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Go-getters and procrastinators: Investigating individual differences in visual cognition across university semesters

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ABSTRACT

University-based psychological research typically relies on the participation of undergraduate students for data collection. Using this particular sample brings with it several possible issues, including the self-scheduling done by the participants. Research on performance between students who sign up early versus late in the semester has been inconsistent. Some research report benefits for early participant semesters, while others find no differences between the two groups. Anecdotally, it seems that the former holds true, as many researchers worry about the data collected late in the semester, sometimes opting for more motivated earlier participants in the next semester. The purpose of our study was to examine for the effect of time of semester across a well-known set of visual cognition tasks. To do so, participants completed canonical versions of a rapid serial visual presentation task, a flanker task, an additional singleton paradigm task, a multiple object tracking task and a visual working memory task. These tasks were chosen as typical measures of executive control, temporal selectivity, visual working memory capacity, resistance to distraction, and attentional capacity. Crucially, we correlated task performance with time of semester students chose to participate. Our results demonstrate that there were no significant differences in any of the tasks across semester timing. Furthermore, our findings support the validity of cognitive research relying on the system of recruiting undergraduate students from volunteer pools where students can self-select the time of the semester they undertake the experiments.

The study of visual cognitive processes, such as what we now term visual attention and visual working memory, is one of the historical cornerstones of experimental psychology. Indeed, among the earliest experiments conducted in psychology concerned visual cognitive performance and its limitations (e.g., Helmholtz, 1896; Wundt, 1907). As psychology labs were, and still are, typically located at universities, it is not surprising that, since its earliest days, experimental psychological research has relied heavily on samples of university students. The benefits of this sample are straightforward; data can be collected with minimal time and expense. This practice, however, has not escaped notice, with researchers raising concerns about the validity and generalizability of college and university students to the general population (Jung, 1969). Furthermore, voluntary research participation among students enrolled in courses suffers from an inherent sampling confound - self-selection. Specifically, participants typically choose when to participate in studies, and participants that choose to sign up early in the semester ("go-getters") may have different characteristics than participants that chose to sign up at the end of a semester ("procrastinators"). In other words, experiments whose data have been collected at different periods of a semester may suffer confounds if individual differences in visual cognitive performance covary with individual differences in participation preferences.

Perhaps surprisingly, scant research has been conducted to address the possibility of semester effects in experimental psychology tasks. The earliest explicit comparison of performance between early- and late-sign up participants that the authors are aware of is that of Underwood, Schwenn, and Keppel (1964), who examined paired-associate learning. Their analyses revealed no differences in performance by participation time. Subsequent studies have often shown differences in self-reported measures of personality variables (e.g., Aviv, Zelenski, Rallo, & Larsen, 2002; Evans & Donnerstein, 1974; Holden & Reddon, 1987; Hom, 1987; Zelenski, Rusting, & Larsen, 2003), but differences in performance are equivocal. Null differences have been reported for cued-recall (Wang & Jentsch, 1998), signal detection, performance-based vigilance tasks (Tomporowski, Simpson, & Hager, 1993), and text comprehension (Langston, Ohnesorge, Kruley, & Haase, 1994).

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However, differences in performance have been reported for visual search (Richert & Ward, 1976), symbol substitution and serial learning (Richter, Wilson, Milner, & Senter, 1981), and, recently, sustained attention (Nicholls, Loveless, Thomas, Loetscher, & Churches, 2015) with the general trend that early semester participants demonstrate overall better performance than late semester participants.

Very recently, however, contradictory evidence has been found showing that there may be little to no effect of semester timing on a variety of cognitive tasks. Robison and Unsworth (2016) conducted a large, multi-university study across a variety of measurements. Participants completed tasks to measure working memory capacity (operation span, symmetry span and reading span tasks), long term memory (delayed free recall, picture-source recognition and cued recall tasks), attentional control (antisaccade, psychomotor vigilance task, and arrow flankers), fluid intelligence (Raven advanced progressive matrices, verbal analogies and number series tasks), and crystallized intelligence (synonym and antonym vocabulary and general knowledge tasks). The general finding was that there were no individual differences that covary with the time at which participants chose to participate.

