2018

Does What You Do Before Class Matter?

Elayne Zhou
Oberlin College

Oberlin College

Department of Psychology

Honors Thesis

HONORS CANDIDATE: Elayne Zhou

THESIS TITLE: Does What You Do Before Class Matter?

DATE: 04/26/2018

HONORS EXAMINATION COMMITTEE:

Nancy Darling, Chair

Paul Thibodeau

Al Porterfield

Does What You Do Before Class Matter?

Elayne Zhou

Thesis Submitted in Partial Fulfillment of the Requirements for the Bachelor's Degree of the Arts

Department of Psychology

Faculty of Arts and Sciences

Oberlin College

Spring 2018

Abstract

Background and aims: The current study builds upon earlier work exploring task switching, learning, and interruption by expanding the timeline to discuss more complex tasks over longer periods. For a student to learn successfully, they must pay attention to the right information. The current study explores how pre-learning conditions affect academic performance by directing attention toward or away from the task. *Methods:* College undergraduates (N = 62) completed two sessions over two consecutive days. The goal of Session 1 was to both observe baseline distraction and learning. Notes for Session 2 were also pulled from Session 1. The goal of Session 2 was to observe differences in learning based on ten-minute pre-lecture conditions: social media usage (n = 22), notes reviewing (n = 21), and control (n = 19). In both sessions, participants were tested on learning after watching a lecture video. Note reviewing was expected to positively impact learning and social media engagement was expected to negatively impact learning due to how cognitively similar or dissimilar they were to the lecture material. Effects were expected to be most visible at the beginning of the lecture and possibly continue throughout. Social media engagement was also expected to increase attentional disruption and off-task social media usage. *Results:* Though the findings did show a pattern, with social media participants going off task more frequently than the others, there was no significant difference between conditions in distraction, scores during the experimental session, or duration of test-taking. *Conclusions:* Possible explanations and implications ranging from lack of motivation and attention to the habitual power of social media are considered in light of the previous task-switching, interruption, and interference literature.

Acknowledgments

I am forever grateful to Oberlin College for being the loving, creative, and supportive place it is to have helped me to grow into the student and person I am.

I would also like to thank my advisor, Nancy Darling, for her wisdom and for challenging me to be a better student and researcher.

I am so glad to have had the insight of Paul Thibodeau and Al Porterfield in the process.

I cannot forget to thank Dylan Bozcar, my research assistant and confidante throughout the process. My mother was my valuable writing partner and shared the title of biggest supporter with my boyfriend.

INTRODUCTION

Students can do many different things while they are waiting for class to start. The primary objective of the current study is to investigate how these pre-lecture activities might affect learning. To contextualize the study, observational data on the introductory psychology class at Oberlin College was collected from the ten minutes before class to the first five minutes of class. Students heavily used social media, fewer engaged in a neutral activity, and still fewer reviewed notes. Reviewing notes may facilitate learning by activating relevant information, because it is cognitively similar to the lecture. Posting on Instagram or Twitter or checking Facebook (engagingly irrelevant) could impede learning by activating irrelevant, but compelling information, making the switch to class more effortful and difficult. I hypothesize that negative effects of social media are most severe at the beginning of class and may impact learning throughout class or disappear by the end. Making the switch from notes to lecture may be easier due to the cognitive similarity between the two. Additionally, I expect students who engaged with social media to be more likely to be off-task during class on social media. To set the stage for why I have arrived at my hypotheses, I will discuss memory processes behind learning, the role of attention in task switching, unique features of the classroom context, social media as a detriment to learning, and notes as facilitators of learning.

Most lectures begin with a brief review of the previous lecture and/or an explanation of what is to come. The goal of teaching using lecture pedagogy is to convey organized, high quality information in a very dense format. Lectures tend to be front-loaded with important information used later in the argument. If a student misses key information, it may or may not be repeated. Therefore, missing part or all of the ‘blueprint’ at the beginning of the lecture may impede their ability to piece it all together. The goal of a student in a classroom is to learn cognitively complex material for later retrieval. To do so, they must be successful through each process of memory.

How We Learn

According to the Atkinson-Shiffrin model of memory (1968), to learn, we need to 1) pay attention to information so it is encoded, 2) keep attending to it as it moves through levels of storage, and 3) retrieve the correct information in appropriate situations. Encoding is like filing information in the right drawer, storage involves holding the information securely in for retrieval, and retrieval is finding the right drawer and pulling out the right file. During encoding, environmental stimuli are categorized and mapped onto existing foundations of knowledge. After successful encoding, the storage process moves sensory information into working memory, and then long-term memory. If a student is not paying attention or ready to pay attention to lecture-relevant material, they might not be able to encode properly and learn. When information has moved into short-term memory, it is only briefly stored before being lost unless rehearsed and understood. At this stage, the active dedication to rehearsing that information is also based on attention and mindset. Once sufficiently understood and rehearsed, it can move onto long-term [semantic] memory. Semantic memory is built from concepts. It allows us to integrate relevant knowledge into preexisting conceptual foundations and memories in the classroom. Testing learned information involves two types of retrieval: recall and recognition. Recall does not require a cue to retrieve information and would be more associated with a short answer question. Recognition would be required for a multiple-choice question, identifying pre-learned information. Though each memory process is different, attention plays a key role and determines whether or not information is learned.

