Title

Sequential Verbal Fluency

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SEQUENTIAL VERBAL FLUENCY

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ABSTRACT

Thinking about, planning for, and completing tasks is a compulsory aspect of everyday life. A less apparent, and far less understood, aspect of our daily lives is the joint influences of thinking about future and present task demands. For instance, imagine you are performing a routine task like getting ready for school, then suddenly you recall your upcoming midterm. In a fluster, preoccupied by thoughts about the midterm, you leave home without brushing your teeth. In this case, realizing the upcoming task (your midterm) interfered with completing a task at hand (brushing your teeth). The present study tests whether knowledge about an upcoming task will interfere with performance on a preceding task. It addresses current and future task interference in terms of verbal fluency (or word generation). It suggests that joint task influences are mediated by pre-castination: the tendency to start subgoals as soon as possible, even at the expense of extra effort. Furthermore, this study seeks to expand pre-crastination to the verbal domain and offers a novel experimental design for verbal fluency. The implications of joint task interference cannot be overstated, given the busyness of the modern-day schedule.

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TABLE OF CONTENTS

INTRODUCTION

The completion of tasks is a compulsory aspect of everyday life. Often, the demands of our day-to-day responsibilities compound, requiring some task sequencing, that is, managing multiple tasks consecutively or, worse still, concurrently. Whether our schedule is carefully planned and self-determined or sprung upon us by the requests of others or by happenstance, the fact remains that our attention is limited, and our tasks are often numerous. How do we manage our attention or effort between multiple tasks? Growing evidence suggests that we can only attend to one thing at a time, that multitasking is the flitting of attention from one thing to another, and, consequently, that any attempt at multitasking will inevitably be detrimental to our performance on the tasks involved (Madore & Wagner, 2020). Thus, we face a constant problem: attend single-mindedly to the task at hand, effectively ignoring tasks on the horizon, or shift attention between current and upcoming tasks, dampening concentration.

Pre-crastination

Pre-crastination, coined by Rosenbaum et al. (2014), describes, to some degree, how people resolve this problem. They begin a subgoal as soon as possible, even at the expense of extra physical effort (Fournier et al., 2018). In essence, when deciding between single-mindedly working on one task at a time or shifting effort between several tasks, people opt for a sooner rather than later approach where they get started on subgoals (tasks) as soon as possible. Various studies have cemented pre-crastination as an indelible behavioral phenomenon. In Rosenbaum's 2014 bucket experiment, participants were given the choice between carrying a nearby bucket a long distance, or a distant bucket, a shorter distance. If people would prefer the less physically demanding choice, the researchers were surprised to find that people opted for the nearby bucket, requiring greater physical exertion throughout the task. To justify their inefficiency, participants

claimed that their near bucket preference was an attempt to complete the task as soon as possible. Considering that the task completion time should be relatively constant regardless of the subject's choice, the researchers suggest that their subjects were referring to completing a subgoal (choosing between the two buckets), not the entire task. The reasoning for such a preference, the researchers suggest, is the reduction of the subgoal's inherent cognitive load.

Over a decade of research on pre-crastination has culminated in the cognitive-load-reduction (CLEAR) hypothesis (Ma & Zhang, 2023; VonderHaar et al., 2019). Fournier et al. (2018) posited that people pre-crastinate as an automatic response initiated by the affordance triggering of a nearby object. In brief, affordance triggering is the function that an object offers an individual (e.g., a bucket offers a person the function of being carried). Fournier et al. (2018) replicate the findings of Rosenbaum et al. (2014), further signifying that people rely on automatic decision-making, such as picking up the nearest bucket, to free up cognitive space for other matters. Additionally, Fournier et al. (2018) found that pre-crastination is the tendency to begin a subgoal as soon as possible (instead of hastening subgoal completion), even at the expense of extra physical effort. Furthermore, VonderHaar et al. (2019) show that when people are provided the choice between a more and less cognitively demanding task, they tend to perform the task requiring more cognitive effort first, again, demonstrating the tendency to reduce cognitive load or, as the researchers put it, to clear one's mind—hence the aptly named CLEAR hypothesis.

