155	Tens	4
687 293 141 532 777 155	Ones	5

Table 1. Examples of digit arrays in Experiment 2

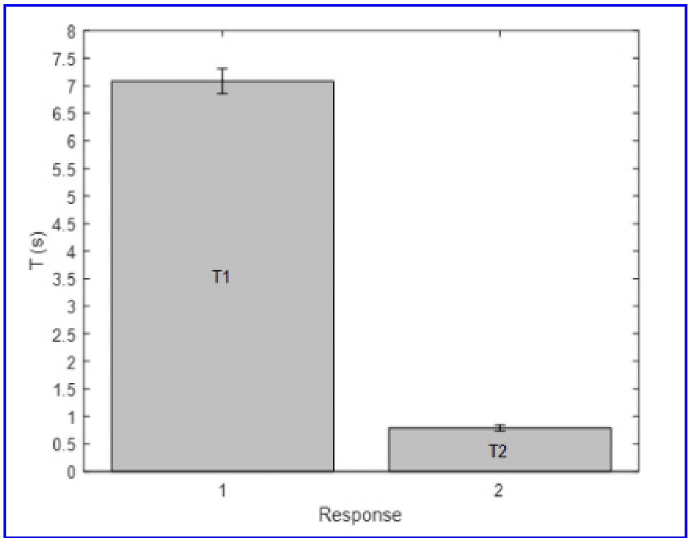
** The underlining and bolding of digits was not shown in the experiment.*

RESULTS

The total average of correct responses in Experiment 1 was calculated to be M=0.89, with P1 (M=0.88) observed as being smaller than P2 (M=0.90). Of this proportion, T1 (M=1.8) was seen to be notably higher than T2 (M=0.2); data showed that T2 values remained consistently shorter than T1 values throughout the experiment.

In Experiment 2, it was observed that P1 (M=.706) was slightly lower than P2 (M=.718). Similarly, T1 was seen to be longer than T2. Our data thus remained consistent with the results obtained from Experiment 1. We saw a correlation between participants' time and responses, where T2 was smaller when R2 matched R1 vs. when there was no match between R2 and R1, as shown in **Figure 1** below.

To further understand participants' accuracy in decision making, the function of Repeat Position was further analyzed in Experiment 2. It was found that when there were no repeats, the proportion correct was higher compared to when there were repeats. Given the presence of a repeat, this proportion became higher when the second number in the three-digit number had a repeat. Additionally, the proportion correct was found to be higher in Response 2 (Rosenbaum, et al., 2022 (in press)). T1 and T2 as a function of Repeat Position ultimately demonstrated that T1 was longer for trials without repeats than with repeats. T2 was found to be smaller than T1 but was not associated with the Repeat Position.



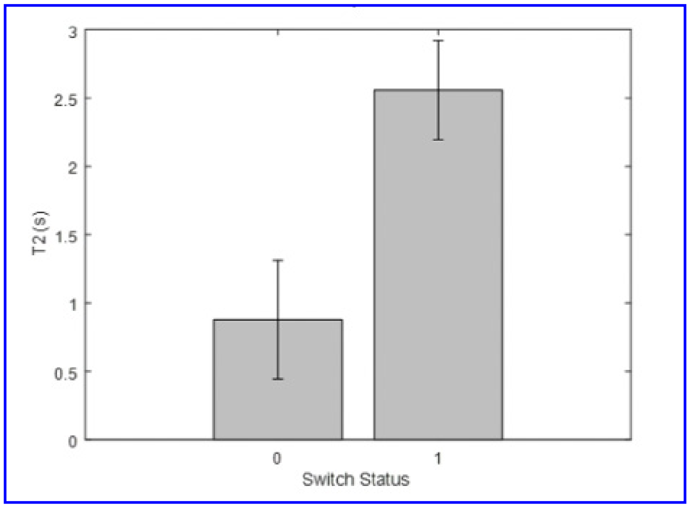


Figure 1. Experiment 2 time results. **Top image:** Mean times (±1 SE), T1 and T2, for the first and second response, respectively. **Bottom image:** T2 mean times (±1 SE) in trials without a response switch (Switch Status = 0) and with a response switch (Switch Status = 1).

DISCUSSION

Results from Experiment 1 had thus far supported the cognitive basis of pre-crastination over the behavioral basis. We observed a characteristically longer T1>T2, and a P2 very slightly, if at all, higher than P1, concluding that participants largely opted to reduce their cognitive load by completing their decision-making upfront.