How Task-Sets Direct Attention and Influence Learning

Learning is dependent on attention. In much of task-switching literature, researchers focus on the idea that there are different ‘task-sets’ that are activated and inhibited (Monsell, 2003). Task-sets are actively maintained cognitive processes necessary for particular tasks. They direct attention toward or away from important information in the classroom, affecting encoding, storage, and retrieval. In class, students’ task-sets for before-class and during-class may be different. Because task switching is influenced by relevant and irrelevant task-sets, it would then direct attention to affect some or all stages of learning.

In this study, I examine how task switching affects attention, and ultimately influences academic performance. Previous research suggests that preparation for a task switch occurs through one or both of two phases: 1) direct task set retrieval [from long term memory] (Logan & Gordon, 2001; Monsell, 1996; Monsell & Mizon, 2006; Rogers & Monsell, 1995) and/or 2) activating associations between task-relevant components (Mayr & Kliegl, 2000). In task switching, it is important to keep in mind that not all tasks are equal. Allport et al (1994) found that task switching to the dominant task rather than a non-dominant task came with a much greater switch cost.

How Task Switching in the Classroom Activates Different Task-Sets

Task switching is also known as set-switching, and is the unconscious shift of attention between tasks. It is highly effortful and is controlled by the central executive. In Baddeley’s model of working memory (1986, 2000; Baddeley & Hitch, 1974), the central executive is a system that is responsible for maintaining goal relevant information and inhibiting goal irrelevant information. In this way, it directs attention. Consequently, it also influences what information reaches more permanent stores. Previous literature found that task switching uniquely involved switch costs and resumption lags, lingering mental taxes from a task interruption or switch (Altmann and Trafton 2007). During this lag time, participants are also more susceptible to errors. Two theories have stemmed from the idea of switching-time costs. The TSI hypothesis (Allport et al. 1994) attributes switch costs to interference and residually activated mental processes from the previous task. The ATA model (Rogers & Monsell, 1995) attributes switch costs to mental adjustment of executive control processes to the new task. Though different, the two views do support the idea of a preparation effect--that with more preparation to switch, switch costs should decrease.

Task Switching Theories of Recalibration and Interference

Some recent studies (Rubinstein et al, 2001) have supported theories like the ATA model and cognitive readjustment in explaining switch costs. Others, however, support the TS1 theory, finding that lingering effects of the initial tasks were present and interfering with the second task long after the stimulus was no longer present (Wylie & Allport, 2000). Vandierendonck et al (2010) created an elegant solution combining both views. Rather than understanding task switching from a lingering or reconfiguration perspective, the Vandierendonck et al (2010) model states that task switching requires both a) reactive control in inhibiting interference from the previous task and b) proactive control in adjusting the task set for the subsequent task.

Interference Effects of Social Media on Mental Load

I expect that interference effects will be particularly severe. They can add to the mental load of students and potentially deter learning. Working memory has a limited capacity and cognitive load is however much information is being held at any moment. High cognitive load impedes our central executive function and its ability to maintain goal relevant information and inhibit goal irrelevant information. With high perceptual load, irrelevant distractors can severely impede task performance (Forster & Lavie, 2008). If we are expending too many cognitive resources at once, it is detrimental to our efforts to learn. In fact, previous research has shown that task switching takes significantly longer when there is a greater load in working memory (Risse & Oberauer, 2010). Because social media is so engaging, when class has begun, many students are switching unwillingly away from social media. I hypothesize that, as a result of this unwilling switch, the resources that social media used during active engagement might still be occupied even after tabs are closed and phones are shut off. Recovering from a task switch between two cognitively different tasks may increase switch costs.

The Lecture Environment and its Effects on Switch Costs

Students can engage in many different tasks while they wait for class to start, including reviewing their notes (task-relevant), reading irrelevant information (neutral-irrelevant) or engaging with social media on their computer or phone (engaging-irrelevant). The relevancy and the level of engagement of these pre-lecture activities may be what impacts and predicts academic performance during and after class. Task switching between two self-chosen tasks is already has recovery challenges, but the classroom context is unique. Lectures are not personalized to any one student. Like an assembly line, they move continuously at a particular pace. Pieces of information move down the assembly line and students either pick them up or do not. Not all pieces are equally important. Missing the first block may be worse than missing a later block. Certain pieces are essential in building a foundation for other pieces to fit together. Lectures tend to be front-loaded with important information, which means that foundational pieces are at the beginning of the assembly line. With the attentional switches from pre-lecture activities to the lecture, students may miss the most important pieces that start the lecture, which can mean that they may not be able to piece later blocks together and catch up.

The current study looks at how the switch costs at the beginning of class can be impacted by how cognitively similar the pre-lecture activity and the lecture are. In other words, can what we are doing ten minutes before class change how many pieces we miss at the beginning of the assembly line? For the students that are engaging with Facebook, Instagram, or Twitter right before the lecture, the transition between the two may be significant and even difficult due to the compelling and engaging nature of social media. On the other hand, if they are reviewing notes for the class, they might have already activated the correct task-set, preparing themselves to learn immediately. Reviewing notes can build contextual prerequisites for understanding, allowing students to then fit lecture information into an already extant knowledge structure (Bransford & Johnson, 1972). Engaging with social media, however, may do the opposite; being ready to learn and retain information may not be as easy as putting phones in pockets or closing Facebook tabs. Just as note reviewing and activation may enhance learning, interference from social media may dampen it.