Pre-crastination describes the tendency and expense of committing physical actions as soon as possible, such as carrying all the groceries in one go, responding to an email too soon, or joining an airport boarding line long before your group is called. Alternatively, it says little about strictly cognitive actions such as jumping to conclusions, speaking before thinking, or other non-

physically demanding behaviors. Physical action and cognition may be inseparable. At a neurological level, considering mirror neurons, there appears to be little difference between body and mind or thought and action, apart from the associated brain regions of activation (Rizzolatti & Craighero, 2004). However, even within this paradigm, a distinction must be made: mental actions (e.g., thinking & planning) require less somatic activity than bodily actions (e.g., walking & carrying). Thus, this study addresses non-physical (or less bodily demanding) pre-crastinatory behavior.

Verbal Fluency

The verbal domain provides a viable cognitive behavior, word generation, because it is a measurable cognitive (i.e., non-physically demanding) behavior, and verbal fluency (VF) provides a falsifiable task design. The verbal fluency test is a long-standing psychological test for the timed measurement of a person's ability to generate semantic or phonemic-related words (Loonstra et al., 2001). The established norms of VF show that the production rate of items declines throughout a test (Bousfield & Sedgewick, 1944), that typical category exemplars are generated earlier and with greater frequency than non-typical ones (Gruenewald & Lockhead, 1980), and that items are generated in semantic or phonemic bursts (Hahnel et al., 2023). Each of these findings relates to a person's performance on a single task. This poses a limitation of the VF literature, which lacks a task design that measures the interactions of multiple tasks. Thus, this study addresses that limitation by sequencing VF tasks.

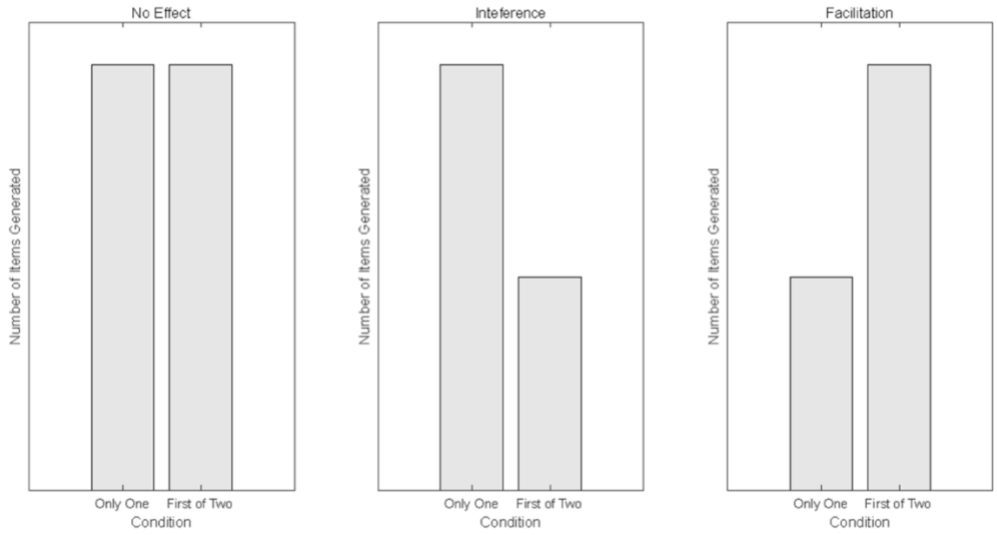
Knowledge & Interference

This research offers a novel VF task design to measure sequential task interactions and seeks to expand pre-crastination to the verbal domain (i.e., non-physical behavior). Given that pre-crastination is the automatic tendency to reduce cognitive load, one would expect that

providing knowledge about an upcoming task (thereby increasing the cognitive demand on a current task and enabling an early start on an upcoming task) would induce pre-crastination. If induced, current task performance will suffer a hit (deficit) due to a shift in attention onto the future task. Finally, the research question becomes apparent. Will knowledge about an upcoming task interfere with performance on a preceding task? Respectively, three hypotheses emerge (refer to figure 1).

