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Busyness and Cognition in Undergraduate Students: End-of-Semester versus Beginning-of-Semester Cognitive Performance

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ABSTRACT

Students frequently report feeling more stress at the end-of-the-semester versus the beginning-of-the-semester (Kofman et al., 2006). Whether this results in worse cognition has not been thoroughly investigated. The current study measured three types of cognition, including long-term memory, working memory, and executive functioning. We assessed whether undergraduates' stress and busyness levels and cognitive performance was different between the end of the Fall 2020 and beginning of the Spring 2021 semester. Contrary to the hypotheses, no significant point-in-semester differences were found in undergraduates' busyness or stress levels at the beginning versus end of the semester. Mixed results were observed for cognitive performance, such that no significant differences were found for picture recall, word recall, picture recognition or letter number sequencing. Performance on the verbal fluency category task and the backward digit span task were found to approach significance, with marginally better performance at the end of the semester. Finally, word recognition was significantly better at the end of the semester, whereas verbal fluency, given a letter cue, was significantly worse at the end of the semester. Therefore, given the lack of observed busyness and stress differences, it is unlikely that busyness and stress are driving differences in students' cognition. Future research is needed to determine if the observed cognitive differences are reliable and to assess additional mechanisms.

1 INTRODUCTION

Past studies have shown that the relationship between stress and performance typically resembles an inverted-U shape, suggesting that mild or moderate stress improves performance whereas very little or very high stress impairs it (Lupien et al., 2009). In animal models, it is evident that chronic stress impairs memory abilities, increases symptoms of anxiety and depression, and reduces growth of new neural (brain) cells in the hippocampus (a region of the brain responsible for the formation of new long-term memories) (see Parihar et al., 2011). On the other hand, some studies found that prolonged mild stress had the ability to increase the growth of neurons in the hippocampus and to reduce depression and anxiety symptoms (Parihar et al., 2011; Li et al., 2008).

In humans, stress has similarly been found to impair (e.g., Oei et al., 2006) as well as improve (e.g., Kofman et al., 2006) mental functioning under different contexts. For example, higher levels of busyness have been found to be associated with higher cognitive abilities in middle-aged and older adult populations (Festini, McDonough & Park, 2016). For younger populations, such as undergraduates, it is less well understood how factors such as busyness or stress may affect cognition. However, undergraduates do commonly report fluctuations in stress and busyness levels throughout the semester such that they experience lower stress and busyness levels at the beginning of the semester before many assignments and projects are due, relative to the end of the semester, when deadlines are typically fast approaching (Kofman et al., 2006; Rafidah et al., 2009). Whether this naturally occurring variation in stress and busyness levels at different points in the academic semester influences cognitive performance has not been thoroughly investigated. A relevant prior study found a favorable effect of semester-related stress on two executive functioning tasks (i.e., higher-level mental control operations, like strategic planning), such that executive functioning efficiency improved in the presence of controllable, chronic stress (Kofman et al., 2006). However, long-term memory, working memory (i.e., what information is currently being held in mind), and verbal fluency (i.e., strategic, rapid information retrieval) was not assessed in this prior work. Based on the existing literature, we hypothesized that students would exhibit higher stress levels, greater busyness, and decreased mental functioning at the end-of-the-semester when compared to the beginning-of-the-semester, which would support prior findings.

2 METHOD

Participants and Design

A sample of undergraduate students ($N = 30$) from a private university in the Southern United States completed a battery of cognitive tasks and digital surveys. Requirements for participation included enrollment at The University of Tampa, fluency in English, a minimum age of 18, and normal or corrected-to-normal vision.

This study implemented a within-participant design where participants from session 1 were contacted again to complete session 2. The study was administered digitally via Qualtrics, and all participants provided informed consent. Participants were instructed to find a quiet location to begin the study and were informed to expect each session to last approximately one hour. Upon completion of data collection all responses were anonymized. This research was approved by the Institutional Review Board at The University of Tampa prior to data collection.