Why Notes May Facilitate Learning

The hypotheses are built on cognitive similarity of tasks, which research has shown to be highly impactful on the success of the switch. If reviewing notes prepares the student for future learning, they might not experience task switch costs because they have essentially 'pre-switched'. With smaller-scale tasks, task switching can be facilitated by alertness to and preparation for the new task, decreasing switch costs and increasing response time (Schneider, 2017). Studies on media-specific instant message (IM) interruptions have reached the same conclusion, that IM's that are relevant to the task are less disruptive than when they are irrelevant. In the same vein, research has shown that time lost through the resumption lag can be partially recovered; external retrieval cues have proven to mitigate interruption costs (Schneider 2016). If we re-conceptualize the lecture as an interruption of the pre-lecture task, we find similar variability in disruptiveness due to cognitive relevance. More relevant interruptions are less disruptive than irrelevant disruptions (Gould et al, 2013), likely interfering with encoding.

Why Social Media May Impede Learning

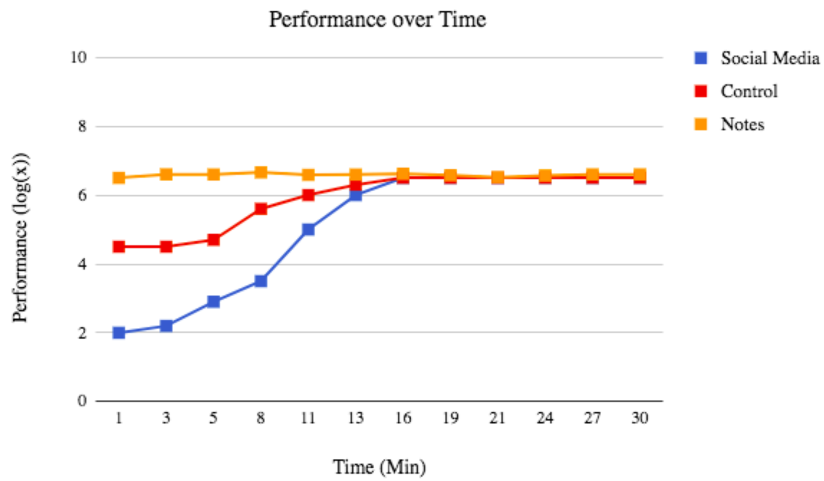
A college lecture can range from 50 minutes to two hours, yet studies have shown that students check their social media more frequently than every 15 minutes (Rosen et al, 2013), which, in a two hour class, means eight interruptions. From the lens of the hypotheses, each interruption includes a recovery as they try to get back on task and a possible information loss every time they are off task. Social media, unlike other irrelevant activities, is both compelling and highly interactive. Tending to social networks takes up around 30% of time spent online (Nielsen NetView, 2009). Social media is rewarding, leading to increased dopamine in anticipation of rewards, likes, or shares (Tamir & Mitchell, 2012). I expect that, because social media is not only irrelevant but also engaging, the task switch will be much more difficult for students. Consequently, even brief exposure to social media will impede subsequent learning.

I build upon classic interruption literature like Gillie & Broadbent (1989), which compared similarity of disruption content to the goal task. However, analyzing disruption during the task itself, I expanded the timeline of interest to include pre-task switches and post-task effects.

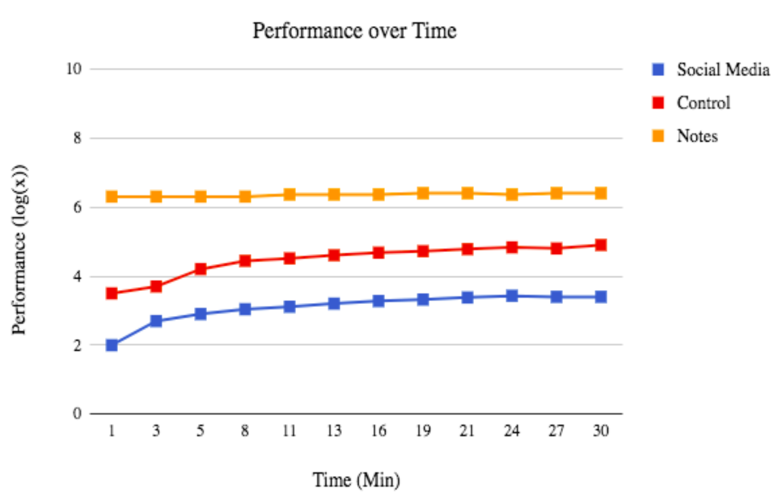
Social media is extremely cognitively dissimilar to the lecture, so I expect that switching from engaging with social media to focusing on class material will be extremely effortful. It is not only cognitively dissimilar, but it is also engaging, so it is expected that it will increase participants' off-task social media usage. I expect there to be an activation from notes of previous information and a positive effect on learning.

In sum, I predict:

1) Participants who engaged in social media would perform worst overall and those who reviewed notes would perform best overall.
2) Participants in the social media condition would experience more subsequent attentional interruption and would have higher rates of off-task social media usage.
3) Exploratory analyses were carried out to determine how long any differences in learning lasted after the task switch as a function of condition.
    - 3a) Schema activation will cause notes participants to avoid the recovery time after a task switch and perform at a baseline. Those in the social media condition have a bigger lag in beginning but eventually perform just as well. The control group has a medium lag and then evens out in performance because it is not compelling. The performance difference is there in the beginning and disappears by the end.