In Experiment 2, methods differed slightly from Experiment 1 because it was found that a feature of the semantics affected the behavioral hypothesis, which may have made the task easier and potentially caused a fallacy. In Experiment 1, it was speculated that participants used a shortcut strategy by looking at the start and end of the sequence thereby allowing them to make a quick decision. In application, participants pressed j (yes) if the leftmost number was small and the rightmost number was large, or otherwise pressed f (no). This potential strategy may be considered a fallacy as it may have allowed participants to make quick and easy decisions, thus disrupting genuine decision-making.

In Experiment 2, the double-response method was continued, but with new, more cognitively taxing stimuli which helped remove the fallacy between numerical size and response type in Experiment 1. Instead of deciding between a 2-digit number increase, participants in Experiment 2 decided whether a 3-digit number following the first set of numbers had a repeat in the hundreds, tenths, or one's columns.

Unlike Experiment 1, in which participants may have checked the ends of sequences to make a quick decision, Experiment 2 prompted participants to implement a more orderly method of decision-making. In both experiments, T1 was longer than T2, and P2 was slightly larger than P1. This correlation between a longer T1 and higher P2 suggested that participants were likely making a decision before taking action, supporting the cognitive hypothesis over the behavioral hypothesis. However, it was observed that participants were grouping responses, or making a single decision and submitting R1 and R2 in rapid succession, resulting in a new fallacy coined the tap-tap phenomenon. Experiment 3 was therefore created to address this potential issue and validate our findings thus far.

EXPERIMENT 3

METHODS

Response grouping (Adam et al., 2003; Miller & Ulrich, 2008; Ulrich & Miller, 2008) may have led to a term we have coined the tap-tap phenomenon, in which participants decide on one response and tap the associated key twice (for R1 and R2) in rapid succession. In an attempt to stop this occurrence in our results, we altered the semantics of R2 and emphasized that only the accuracy of R2 mattered in our participants' instructions. This change in semantics gave participants an incentive to conduct two separate motor plans instead of sticking to one response throughout a trial, therefore giving rise to slightly higher P2 and T2. In Experiment 3, participants were also given feedback on the accuracy of their final answer as a motive to answer correctly, and to ensure that they understood instructions.

To implement our adjustments, the task of R2 was changed from a yes/no judgment to a confirm/disconfirm judgment. Participants would accomplish the task by continuing to tap the j key to convey a yes (match) or the f key to convey a no (no match) for R1; however, they would thereafter press j to confirm their judgment or f to disconfirm their judgment (i.e. reverse their initial response) in R2. This inclusion of a confirm/disconfirm R2 would halt response grouping, as our program would randomly determine that pressing the j key half the time and pressing the f key the other half of the time throughout R1 and R2 would yield a correct response. This sequence made it essentially impossible to blindly group responses in order to consistently obtain a correct final answer throughout the experiment.

Seeing as the instructions for this experiment were more complex than the previous two, research assistants ensured that the participants did not begin the trials until they were coached and fully confident with the directions. As mentioned previously, participants were not given feedback on accuracy or reaction times in the first two experiments. In the third experiment, participants were given feedback regarding the accuracy of their final response in order to not only verify their understanding of the experiment, but to also check the accuracy of the results acquired from the first two experiments.

RESULTS

According to **Figure 2**, the first common response from participants was R1 and R2 being both correct (total number=4481). The second most common response was R1 and R2 both being incorrect (total number=380). The remaining two choices were chosen least commonly: incorrect and then correct (total number= 110) or correct and then incorrect (total number=68). P2 values were observed to be well predicted by P1.

Additionally, **Figure 2** demonstrates that T1 (M=9.16 s)