Figure 1

Hypotheses: Null, Interference, & Facilitation of Advance Knowledge on Trial 3 Performance



Note. On the x-axis, only one refers to the nAK group on trial 3—participants know only one VF task category—whereas the first of two refers to the AK group on trial 3—participants know two VF task categories. They are performing on the first of two.

Interference: Knowledge about an upcoming task will interfere with performance on a preceding task. Facilitation: Knowledge about an upcoming task will facilitate performance on a preceding task. Null: Knowledge about an upcoming task will not affect performance on a preceding task.

METHODS

The research for this study was conducted under the auspices of the UCR IRB-approved study on Perceptual-Motor and Cognitive Task Coordination. This study was endorsed by the Laboratory for Cognition and Action, under principal investigator Dr. David A. Rosenbaum, within the Psychology Department of the University of California, Riverside. The task involved a series of verbal fluency assessments. All subjects were recruited through UCR's Department of Psychology Research Participation System, SONA.

Participants

The sample for this study comprised 55 undergraduates at the University of California, Riverside. All participants were recruited through SONA and were compensated for their time with research credit to their corresponding Introductory Psychology course of either PSYC 001 or PSYC 002. Among the 55 participants, the data for 10 of them were excluded for various reasons. Some (n=6) were excluded due to researcher error, and others (n=4) were excluded due to internet disruptions and/or noncompliance. Of the remaining participants assessed (n=45), 71% were female (n=32) and 24% were male (n=11). Their median age was 19, ranging from 18 to 25 years. Participants' undergraduate status or year at UCR were 40% freshman (n=18), 38% sophomore (n=17), 18% junior (n=8), and 2% senior (n=1). Ethnicity was not recorded. 73% claimed English as their first or native language (n=33). All participants displayed English fluency, so no one was excluded based on English as a non-first or non-native language.

Measures

Participants completed four 1-minute semantic verbal fluency tests (SVF) comprising four categories. The categories included were animals, clothing items, body parts, and sports. Participants produced words that fit within each category. The categories were spoken aloud by the researcher to the participants; likewise, response items were spoken aloud by the participants

to the researcher. Each SVF was characterized by a single category and was timed to one minute (i.e., precisely 60 seconds). The 1-minute time limit is consistent with VF norms (Opasso et al., 2016; Quaranta et al., 2016). The categories were carefully chosen for their relatively similar lexical banks (i.e., the number of words of each category within the English lexicon is sufficiently large) (Banks & Connell, 2023). Thus, a potential confound of lexicon dissimilarity between categories was negated. All words produced by participants, regardless of accuracy and relevance, were recorded, but redundant words were excluded from the assessed data.

Procedure

The Sequential Verbal Fluency experiment was conducted virtually via Zoom. Video, audio, and an automated transcript were recorded throughout the experiment. Data were collected throughout the Winter quarter of 2025 and up to the second week of Spring 2025. Before beginning the experiment, all participants completed a written consent form followed by demographic-related questions. They were provided written instructions, asked if they understood their role, and then were provided verbal instructions to ensure comprehension of the experiment. For testing, participants completed four trials, each comprising a 1-minute verbal fluency task with a 5-second delay between each trial. After testing, participants were provided a debriefing form and an opportunity to share feedback about the experiment.

The essential component of the written instructions said, “During each trial, please generate as many words relevant to the specified category as possible.” The verbal instructions clarified this point by asking that they begin generating (by speaking aloud and enunciating) as many words as possible within the category, noting that their words should be nouns defined by the relevant category. They were instructed to do their best not to repeat words.

The experiment used a between-subjects design consisting of two groups, a non-Advance Knowledge group (nAK group) and an Advance Knowledge group (AK group). In the nAK group, participants completed four 1-minute VF trials in succession without interruption except for the 5-second delay between trials. In the AK group, participants completed four 1-minute VF trials with an interruption after trial 2, immediately before trial 3, wherein they were given the category of trial 4 in advance. The interruption for AK group participants was a verbal statement, suggesting that "some people find it helpful to be given the category of the upcoming trial in advance, so, for the upcoming trial, your category will be 'blank' and for the current trial, your category is 'blank.'" Refer to Figures 2 and 3 for illustrations of the experimental designs for the nAK and AK groups, respectively (note that Figures 2 and 3 are purely illustrative; Categories were not shown to participants).