Procedure and Materials

Due to the constraints of the research timeline, a logistical decision was made to collect the end-of-semester data first, during Fall of 2020, followed by the beginning-of-semester data, during Spring of 2021. Recruitment of undergraduate students to participate in the Fall 2020 session occurred in various ways. Digital flyers were shared with students via email and other social platforms. The study was also advertised to students by word of mouth from professors, classmates, etc. Data collection for the Fall 2020 end-of-semester session occurred during the 10th–24th of November, which was the

second and third to last weeks of the semester. In compensation for their participation, students received a $10 Amazon gift card. At the beginning of the Spring 2021 semester, the original participants were contacted again with an invitation to participate in the second session of the study. Data collection for the Spring 2021 beginning-of-semester session ran from the 21st of January to the 4th of February which was the first and second week of the semester. Participants received another $10 Amazon gift card for completing session two.

Each session implemented the same types of cognitive tasks and surveys in the same order. However, they utilized and presented different stimuli in session one versus session two to minimize practice effects. The Medical Research Counsel (MRC) Psycholinguistic Database (`https://websites.psychology.uwa.edu.au/school/mrcdatabase/uwa_mrc.htm`) was used to select the word stimuli such that the stimuli had similar characteristics and therefore difficulty. The parameters for word stimuli selection included a minimum of four and maximum of eight letters, a minimum of one and maximum of four syllables, a minimum Kucera-Francis written frequency of ten and maximum of 150, a minimum familiarity rating of 400 and maximum of 700, and a minimum concreteness rating of 300 and a maximum of 600. The visual stimuli were selected from the Bank of Standardized Stimuli (BOSS) database (Brodeur, Guérard & Bouras, 2014). The parameters for the visual stimuli included a familiarity of 3.80–5.00, a visual complexity of 1.60–3.00, and an object agreement of 3.00–5.00.

For both sessions, the cognitive tasks were administered first, followed by the surveys. Episodic long-term memory was measured via 4 assessments: picture recall, picture recognition, word recall, and word recognition. For the recall tasks, participants were shown either a series of pictures or words one at a time for 5 seconds each. After viewing all the stimuli, they were asked to recall as many items as possible by typing their responses. The recognition task followed, and participants were asked whether they recognized stimuli items that were also presented to them one-by-one. Working memory was assessed via the letter number sequencing and backward digit span task. The Letter Number Sequencing task (Wechsler, 1997) required that participants study a string of inter-mixed letters and numbers which were presented one at a time for 5 seconds each (e.g., 5-L-3-D-8). After viewing the sequence of letters and numbers, the participant was asked to mentally rearrange the stimuli and report them back in ascending numerical order followed by alphabetical order (e.g., 3-5-8-D-L). The Backward Digit Span Task (Wechsler, Laicardi & Orsini, 1997) asked participants to view a sequence of numbers one-by-one for 5 seconds each. Participants were then required to mentally rearrange the number sequence and report it back in the opposite order, such that 2-7-1-3 would be reported back as 3-1-7-2. Lastly, executive functioning was measured via a verbal fluency task (Beck et al., 2012). Participants were asked to report as many words as they could think of within a 60 second time frame that satisfied a given rule. They were asked to do this for a particular category (e.g., animals) and for a particular letter (e.g., M).

Additionally, to further reduce the influence of practice effects between sessions, participants were given detailed instructions, example trials, and practice trials before they began the real assessments. This practice was intended to provide participants with thorough details about what to expect during the first session; therefore, mitigating differences in results that may have arisen due to participants being more experienced with the assessments during the second session.

Participants were also asked to complete the Perceived Stress Questionnaire (Levenstein et al., 1993) and the Martin & Park Environmental Demands Questionnaire (Martin & Park, 2003). The perceived stress questionnaire (PSQ) required participants to rate how often certain statements applied to them within a two-week time period using a Likert scale of Almost Never (1) to Usually (4). Sample statements included *You have too many things to do*, *You feel loaded down with responsibility*, and *You feel mentally exhausted*. Raw PSQ scores were converted to an indexed score (0–1) such that higher values indicate more stress. The Martin & Park Environmental Demands Questionnaire was used to assess busyness levels. Ratings were provided on scales from 1–5, with higher values indicating higher levels of busyness. Sample items included *How often do you have too many things to do each day to actually get them all done?* and *How often do you have so many things to do that you go to bed later than your regular bedtime?*. An exit survey was also administered to gain participant feedback about their experience participating in the study.