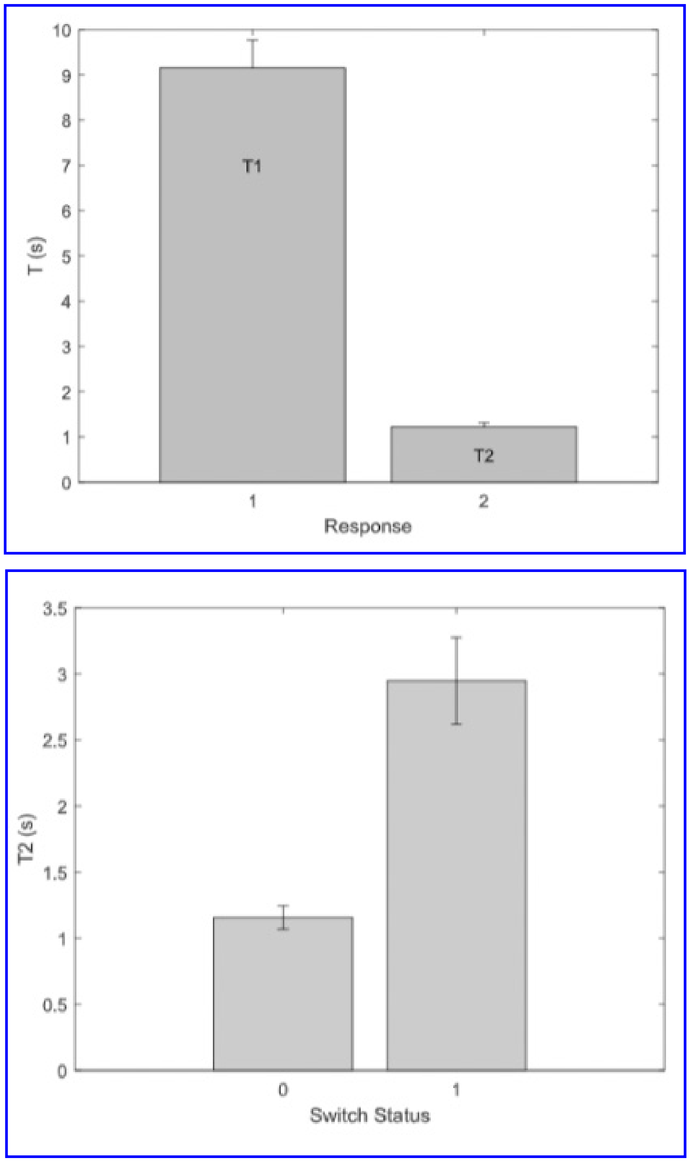


Figure 2. Experiment 3 Results. **Top image:** Mean times (±1 SE), T1 and T2, for the first and second response, respectively. **Bottom image:** T2 mean times (±1 SE) in trials without a response switch (Switch Status = 0) and with a response switch (Switch Status = 1)

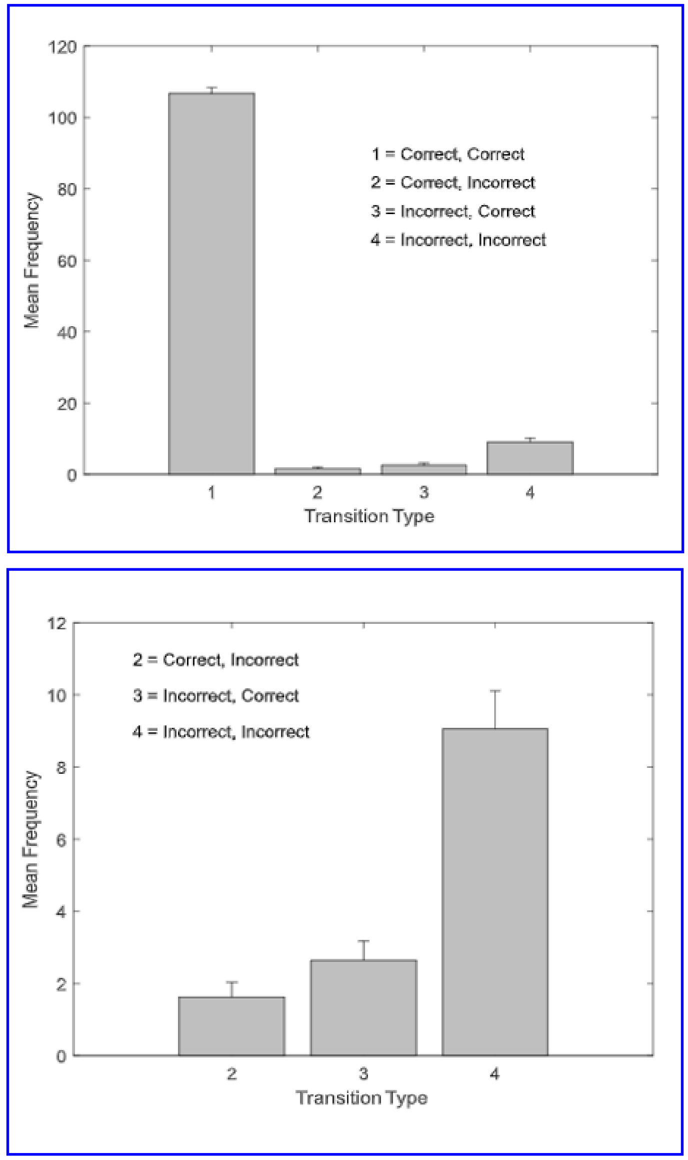


Figure 3. Experiment 3 transition types. **Top image:** Mean frequency (±1 SE) of the four transition types in Experiment 3. **Bottom image:** Blowup of frequencies from left panel.