- 3b) Poor foundation hypothesis: Note reviewing participants are essentially pre-switched to focusing on lecture material, so they are better prepared to learn the foundational points at the beginning of the lecture. As a result, they continue to do better overall. The control group experiences normal switch costs lag because it is a switch from irrelevant material to the task. Social media is so engaging and cognitively dissimilar from the lecture material that it requires the most cognitive resources. Participants experience greater switch costs, missing foundational points and continuing to underperform, possibly never to recover.



METHODS

Sample and Procedure

Oberlin College students ($N = 62$) were observed on two consecutive days. The majority were students in the introductory psychology course ($N = 55$), earning course credit, while some participants were paid students in varying class years at Oberlin College ($N = 7$). In both sessions, students watched a lecture on novel material. In Session 1, students were tested on the material to set a baseline for academic performance and observed for baseline distraction level. In Session 2, students were randomly assigned to ten-minute conditions: social media ($N = 22$), notes ($N = 21$), and control ($N = 19$). After watching the second lecture, they were tested on their cumulative learning. The experimental manipulation was a between-subjects approach to explore variations in learning, task-switching, and attention as a result of pre-task conditions. Distraction effects during the class were also observed, potentially as a result of exposure to pre-class social media, as a possible mediator of academic performance and the amount of attention paid to the lecture.

Session 1: Baseline and Notes

Session 1 familiarized participants to the classroom setting. Baseline retention and distraction scores were collected. Notes were created from this session for the Session 2 experimental notes-reviewing condition. The first session included a 30-minute lecture video on sensory systems from the MIT online lecture series followed by a 20-question test, with a total of 40-45 minutes.

Set Up

A day prior to the study, participants were sent an email preparing them for the study by asking them to bring appropriate class materials–that is, to bring their laptop and, if they typically took handwritten notes during class, writing utensils and notebooks. Participants were randomly assigned to seats in a lecture hall. They were given an overview of Session 1 and data was collected via Qualtrics survey software. Participants were instructed to recreate their typical class behavior. Note-takers were informed that they would not be able to use their notes on the test.

Lecture Video

MIT sensory systems lecture videos were chosen because of the structure of the lesson plan. They present introductory material at the beginning and clearly organize the rest of the lecture within the first five minutes. The information is cumulative. Participants watched the introductory 30-minute lecture to the course, which described visual systems and measures of visual systems.

Confederate and Attentional Baseline

An upperclassman Psychology major was hired to act as a confederate in the study. While participants watched the video projected on the screen, the confederate noted attention and distraction every other minute. Participants were randomly assigned to seats that allowed for maximum visibility of screens to the confederate, who was always seated in the corner of the last row. Sessions were limited to a maximum of seven participants to ensure that the confederate would be able to observe all participants over the lecture.

Post-Lecture Test

The test was 20 questions, of which 19 were multiple choice with three options (see Appendix A). The Session 1 test began with a free recall question, asking participants to list as many topics from the lecture as they can. This question served to allow researchers to compare specificity of learning engagement as well as the time points at which participants remembered different amounts of information.

Session 2: Experimental Manipulation

In the second session, participants engaged in randomly assigned ten-minute conditions, watched the next video of the MIT sensory system lecture series, and completed a 40-question cumulative test. The second session took from 50 minutes to an hour.

Note reviewing participants were expected to perform best because their attention was already focused on the lecture material and they would retain more information at the beginning of the lecture. Those in the social media condition were expected to perform worst at the beginning because their initial attentional shift is the greatest. Social media participants were also expected to perform worst overall because the attentional shift in the beginning impacted their ability to build upon the foundational information.

Pre-Lecture Activity

Participants were assigned to the same seats and were randomly assigned to one of three experimental conditions: notes (relevant task), control (partially relevant task), and social media (irrelevant task). Before starting the task, participants were again given instructions to have notes and other relevant class materials ready for the lecture video; instructions for each step of the study were not repeated between each stage. The notes participants read main points from the first session (see Appendix C for notes materials) on their laptops. Those in the control condition read an Ancient History Encyclopedia article on Mummification in Ancient Egypt on their laptops. Participants in the social media condition were asked to engage with any social media of their choosing on either their phones or laptops.

Lecture Video

Participants watched the second lecture video in the MIT sensory systems series, which again laid out the structure of the class and lesson plan in the first few minutes. This video built upon the first, expanding on the visual system and detailing the retina.

Confederate and Attentional Disruption

The confederate once again marked attention for every other minute during the lecture video based on laptop tabs, phone visibility, phone check, and note taking. The performance of social media participants was expected to improve as the interference effect lessens over time, but it is also possible that their exposure to the social media prior to the activity would make them more likely to shift their attention away from the lecture. The expectation was that once they begin engaging with social media, it would be much more difficult for them to stop thinking about it.

Post-Lecture Test

After watching the lecture video, participants took Test 2, which included questions from Test 1. The cumulative test was 39 randomized questions: 16 from Lecture 1 and 23 from Lecture 2 (see Appendix B). See Table 1 for preliminary descriptive statistics on all relevant study variables.