Figure 2

Visual Representation of nAK Group's Experimental Design

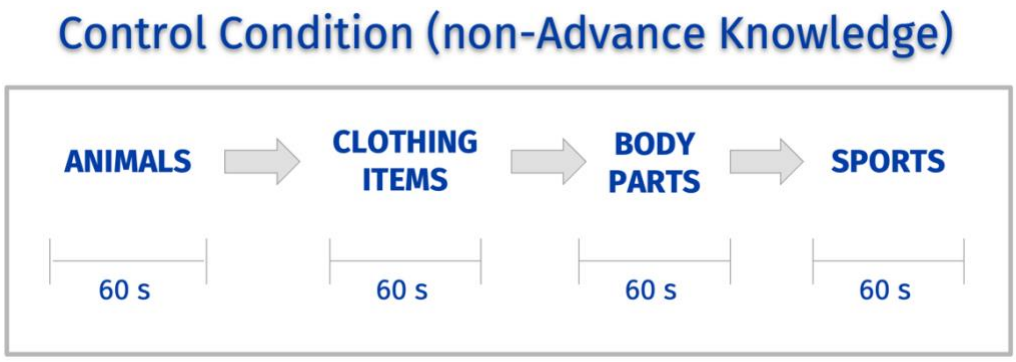
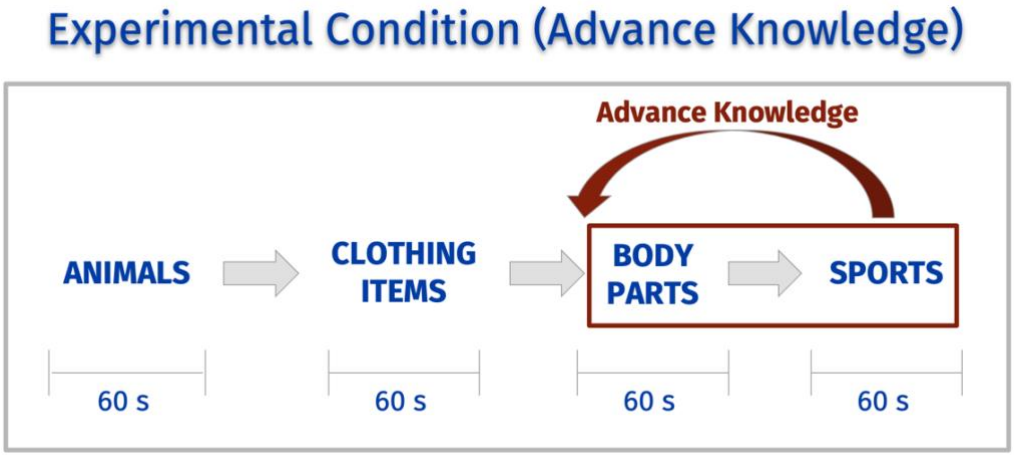


Figure 2 shows four trials, where each category corresponds to a single trial comprising 1 minute, and the arrows represent a 5-second delay between trials. Participants completed the trials from left to right; in this case, they would have begun with animals and ended with sports. Each trial was initiated by the statement, "for trial 'blank,' your category is 'blank, start' and concluded with the statement, "the timer has ended, stop." As illustrated in Figure 3, the AK

group's experimental design was identical to the nAK group's design except for the manipulation, which only occurred in the AK group. The manipulation, represented by the red arrow with the Advance Knowledge label, was the presentation of the category for trial 4, before trial 3.

Figure 3

Visual Representation of AK Group's Experimental Design



Last, to prevent potential category order effects, given the four distinct categories, each group comprised 24 total VF sequences (total sequence iterations for four trials: 4! =24). The experiment was designed so that any given participant within a group was exposed to a unique VF sequence. The 24 VF sequences were repeated between groups. Thus, the experiment had 48 VF sequences (nAK=24; AK=24).