3 RESULTS

Planned comparisons evaluated whether participants exhibited different levels of busyness, stress, or cognition at the beginning versus end of the semester. See Table 1 for summary statistics. Paired-samples t-tests indicated that there was no significant difference in busyness levels at the beginning versus the end of semester. See Figure 1. Also, there were no significant differences found for stress levels at the beginning compared to the end of semester. See Figure 2.

Mixed results were evident when analyzing cognitive performance. See Table 2 for summary statistics. No significant differences were found for picture recall or word recall, picture recognition, or letter number sequencing, all $ps \geq 0.347$.

Comparisons of backward digit span and category verbal fluency approached significance, $ps < 0.09$, such that performance was marginally better at the end of the semester. The remaining tasks showed significant differences: word recognition abilities improved at the end of the semester, but verbal fluency, with a letter cue, worsened. See Figures 3 & 4.

4 DISCUSSION

This study examined whether there were differences between end-of-semester versus beginning-of-semester busyness and stress

	Beginning		**End**		**Statistics**		
Survey	***M***	***SE***	***M***	***SE***	***t***	***df***	***p***
Busyness	3.76	0.92	3.79	0.92	-0.23	29	0.821
Perceived Stress	0.46	0.20	0.49	0.20	-1.24	28	0.225

Table 1. Summary of busyness and stress at the beginning and end of the semester. Means, standard errors, and statistics from paired-samples t-tests are reported.

	Beginning		End		Statistics		
Cognitive Task	***M***	***SE***	***M***	***SE***	***t***	***df***	***p***
Verbal Fluency Category	15.33	3.90	16.97	4.90	-2.03	29	0.052
Verbal Fluency Letter	18.57	4.72	15.40	3.74	4.14	29	<0.001*
Backward Digit Span	10.00	1.95	10.63	2.37	-1.76	29	0.089
Letter Number Sequencing	13.81	5.68	14.44	4.32	-0.79	26	0.435
Word Recognition	82.17	10.78	87.07	7.31	-2.86	29	0.008*
Word Recall	7.50	3.37	7.97	2.37	-0.82	29	0.422
Picture Recognition	95.65	5.59	95.10	9.31	0.48	28	0.635
Picture Recall	10.03	3.17	10.62	2.85	-0.96	28	0.347

Table 2. Summary of cognitive performance at the beginning and end of the semester. Means, standard errors, and statistics from paired-samples t-tests are reported.

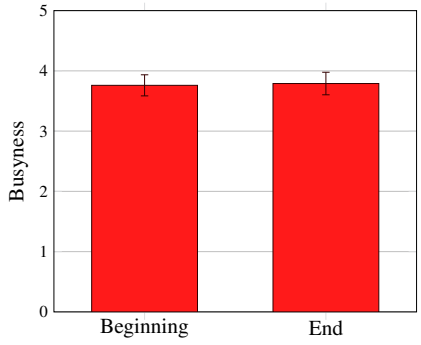

Fig. 1. Busyness levels (±1 standard error) at the beginning and end of the semester

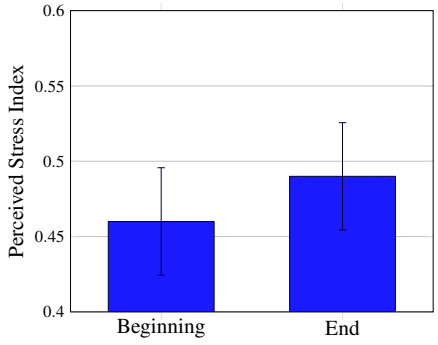

Fig. 2. Stress levels (±1 standard error) at the beginning and end of the semester

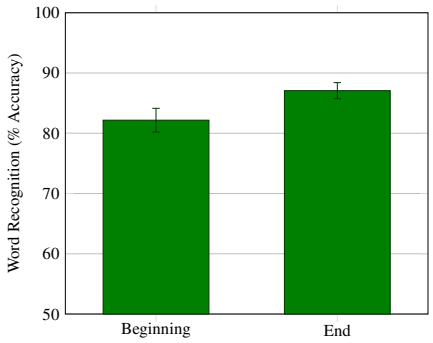

Fig. 3. Word recognition performance (±1 standard error) at the beginning and end of the semester