Table 1

Descriptive Statistics for All Variables

Variable	n	M	SD
Session 2 Test-Taking Duration	62	2787.42	714.147
Session 1 Test-Taking Duration	62	2047.94	954.328
Session 2 Scores on Baseline Material	62	0.6324	0.15499
Session 2 Scores on New Material	62	0.6295	0.12265
Total Session 2 Scores	62	0.6306	0.10467
Baseline Scores	62	0.5814	0.15062
Baseline Social Media Usage (%)	54	0.5	0.50469
Session 2 Social Media Usage	54	0.6481	0.48203

Measures

Tests were developed from lecture video transcripts and were taken through Qualtrics. Test durations for each participant were recorded (*s*). One to two questions were selected from lecture material for every minute of the lecture to measure performance at different blocks of time. If there was not enough material for a particular minute, questions were chosen from material from the minute before or the minute after. Questions were randomized for participants but graded chronologically. For each participant, the confederate noted phone visibility, phone check, irrelevant laptop tabs, and note taking, recording baseline distraction during Lecture 1. They observed distraction following pre-task conditions during Lecture 2. For Lecture 2, I was most interested in distraction levels following engagement with social media and whether or not they would increase, accompanied by a decrease in overall academic performance.

RESULTS

The primary objective of the current study was to investigate the effects of pre-class conditions on learning. Initial explorations of the data included a boxplot and zero-order correlations before moving forwards to test differences between groups. To test learning differences as a result of pre-lecture activities, I separated participants by condition and performed one-way analyses of variance (See Figure 1 for an initial boxplot comparing session 2 scores by conditions and Table

2 for descriptive statistics). I compared test-taking duration, overall scores in session 2, and performance on scores on questions repeated from the first test. I also performed analyses of covariance, comparing scores on questions from lecture 2 alone, while controlling for baseline performance as well as on repeated questions, while controlling for baseline performance. To test my supplementary hypothesis, I also compared off-task social media usage between conditions using a one-way analysis of variance. Implications of the research and study limitations as well as future research directions are then explored.

Figure 1. Boxplot of Session 2 Scores by Condition.

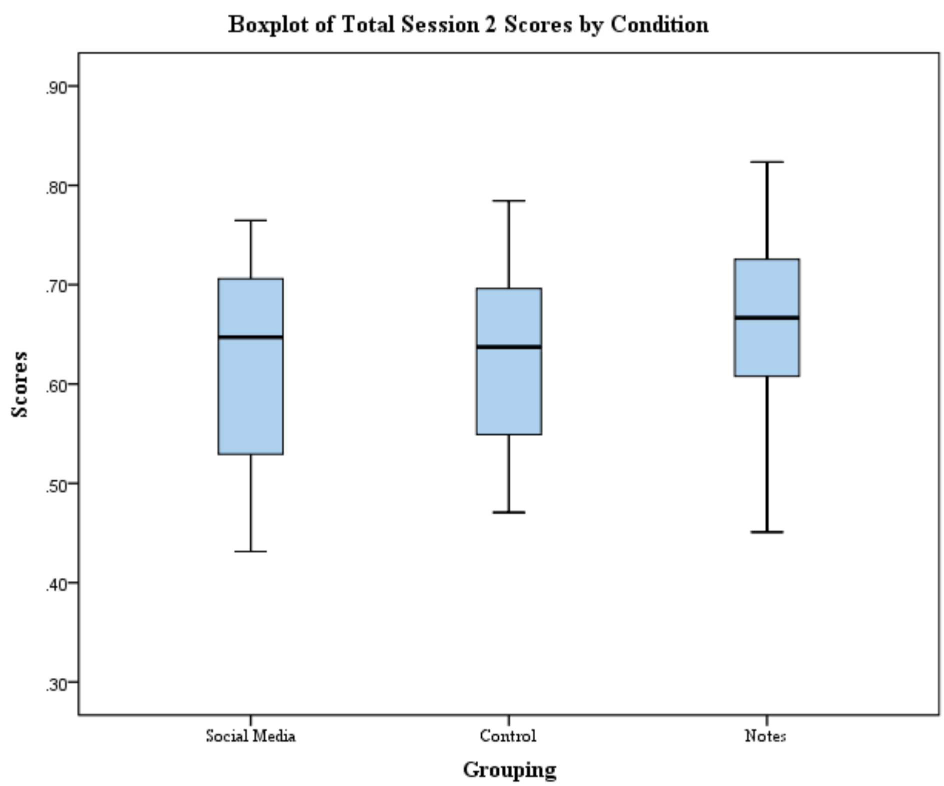


Table 2
Descriptive Statistics for Session 2 Performance

Session 2 Total Scores

Condition	*n*	*M*	*SD*
Social Media	22	0.6168	0.10424
Control	19	0.6264	0.09414
Notes	21	0.6489	0.116

To initially explore relationships between variables, a zero-order correlation was performed, which showed that there was a moderately positive correlation between baseline performance and the same questions presented again in Session 2 ($r(60) = .329$, $p = .009$). The moderately positive correlation found was not in line with expectations; I expected a strong positive correlation overall, as this was the second time that participants were encountering the same material and questions. As expected, there was a strong positive correlation between performance on repeated questions and total score during Session 2 ($r(60) = .692$, $p < .01$) and performance on newly learned material and total score during Session 2 ($r(60) = .841$, $p < .01$). It was unsurprising that higher performance on sections of the exam was linked to higher performance overall. Baseline academic performance and baseline social media usage were moderately negatively correlated ($r(52) = -.303$, $p = .026$). It was expected that using social media during class would be linked to lower academic performance and detriments in learning, but no initial correlations were found as a function of condition.