RESULTS

Data for 55 participants were collected. However, due to researcher error, technical disruptions, and noncompliant participants, data for 10 participants were omitted. Ultimately, data from 45 participants were analyzed. For every participant, all responses (items or words produced) for each category were recorded by audio capture and by an automated transcript (both in-built Zoom functionalities). Redundancies were omitted from the data for data analysis.

Thus, the data represent participants' adjusted responses, that is, items produced excluding redundancies. Whenever a discrepancy arose between the items recorded by audio capture and the automated transcript, the researcher deferred to the data indicated by audio capture.

Cumulative Data

Figure 4

Cumulative Data Comparison Across All Trials with Mean & Median Overlay

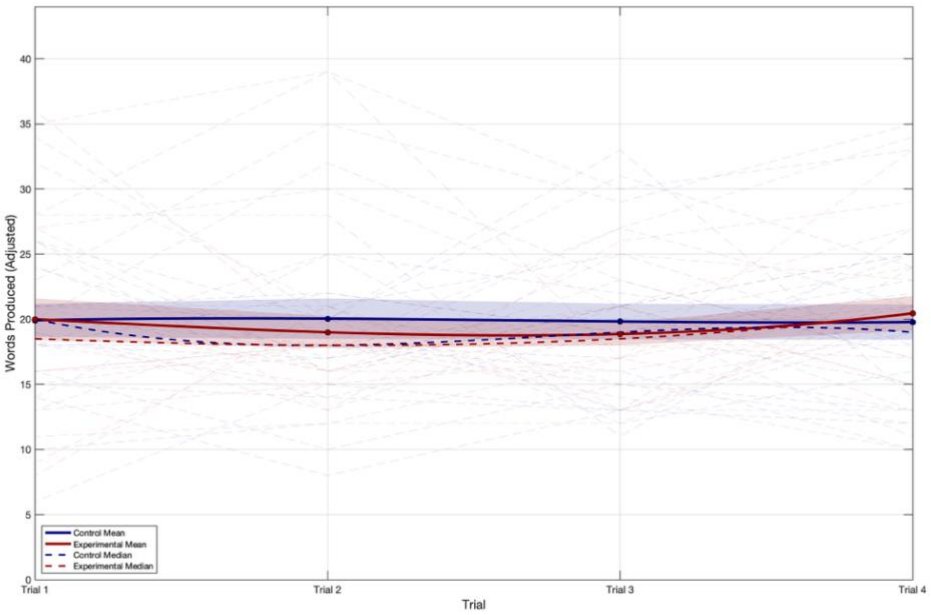


Figure 4 shows a multiple-line graph for the performance of all participants across every trial, overlayed with mean and median lines for both groups. Words produced (i.e., performance) label the y-axis, and trial (i.e., trials 1-4) labels the x-axis. The 45 low opacity dashed lines in the background represent individual participants' performance across the trials—each of the 45 dashed lines connects 4 data points, which are the individual participant performances per trial, that intersect with the trials. The four high-opacity solid and dashed lines in the foreground represent mean and median group performance, respectively, across the trials. The solid blue line (labeled control mean) represents the nAK group's mean performance per trial: trials 1-4 are

19.913, 20.044, 19.826, and 19.783, respectively. The solid red line (labeled experimental mean) represents the AK group's mean performance per trial: trials 1-4 are 20, 19, 18.864, and 20.455, respectively. The dashed blue line (labeled control median) represents the nAK groups' mean performance per trial: trials 1-4 are 20, 18, 19, and 19, respectively. The dashed red line (labeled experimental median) represents the AK group's mean performance per trial: trials 1-4 are 20, 18, 19, and 19, respectively. The shaded areas surrounding the control and experimental mean lines represent the region of error (otherwise, error bars).