was longer than T2 (M=1.22 s). This implies that participants were thinking about their response before responding, supporting the cognitive model. The histograms in **Figure 3** continue to point out the great difference between T2 and T1, showing T2 being characteristically shorter than T1. This trend was inconsistent in only one case, in which T2 times were found to be longer when participants switched their decision for R2 (M=1.18s), compared to the non-switch case where T2 (M=1.22). It is important to note once again that a response switch in Experiment 3 meant the participant was disconfirming their first response; however, this did not imply switching the buttons pressed.

DISCUSSION

As stated in the methods for this experiment, the potential fallacy of response grouping observed in the prior two experiments was addressed in our altered procedure. We intended to diminish response grouping by (1) changing the semantics of R2 and (2) shifting emphasis in the instructions.

Redefining R2 from a simple yes/no judgment to a confirm/disconfirm judgment caused cessation of repeat answers in R1 and R2 of each trial by encouraging participants to genuinely plan out their motor responses for both submissions. Response grouping would thus be violated for participants to receive an accurate final answer throughout the experiment.

Only underscoring the accuracy of R2 to the participants and, moreover, giving the participants feedback on the accuracy of their final answer helped to incentivize the quick behavior of R1. In other words, R1 could be given quickly at no cost to accuracy, thus leveling the playing field for both the cognitive and the behavioral hypotheses. More importantly, allowing the participants feedback on accuracy would resolve any misunderstandings and also verify the viability of previous experiments.

Experiment 3 continued to show the same results as Experiment 1 and 2, even though the task was made more challenging and the meaning of the responses changed. T1 continued to be longer than T2, demonstrating that the hypothesis made previously about their existing response grouping in Experiment 2 was wrong, given that the same results were seen in Experiment 3. This means that participants were taking their time to make a decision in all three experiments instead of making a quick and thoughtless action. Thus, these results support the cognitive model for decision-making.

GENERAL DISCUSSION

Experiment 3, the focus of our results and ultimately the concluding factor in our study, establishes that pre-crastination is built on a cognitive basis, i.e. decision-making is completed before action-planning, resulting in a delay of the first response (T1). We include experiments 1 and 2 in our article body because they necessarily built the foundation upon which our lab began to concretely build the cognitive vs. behavioral methods of early decision-making.

Through analysis and study of these two prior experiments, Experiment 3 eliminates all potential fallacies by (1) giving feedback at the end of each trial and (2) altering R2 to a confirm/disconfirm judgment as opposed to yes/no. In the end, the results of experiment 3 continue the trend of supporting the cognitive basis with P2>P1 and T1>T2, thus confirming the results of our lab's first two experiments.

This implication is significant in studies of perceptual-motor performance, as support for the cognitive basis of pre-crastination essentially enforces that pre-planning of action takes place when presented with a mentally demanding task. For instance, if one were to bear a heavy memory load (i.e.

have a lot on their mind) while walking through a crosswalk of a busy intersection, it is important to understand what would be prioritized in order to safely make it across: thinking or walking? As per our results, we hypothesize that the individual would think critically before crossing as a form of reducing the additional memory load that comes with "looking both ways." In the real world, however, humans are much more complex. Some have heavier memory loads than others and may follow the cognitive hypothesis of pre-crastination, while others bearing lighter memory loads may follow the behavioral hypothesis of pre-crastination. Therefore, in order to further study such nuances of pre-crastination and its impact in decision-making, we must continue to explore this modest field of psychological research.

FUTURE DIRECTION, LIMITATIONS, AND CONCLUSION

Due to the COVID-19 pandemic, Experiment 3 was conducted via zoom. This caused some technical difficulties, e.g. losing internet connection in the middle of the experiment. There existed further limitations, which are further detailed in *Think Then Act, or Act Then Think*?, a publication currently in press to be published (Rosenbaum et al., 2022). In order to replicate this study in the future, testing a larger pool of participants may be necessary in validating our findings, as this current study overall had a small sample size (N=89) which may have increased the margin of error in our results. Ultimately, we hope results from our experiments will help bring more awareness to the study of our new theory of pre-crastination, which in turn may bring new discoveries regarding how decision-making is prioritized.