As shown in Table 3, the ANOVA test comparing test-taking duration showed no significant differences between conditions ($F(2, 60) = .034$, $p = .966$, $\eta p^2 = .011$). Please note that Qualtrics measured the length of time the test was open, including during the lecture. Though I did not expect differences in duration, longer duration for notes participants may have indicated an activation of more complex knowledge structures. Shorter duration for social media might have indicated the opposite or a lack of motivation to perform well. In this way, the lack of significance in main effects of duration did not support my hypotheses of performance differences amongst conditions.

Table 3

Descriptive Statistics for Test Taking Duration by Condition in Session 2

Duration			
Condition	*n*	*M*	*SD*
Social Media	22	2717.68	897
Control	19	2897.32	330.54
Notes	21	2761.05	771.23
Total	62	2787.42	714.15

Table 4

One-Way Analysis of Variance of Test Taking Duration by Condition in Session 2

	df	SS	MS	F	p
Between Groups	2	41117.132	20558.566	.034	.966
Within Groups	60	36169031.730	602817.195		
Total	62	36210148.860			

To further analyze academic performance, I compared overall scores between experimental conditions in session 2 by performing another ANOVA. As shown in table 5, the analysis also did not produce significant results ($F(2, 60) = .584$, $p = .561$, $\eta p^2 = .017$). There were no overall performance differences between conditions in session 2. These results did not support my hypothesis that overall, social media participants would perform the worst and notes participants would perform the best.

Table 5

One-Way Analysis of Variance of Scores by Condition in Session 2

Source	df	SS	MS	F	p
Between Groups	2	.013	.007	.584	.561
Within Groups	60	.670	.011		
Total	62	.683			

I performed a final ANOVA to compare off-task social media usage during the lecture between conditions. As shown by Table 7, the ANOVA did not produce significant results, and failed to confirm my hypothesis that, once exposed to social media, those participants would be more likely to re-engage with social media and go off-task ($F(2, 51) = 1.70$, $p = .193$, $\eta p^2 = .062$).

Table 6

Descriptive Statistics for Off-Task Social Media Usage by Condition in Session 2

Off-Task Social Media Usage			
Condition	*n*	*M*	*SD*
Social Media	17	0.8235	0.39295
Control	18	0.5556	0.51131
Notes	19	0.5789	0.50726

Table 7

One-Way Analysis of Variance of Session 2 Off-Task Social Media Usage

Source	df	SS	MS	F	p
Between Groups	2	.768	.384	1.697	.193
Within Groups	51	11.547	.226		
Total	53	12.315			

I found no significant differences in total scores between groups or in scores on the questions repeated from session 1. Because there were no main effects of pre-class learning conditions, I did not test for a time interaction. The analyses also did not support the hypothesis that there was a larger distraction factor for those in the social media condition; in fact, I did not find any differences between conditions in distraction.

To test my main question of whether or not social media and note reviewing would influence subsequent learning, I performed an analysis of covariance. I compared performance on time 2 questions between each group, controlling for baseline scores. As shown in Table 9, there were no significant differences amongst conditions, which did not support my main hypothesis that new learning was influenced by pre-learning activity. I ran an additional ANOVA without controlling for session 1 scores, and it did not increase the power of the analysis ($F(2, 60) = .021$, $p = .979$, $\eta p^2 = .001$).

Table 8

Descriptive Statistics for Performance on New Material by Condition in Session 2

New Material Performance			
Condition	*n*	*M*	*SD*
Social Media	22	0.625	0.12388
Control	19	0.6316	0.132
Notes	21	0.6324	0.11855

Table 9

ANCOVA for time 2 questions by condition controlling for baseline scores

Source	df	*SS*	*MS*	F	*p*	ηp2
Baseline	1	0.003	0.003	0.162	0.688	0.003
Condition	2	0.001	0	0.03	0.971	0.001
Error	58	0.914	0.016			

I ran a second ANCOVA to see if their memory for the first session differed by condition while controlling for baseline scores. As shown in Table 11, with baseline performance as a covariate, there were not significant differences between conditions. These results also did not support our hypothesis that notes reviewing participants would perform better on questions based on information they had reviewed.

Table 10

Descriptive Statistics for Performance on Repeated Material by Condition in Session 2

Repeated Material Performance			
Condition	*n*	*M*	*SD*
Social Media	22	0.6029	0.16936
Control	19	0.6177	0.11348
Notes	21	0.6767	0.16833

Table 11

ANCOVA for session 1 questions in time 2 by condition controlling for baseline scores

Source	df	*SS*	*MS*	F	*p*	ηp2
Baseline	1	0.176	0.176	8.321	0.005	0.125
Condition	2	0.082	0.041	1.938	0.153	0.063
Error	58	1.225	0.021			

There were no additional statistical analyses that I could perform, as none of the tests produced significant results and did not support the hypotheses.

DISCUSSION

Main Findings

The primary objective of this study was to investigate student performance and learning differences as a result of pre-class activity. Participants were separated into three conditions of varying semantic relevance to class material: notes (relevant, non-engaging), control (irrelevant, non-engaging), social media (irrelevant, engaging). The results of the analyses did not support the hypothesis that there would be significant differences in academic performance between the three groups. Further exploratory analyses controlling for performance on the first session also did not show a learning difference between groups based on what they do before class. Analyses of time effects also did not produce significant results.