Group Comparisons of Trial 3 Performance

Figure 5

Group Variance Comparison of Trial 3 Performance

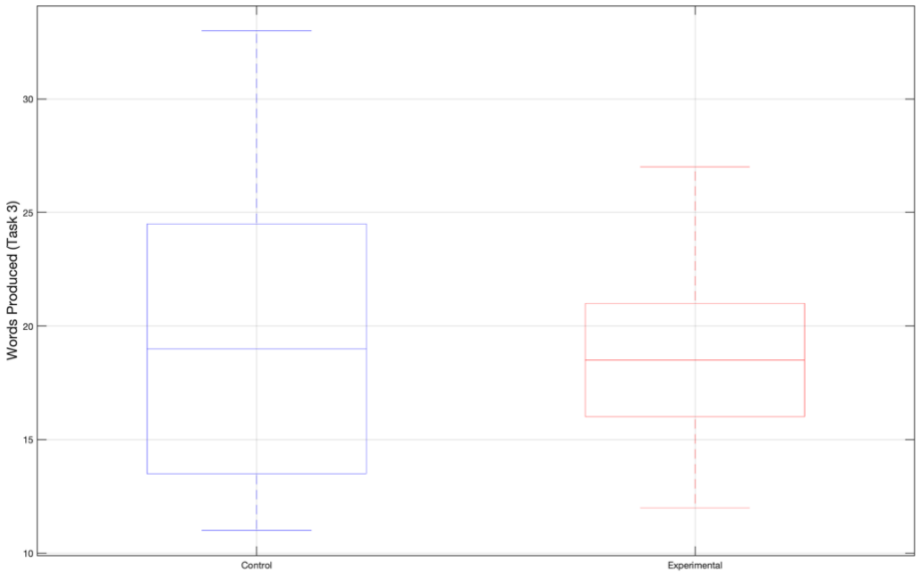


Figure 5 shows a box plot comparing mean group performance on trial 3. The y-axis is labeled words produced (trial 3), and the x-axis shows control (nAK group) and experimental (AK group) conditions. The leftmost blue box plot (labeled control) represents nAK group performance on trial 3; likewise, the rightmost blue box plot (labeled experimental) represents

AK group performance on trial 3. Irrespective of group, both plots' bottommost and topmost lines represent the lower and upper adjacent scores on trial 3, respectively. The central boxes, irrespective of group, capture the 25th (lower line) through the 75th (upper line) percentiles; the centermost lines represent the median scores. For the nAK group, the lower adjacent was 11, the 25th percentile was 13.5, the median was 19, the 75th percentile was 24.5, and the upper adjacent was 33. For the AK group, the lower adjacent was 12, the 25th percentile was 16, the median was 18.5, the 75th percentile was 21, and the upper adjacent was 27. The AK group's performance displays a tighter spread due to less variance between participant scores on trial 3, comparatively.

Figure 6

Group Mean Comparison of Trial 3 Performance

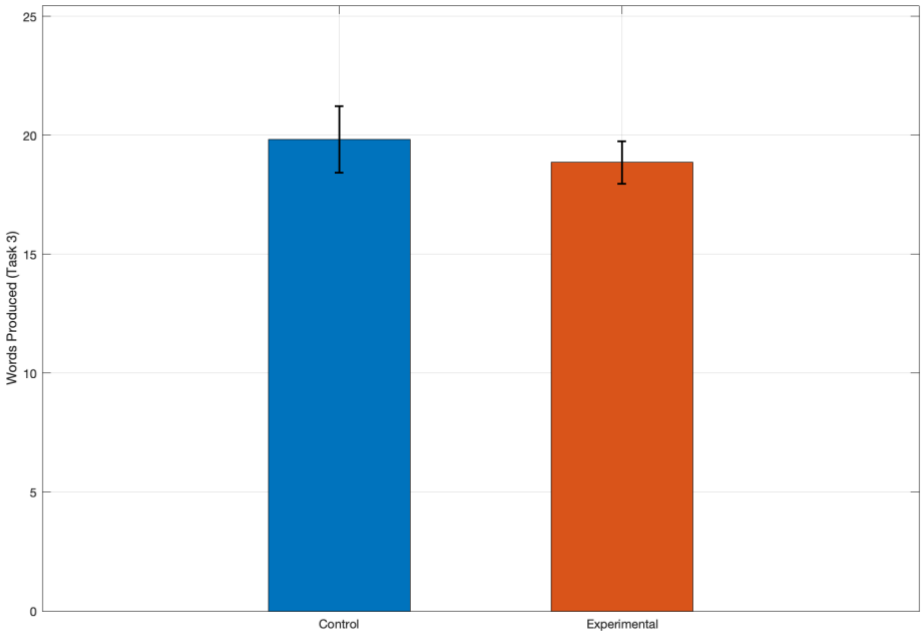


Figure 6 illustrates a bar graph comparing mean group performance on trial 3. The y-axis is labeled words produced (trial 3), and the x-axis shows the control (nAK group) and