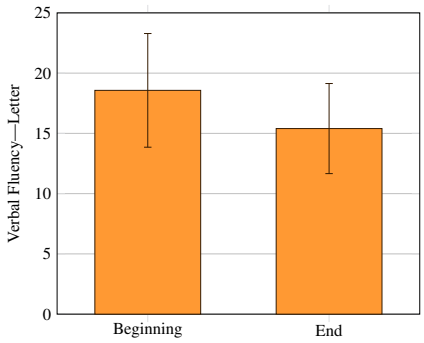

Fig. 4. Verbal fluency—letter performance (±1 standard error) at the beginning and end of the semester

levels in undergraduate students, as well as whether this variation in semester-related stress resulted in changes in their cognitive performance. Previous research has found that at the end of the semester, students typically report greater stress levels due to factors such as an increased number of assignments (Kofman et al., 2006). However, still not much is known regarding how stress and busyness level fluctuation during the semester affects students' cognitive performance. Studies on other populations have demonstrated that moderate stress levels may increase cognitive abilities (Parihar et al., 2011), whereas stress levels that are too high can impair them (Lupien et al., 2009). Additionally, in older adults it has been found that higher levels of busyness may elicit improvement in cognition

(Festini, McDonough & Park, 2016). The current study aimed to assess whether undergraduate student stress and busyness levels are different at the start and end of the semester and if cognition exhibits point-in-semester variations as well.

Contrary to the hypotheses, we observed that stress levels and busyness levels did not significantly differ between the beginning versus the end of semester. This finding does not coincide with previous research that has found that students report less stress and busyness at the beginning of the semester, compared to the end of the semester (Kofman et al., 2006; Rafidah et al., 2009). Additionally, the cognitive performance findings of this study were mixed. No significant differences were found for recall abilities, picture recognition, or the letter number sequencing task that assessed working memory. Yet, the comparison for the backward digit span task and verbal fluency category task were marginally significant. Both assessments showed that performance tended to improve at the end of the semester. Similarly, participants had significantly better word recognition performance at the end of the semester. This suggests that the comprehensive material often presented to students at the end of the semester may heighten their memory for words.

On the other hand, performance on the verbal fluency letter task was found to be significant in the opposite direction, such that performance on this task was worse at the end of the semester. Prior research observed facilitation of executive functioning performance at the end of semester (Kofman et al., 2006), but we observed inconsistent findings, such that one executive functioning assessment (verbal fluency with a category cue) trended toward end-of-semester facilitation, whereas the other executive functioning assessment (verbal fluency with a letter cue) showed end-of-semester impairment. Future research is needed to further investigate the reproducibility of these cognitive findings, especially due to the mixed direction of the results. Further, given that busyness and stress levels were found to be similar at the beginning and end of the semester, it seems there may be some variable other than busyness and stress that are influencing these differences in cognition.

One limitation of the present research was that it was conducted during the COVID-19 pandemic. It may be possible that student stress levels were heightened due to the nature of the pandemic and its effects on the learning environment. It is also thought that student busyness levels may have differed from their usual levels because extracurriculars were extremely limited due to the need to socially distance and isolate. Another limitation of the study is that, due to its exploratory nature, corrections for multiple comparisons were not performed. Future studies would be needed to confirm these findings; however, if replicated, the results of the study suggest that busyness and stress levels remain relatively stable in college students during the semester and do not seem to have as large of an impact on cognition as hypothesized.

In the future, studies should look at the effects of busyness and stress on cognition during a climate which is not affected by a pandemic. It may also be more ideal to collect data from the same semester, when coursework and other obligations are more similar rather than across the span of two different semesters. This is because it is unknown whether changes between the semesters could impact student stress or busyness levels. Also, it may be interesting to assess whether different types of stressors (i.e., relationships, jobs, extracurriculars) may impact cognitive function differently. Lastly, it would be best to provide a controlled test environment for all participants to further eliminate any extraneous variables which may have caused distraction.

Overall, this study was the first to systematically measure busyness, stress, and a wide variety of cognitive variables at both the beginning and end of the semester. Despite previous research and anecdotal support for claims that students are busier and more stressed at the end of the semester, we did not observe this. Surprisingly, we found that, on average, students did not experience significant changes in their busyness or stress levels at different points in the semester. However, some fluctuations in cognitive ability still occurred such that specific aspects of their performance were either improved or hindered, suggesting that other variables may be at play.

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