Explanations

There are a few logical explanations for why the results were nonsignificant and why they did not support the hypotheses about the learning phenomenon. The first is that students are so habituated to checking their phones and social media before class that minor differences do not matter. This floor effect negated any potential intervention effects and the effect size was likely too small. To compare the results to the real-life setting, I observed the introductory psychology course in the ten minutes before class to the first five minutes of class. Only 19 people had arrived ten minutes before class, and of those students, the majority were either on social media or were socializing with classmates. These two groups far outweighed the students who reviewed notes before class even as more students trickled in. All students who had been accessing social media on their laptops kept their laptops out to take notes, and almost none closed the irrelevant tabs. The observational data also showed that even the PSYC 100 students that naturally chose to review notes or engage in a neutral activity before class checked their social media throughout those activities. Social media is such an ingrained habit that it overrides [the effects of] other activities. It could be part of the students' preparation for the start of the lecture and therefore, it undermines differences between tasks. Observation also showed an increased social media use in PSYC 100 in the minutes immediately prior to expected class start. In the 5 minutes immediately prior to class, virtually all students stopped conversations and note reviewing they were engaged in to check social media. Social media may thus be part of the preparation students make for task switching, rather than a task that interferes with task switching.

It is also possible that the hypotheses were simply incorrect, as the results were inconsistent with previous literature. A more likely explanation for the nonsignificant results is that students simply did not pay careful enough attention, which made the phenomenon difficult to detect. Evidence for this explanation is visible in the overall subpar mean performance for session 1 (M = 58% correct, SD = .15) and session 2 (M = 63% correct, SD = .10). A one sample t-test showed that, in the first ($t(61) = 30.40$, $p < .001$, $d = 3.8$) and the second session ($t(61) = 47.44$, $p < .001$, $d = 6.3$), students performed better than chance, though still much more poorly than would be expected for college students at a rigorous academic institution. Observational evidence from the confederate showed that the students were paying little attention in either session.

A potential explanation for this lack of attention could be a combination of the lack of interest in the material due to its subject material and a lack of motivation to pay attention in the first place. The lecture material was chosen because it was unfamiliar information and researchers wanted to accurately gage learning of new material. However, this aspect of the subject material may have made it more difficult for students to pay attention. Lack of attention may explain not only why there was no difference between conditions for newly learned information but also why there was no improvement in performance for note reviewing participants. Students who were exposed to social media ten minutes before class were expected to experience more disruptions and continue engaging with social media, thus undermining their learning ability. Though differences found were not significant, a pattern was found, with social media students using their social media during class 82% of the time, control doing so 56% of the time, and notes doing so 58% of the time. Nevertheless, they further supported the explanation that students as a whole were not paying much attention to the lecture content, and therefore did not experience interruptions and heightened distraction.

If the results were due to an overall lack of attention and/or motivation, future studies should combat that effect by providing incentives. Participants in the current study received credit for participation but lacked the same incentive to perform well from academic pressures in an actual college course. Added sessions would also more accurately mimic a classroom setting and measure total learning over the course of a semester-long class. Most of the previous literature has looked at task switching between simple tasks, measured in seconds. The objective of the current study was to replicate classroom learning effects, comparing task switching effects of more complex tasks in a real-life setting. Apart from the cognitive difficulty of the tasks themselves, the current study also differed from previous literature in that it looked at pre-class activity, classroom activity, and post-class performance. It is unique in that it follows complex learning over longer periods of time under varying learning conditions. Classroom studies may have tremendous implications on academic performance and in helping students change their habits in a simple but effective way that may make a difference in their learning.

Appendix A: Session 1 test

Name as many of the (6) topics of interest as you can:

1. Why is depth perception particularly interesting?
    a. The retina is arranged in a two-dimensional manner.
    b. It relies more on sound than sight.
    c. The brain functions in 2D but the eyes see 3D.
2. The first half of the lectures will be on:
    a. retina, visual system/cortex
    b. Pathways of the brain and neurotransmitters

c. Anatomy of the ear, hearing aids, hair cells

3. The second half of the lecture will focus on:
   a. Pathway of auditory communication
   b. Visual system connections to other sensory systems
   c. Adaption, color/depth/form perception
4. List the methods of understanding the system from least to most intrusive (to humans):
   a. Imaging, pharmacology, psychophysics, optogenetics, anatomy, pharmacology, brain lesions
   b. Psychophysics, imaging, anatomy, optogenetics, electrophysiology, pharmacology, brain lesions
   c. Brain lesions, pharmacology, anatomy, optogenetics, psychophysics, pharmacology, imaging
5. What is the main tool used in psychophysics?
   a. Amplifiers
   b. Microelectrodes
   c. Color monitor
6. How do psychophysics determine how well humans/animals can see?
   a. Discrimination tasks
   b. Illusion tasks
   c. Adaptation tasks
7. Which are located at the back of the eye?
   a. Fovea
   b. Aqueous Body
   c. Lens
8. What is unique about the fovea?
   a. High acuity
   b. High processing speed
   c. Contains blind spot
9. Why do we need to make multiple eye movements to see fine details?
   a. Low acuity in the periphery
   b. Compensate for blind spot overlap
   c. Dense distribution of cells
10. What is unique about the optic nerve?
    a. Projection point to nervous system
    b. High processing speed, consolidates photoreceptors and other cells
    c. High acuity
11. What is important about the blind spot?
    a. There is only one.
    b. There is one in each eye in the same location.
    c. There is one in each eye with no overlap.