experimental (AK group) conditions. The blue left bar (labeled control) represents the nAK group's mean performance (19.826) on trial 3. The red right bar (labeled experimental) represents the AK group's mean performance (18.864) on trial 3. Error bars are included on both bars.

DISCUSSION

Findings of Knowledge & Interference

The results indicate that performance across all trials was consistent between the control and Advance Knowledge groups at the cumulative and group levels. Regardless of advance knowledge, participants produced, on average, relatively the same number of words for each category on every trial. The only noticeable trend was the variance in the number of words produced on trial 3 for the AK group. The number of words produced by most participants for the AK group varied much less than for the nAK group on every other trial (trials 1, 2, and 4). Nevertheless, this trend has no bearing on the hypothesis. Thus, the data do not support the predicted interference hypothesis. Instead, they support the hypothesis that foreknowledge about an upcoming task does not affect the performance of a preceding task. Thus, I fail to reject the null hypothesis.

Logic of Sequential Verbal Fluency

The logic for this study began with a real-world problem about task decision making. As one's daily tasks compound, one faces a decision: proceed head down on the task at hand, without regard for or thought about upcoming tasks, or attend to multiple tasks simultaneously, spreading concentration thin. Pre-crastination suggests that, in most cases, people will choose to spread their attention thin and work on multiple tasks, if possible. Research on pre-crastination shows that people employ a sooner rather than later mentality when it comes to tasks (Rosenbaum et al., 2019); that is, they get started on subgoals as soon as possible, even if that

requires extra effort. The evidence for such behavior is robust, at least regarding physical behaviors. What about for strictly cognitive behaviors that do not require physical effort? In need of a non-physically demanding and measurable behavior, verbal fluency emerged. While verbal fluency research for single task performance is profuse and the norms well-established, the joint influences of sequential tasks are, as far as I know, undocumented. Thus, I devised an experimental design to kill two birds with one stone, so to speak. Sequential Verbal Fluency seeks to expand pre-crastination research to non-physical, cognitive behavior via the verbal domain. It addresses the lack of research on successive task interactions within the verbal fluency literature.

Sequential Verbal Fluency was devised to answer a question. Will knowledge about an upcoming task interfere with performance on a preceding task? Suspecting yes, I hypothesized that knowledge about an upcoming task would interfere with, effectively diminishing, performance on a preceding task. Alternatively, foreknowledge could facilitate performance. Also, as the null hypothesis suggests, foreknowledge would not affect performance. (For an easy-to-comprehend illustration of these hypotheses, refer to Figure 1.) I designed a verbal fluency experiment comprising two groups and four consecutive, semantic verbal fluency tests to test this. Participants of the non-Advance Knowledge group (control condition) completed four VF tasks in succession. Conversely, participants of the Advance Knowledge group (experimental condition) completed the same four successive VF tasks; however, before task 3, they were given foreknowledge about task 4. Given that pre-crastination is most likely an attempt to reduce cognitive load (Patterson & Kahan, 2019), I expected that increasing the cognitive demand of task 3 and providing an opportunity to start thinking ahead on task 4, participants would be compelled to pre-crastinate.

Findings of Cumulative Data

The results of the cumulative data analysis (Figure 3) show practically no difference in performance among participants between trials. The group level differences, represented by the overlayed mean and median lines, indicate as much. Some slight performance differences, albeit minuscule, emerge, nonetheless. The AK group performed better on average, by a small margin, on trials 1 and 4, whereas the nAK group performed better on average on trials 2 and 3. Performance for all participants averaged around 20 words produced per trial. This result is consistent with verbal fluency norms for college students of this sample's average age, 19.