Research outlining pre-crastination and implications in cognitive-behavioral psychology have led researchers to extend experiments beyond human subjects and observe how animals behaviorally make decisions in their primitive form. In a 2015 study, researchers found that pigeons unequivocally would move locations sooner rather than later in order to be rewarded with food while following the double-response method (Wasserman and Brzykcy, 2015). Thus, similar outcomes regarding pre-crastination were observed in non-human subjects, albeit through the behavioral hypothesis. Such innovative experiments on animals' decision-making may be progressed in attempts to further understand decision-making at the elementary level, or perhaps even build on Wasserman's experiment to study animals through the cognitive hypothesis, yielding the bigger question – how do animals as a whole think?

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REFERENCES

Adam, J. J., Hommel, B., & Umiltà, C. (2003). Preparing for perception and action (I): The role of grouping in the response-cuing paradigm. Cognitive Psychology, 46, 302-358.

Danielmeier, C., & Ullsperger, M. (2011). Post-error adjustments. *Frontiers in Psychology, 2, 233*. doi: 10.3389/fpsyg.2011.00233

Donders, F. C. (1868). On the speed of mental processes. [W. G. Koster, 1969, Trans.]. *Acta Psychologica*, *30*, 412-431.

Fournier, L. R., Coder, E., Kogan, C., Raghunath, N., Taddese, E., & Rosenbaum, D. A. (2018). Which task will we choose first? Precrastination and cognitive load in task ordering. Attention, Perception & Psychophysics, 81, 489-503.

Fournier, L. R., Stubblefield, A. M., Dyre, B. P., & Rosenbaum, D. A. (2019). Starting or finishing sooner? Sequencing preferences in object transfer tasks. Psychological Research, 83, 1674-1684.

Hillyard, S. A., & Kutas, M. (1983). Electrophysiology of cognitive processing. *Annual Review of Psychology, 34*, 33-61.

Hsee, C. K., Yang, A. X., & Wang, L. (2010). Idleness aversion and the need for justifiable busyness. *Psychological Science, 21,* 926-930.

Luck, S. J., Heinze, H. J., Mangun, G. R., & Hillyard, S. A. (1990). Visual event-related potentials index focused attention within bilateral stimulus arrays. II. Functional dissociation of P1 and N1 components. *Electroencephalography and Clinical Neurophysiology, 75*, 528-542

Miller, J., & Ulrich, R. (2008). Bimanual response grouping in dual-task paradigms. Quarterly Journal of Experimental Psychology, 61, 999-1019.

Patterson, E. E., & Kahan, T. A. (2020). Precrastination and the cognitive-load-reduction (CLEAR) hypothesis. Memory, 28, 107-111.

Rayburn-Reeves, R. M., Molet, M., & Zentall, T. R. (2011). Simultaneous discrimination reversal learning in pigeons and humans: Anticipatory and perseverative errors. *Learning & Behavior, 39*, 125-137.

Rosenbaum D. A., Gong L., & Potts C. A. (2014). Pre-Crastination: Hastening Subgoal Completion at the Expense of Extra Physical Effort. *Psychological Science. 2014;25*(7):1487-1496. doi:10.1177/0956797614532657

Rosenbaum, D. A., Fournier, L. R., Levy-Tzedek, S., McBride, D. M., Rosenthal, R., Sauerberger, K., VonderHaar, R. L., Wasserman, E. A., & Zentall, T. R. (2019). Sooner rather than later: Precrastination rather than procrastination. Current Directions in Psychological Science, 28, 229–233.

Rosenbaum D. A., Sturgill H., & Feghhi I. (2022). Think Then Act, or Act Then Think? Double Reaction Times Shed Light on Decision Dynamics in Pre-Crastination. In press to be published. *Journal of Experimental Psychology,* pp. 1–40.

Song, J. Y., & Nakayama, K. (2009). Hidden cognitive states revealed in choice reaching tasks. *Trends in Cognitive Science, 13*, 360–366.

Ulrich, R., & Miller, J. (2008). Response grouping in the psychological refractory period (PRP) paradigm: Models and contamination effects. Cognitive Psychology, 57, 75-121.

Wasserman, E. A. (2018). Precrastination: The fierce urgency of now. Learning & Behavior, 47, 7-28.

Wasserman, E. A., & Brzykcy, S. J. (2015). Pre-crastination in the pigeon. *Psychonomic Bulletin & Review 22*, 1130–1134. https://doi.org/10.3758/s13423-014-0758-3

Zhu, M., Yang, Y., & Hsee, C. K. (2018). The mere urgency effect. Journal of Consumer Research, 45, 673-690.