Our focus in the present study was the area of visual cognition, and especially visual attention, an area that has seen rapid growth over the last three decades (see Carrasco, 2011). On the one hand, individual differences are known to exist in visual-cognitive ability (e.g., Fukuda & Vogel, 2009; Green & Bavelier, 2003), raising the possibility that early and late volunteers may differ in their ability to complete tasks involving visual cognition. On the other hand, these differences may not be reflected in self-selected participation times as seen in other cognitive tasks (Robison & Unsworth, 2016). Assessing the extent and character of any possible semester differences is critical for ensuring that data in visual cognitive experiments are reliable across time, especially as studies typically consist of experiments conducted at different points in time during the academic semesters. Indeed, researchers at experimental psychology conferences frequently speak of being concerned with their end of semester data. Concerns about early semester participants, however, are virtually unheard of. The question addressed by this study is exactly this; is there any empirical evidence to substantiate such concern?

In order to evaluate whether early and late volunteers differ in their visual cognitive abilities, we administered an experimental battery designed to test five components of visual cognition: executive control, temporal selectivity, visual working memory capacity, resistance to distraction, and attentional capacity. These abilities were operationalized using common visual cognitive tasks: a Flanker Task, a Rapid Serial Visual Presentation (RSVP) task to measure the attentional blink, the one-shot change detection task, an additional singleton visual search task, and a multiple object tracking task, respectively.

1. Experiment 1

In our first experiment, the battery of five tasks was run at two time points within a single semester of an introductory Psychology course; the first three weeks and the last three weeks.

2. Methods

2.1. Participants

Fifty five students, (16 males, 39 females, mean age = 18.88) enrolled in the undergraduate introduction to psychology course (Psychology 100) at the University of Toronto participated in the experiment. Over 2500 students enroll in Psychology 100 each year, and the students are informed of experimental participation portion of the course, which counts toward their course grade, on the first week of classes. Participants were able to sign up for this study on the first three and last three weeks of the Psychology 1000 participation pool (last three weeks of January and last two weeks of March/first week of April respectively). Each participant completed two 1-h experiments and received 1% of their total course grade. None of the participation was for bonus marks or for paid participation. Twenty five students signed up in the early semester condition, and thirty signed up in the late semester condition. Our intention was to collect as many participants as possible during the appropriate weeks. Critically, no participants were recruited for our study, and participants were not aware that this study only accepted sign-ups during specific weeks; from the participant's perspective, our study was simply one of many Psychology studies available to participate in at whatever time they chose on the online sign-up system. Informed consent was obtained from all participants, all work completed complied with the University of Toronto Research Ethics board, all reported normal or corrected-to-normal vision and none were aware of the hypothesis tested.

2.2. Apparatus

Testing was conducted on a computer with a CRT monitor operating at a refresh rate of 85 Hz. A chin and head rest maintained viewing distance at 54 cm. Responses were collected on a standard keyboard. All stimuli were presented on a grey background.

2.3. Flanker task

A Flanker task was chosen as one of the tasks in our attentional battery as a tool to assess the participants' ability to suppress responses that were invalid in a particular context. First used by Eriksen and Eriksen (1974), years of research suggests that the flanker task assesses executive control (Callejas, Lupianez, Funes, & Tudela, 2005; Kopp, Mattler, Goertz, & Rist, 1996), and participants' ability to inhibit particular responses that may change with context (Eriksen, 1995). Our flanker task consisted of firstly a presentation of a white fixation cross for 1000 ms. Next, a flanker display was presented, with a central distractor (a white "N", "F" or "X", approximately $1^\circ \times 1^\circ$, 25 trials for each distractor type), accompanied by a target letter in one of 6 possible target locations, all 8° from the distractor, forming a circle around the distractor. The target letter was either a white "N" or "X" (also $1^\circ \times 1^\circ$), with the remaining 5 locations occupied by a small white dot placeholder. The target display remained on the screen for 150 ms, at which time participants were asked to indicate the identity of the target by pressing either "N" or "X" (Fig. 1).

2.4. Rapid serial visual presentation (RSVP) task

The use of a RSVP task to demonstrate the attentional blink has been well documented (Broadbent & Broadbent, 1987; Kanwisher, 1987; Kanwisher & Potter, 1989; Raymond, Shapiro, & Arnell, 1992; Reeves & Sperling, 1986). A typical RSVP task (as used by Raymond et al. (1992)) presents participants with a stream of centrally fixated letters (approximately $1.5^\circ \times 1.5^\circ$ each) in rapid succession. Participants are instructed to both indicate the target white letter (T1) in a stream of black letters, while also determining the presence of a second target (T2). What is commonly reported is that processing of the first target inhibits processing of the second target if it appears within 180–270 ms after T1. This performance decrement is described as interference from the first target, creating a temporary suppression of attentional mechanisms, creating an attentional "blink". This result has been

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