Findings of Group Comparisons of Trial 3 Performance

Likewise, the group comparisons of trial three performance show no performance differences between the nAK and AK groups. However, one trend does emerge. The variance of words produced by the AK group on trial 3 (illustrated best by Figure 4) was dramatically smaller than the variance of both groups on every other trial. This means that participants were more consistent in the number of words they generated on this task. Perhaps this was due to the manipulation. This is because when participants, who in general may have taken the task less seriously than others, were told about the upcoming task, they paid closer attention and performed at their best. Similarly, when participants, who in general may have taken the task more seriously than others, were told about the upcoming task, they hesitated and performed slightly worse than they may have otherwise. Both ideas are purely speculative but pose interesting implications.

Limitations & Future Directions

The limitations of this study are twofold, and they stem from a fundamental question. Why did the manipulation not alter behavior? If people tend to get started on work early, even at

the expense of extra effort, as pre-crastination suggests, then why, when allowed to get started on a verbal task early, would they not take it? Do they value their performance on the task so much that they resist the inclination to do work early? Or do they not care about future tasks because they are too busy with the task at hand? The potential answers to these questions lie within the following ideas. Either the experimental design was not powerful enough to induce a significant effect, or the interference hypothesis was misattributed.

Because of the former idea, it is possible that the sample size (n=45) prevented the emergence of an effect. The results may be different by doubling or even tripling the sample size. Another possibility may have been that participants did not have enough time to register and get to work on the upcoming VF task. They were told about the upcoming category approximately five seconds before they began trial 3. Without time to register the foreknowledge stimulus or give it much thought, it is possible that participants ignored the seemingly unimportant information because of its irrelevance to the task at hand. I could alter the experimental design to incentivize remembering the foreknowledge stimulus to overcome this potentiality. Alternatively, I could have told participants about the category for trial four much earlier. As a side note, Dr. David A Rosenbaum, principal investigator of UCR's Laboratory for Cognition and Action, brought a unique and potentially novel semantic verbal fluency task design to my attention. That is, provide participants with two categories for a single trial. This design may have interesting implications for category prioritization and word selection.

Because of the latter idea, perhaps people do not care about the upcoming task. Maybe they adopt an "I will get to it when I get to it" mentality. After all, verbal fluency is not the most important thing in their busy lives. Participants might try to complete the experiment as quickly and effortlessly as possible in this scenario. On the other hand, the cost of starting early might be

too great. To start the upcoming task early, participants must completely neglect the task at hand. Maybe the hit to their overall performance, for starting early, is too great to justify? All possibilities are intriguing and equally uncertain. Thus, they provide ample opportunity and reason for continuing this research.

Significance

Task completion is a non-negotiable part of everyday life. In a world where productivity is valued above most things, or at least imposed upon us as worth being valued above most things, it is not uncommon for our schedules to become overloaded with tasks. A schedule overloaded with tasks poses a burdensome cognitive load. Research shows that when our cognitive load becomes heavy, we tend to reduce it. As the task demands of our schedule become burdensome, we will try to reduce its cognitive load by either completing and checking tasks off the list or by thinking about and/or planning for future tasks. In some instances, our thoughts about future tasks may occur while working on a task at hand, interfering with the current task. Accordingly, the joint influences of thinking about and working on current and future task demands are more pertinent than ever. Thus, research in this domain is welcome and warranted. Verbal fluency or word production is one of many viable ways to peer inside of the ever-demanding and compounding tasks of our day-to-day responsibilities.

In conclusion, despite a failure to reject the null hypothesis. This study has made headway on several fronts. It has sought to expand pre-crastination research to the verbal domain. It has offered a novel sequential verbal fluency task design for studying verbal fluency. Last, it has examined the joint influences of current and future task demands. Moreover, further research on pre-crastination for cognitive behaviors that do not require physical exertion could benefit the field. Finally, because verbal fluency has been validated for the assessment of various

psychological pathologies, additional implementations of sequential verbal fluency tasks may have important implications for understanding psychological disorders that affect language comprehension and speech production.

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