12. How are cells labeled?
    a. In groups
    b. With stains
    c. With microelectrodes
13. What is the difference between Nissl and Golgi stains?
    a. Nissl stains are more accurate.
    b. Nissl stains highlight cell bodies, dendrites, and axons.
    c. Golgi stains label cell bodies, dendrites, and axons.
14. What is the advantage of studying the brain electrophysiologically?
    a. You study it before staining, allowing you to study it before exploring what it does.
    b. You study it after staining, allowing you to learn more after the cells are already labeled.
    c. It is a slower process that gets a more accurate result.
15. How are microelectrodes used?
    a. To record and make audible action potentials from single cells.
    b. To pass currents to mimic action potentials to elicit responses.
    c. To mute action potentials of certain cells to observe whole brain responses.
16. What does pharmacology entail?
    a. Stains are used in various combinations to allow for larger analyses.
    b. Glass pipettes inject neurotransmitters and responses are observed.
    c. The brain is stimulated or cooled with different chemical agents.
17. Brain lesions inspired work in brain inactivation. What are the two most commonplace methods used?
    a. Electronic cooling and anesthetics
    b. Injection of neurotransmitters and recording
    c. Sensitive substances are injected and interact with different types of cells
18. How do fMRI's work?
    a. Different neurotransmitters in the brain react to magnetic agents.
    b. In a large magnet, repeated stimuli visibly activate brain regions.
    c. A stimulus is presented once, and magnets continuously activates brain areas.
19. How do optogenetics work?
    a. Inject cells to increase brain activity and stimulate different responses.
    b. Inject light-sensitive substances and inhibit/excite cells.
    c. Better than electrical stimulation, because it addresses different types of cells and elicits multiple responses at once.

Appendix B: Session 2 Test

1. What are the main goals of today's lecture?
    a. Understand the course of evolution in developing the occipital lobe and how it

interacts with the other lobes in the brain.
   b. Understand the layout of the visual system, retina, and progression of discoveries in the visual system.
   c. Understand cross-cultural disparities in the development of the visual system and how environmental factors contributed.
2. What is a major difference between lower order animals and higher order animals?
   a. Higher order animals have expended more energy in developing better auditory perceptivity and can therefore survive in a larger range of environments.
   b. Higher order animals have front-facing eyes instead of side-facing eyes.
   c. Lower order animals are better able to detect changes in their environments due to higher visual perceptivity.
3. Why did that change between lower order and higher order animals happen?
   a. Sideways looking eyes missed a large portion of the visual field.
   b. Front-facing eyes are more sensitive to light and color.
   c. To allow for depth perception.
4. How do eyes make their connections through the ganglion cells to the central nervous system?
   a. The input from the left eye projects into the right half of the brain and the input from the right eye projects into the left half of the brain.
   b. The input from the left eye projects into the left half of the brain and the input from the right eye projects into the right half of the brain.
   c. The optic nerve does not cross over at the chiasm so the connections are made more smoothly to the central nervous system.
5. For sideways-looking eyes, what is the main difference from forward-looking eyes?
   a. The lateral geniculate nucleus is small and underdeveloped.
   b. The left cortex receives input from the left eye and the right cortex receives input from the right eye.
   c. They experience encephalization and development of cortex.
6. For forward-looking eyes, what are the differences?
   a. There is no inversion of the eyes.
   b. The cortex and the lateral geniculate nuclei in the thalamus are much larger and more complex.
   c. Both A and B.
7. For forward-looking eyes, what becomes more important in visual processing?
   a. Cornea
   b. Thalamus
   c. Temporal lobe
8. How does the Horopter Circle work?
   a. The diameter depends on the point of the eye through which the circle goes.
   b. A spot will activate one region in the brain within the frontal lobe anywhere along

the horopter.

c. Two different regions in both eyes are activated and go to different locations.

9. What does the Horopter Circle have to do with depth?
   a. Images falling outside or inside the circle and falling on non-correspondent points are tied to depth stereopsis.
   b. The two eyes have input to corresponding points in the brain so that you see double of the image and provides depth information.
   c. Both A and B
10. What's important about the iris?
    a. Becomes thicker or thinner to control the amount of light coming into the eye, which is why eyes look lighter in the sun.
    b. Can become bigger or smaller to control the size of the opening into the lens.
    c. Becomes thicker or thinner to control focus on an object that is close or far away.
11. What does the lens do generally? Select all that apply.
    a. Allows us to focus on objects that are close and far by changing thickness.
    b. When it is dim, the lens open to allow more light/photons to enter.
    c. When it is bright, the lens open to allow more light/photons to enter.
12. How is the lens different from a camera?
    a. With cameras, the closer the image, the further out the lens has to go, but the lens in the eye thickens instead of bulging.
    b. There is no difference between the lens in the eye and a camera.
    c. There is a different adjustment process from far to close and a separate one for close to far in the lens, whereas a camera has the same adjustment.
13. Select the true statement about the specifics of lens thickness:
    a. Ciliary muscles open the lens to allow more photons to come in when it's dim.
    b. For close objects, the lens is thick and for far objects, the lens is thin.
    c. For close objects, the lens is thin and for far objects, the lens is thick.
14. What are some common problem with the lens? Select all that apply.
    a. With age, the lens becomes loose and adjusts too far, causing blurred vision and inability to focus correctly on objects.
    b. With age, the lens becomes stiff and doesn't adjust as much.
    c. Cataracts block the lens and reduce its ability to focus accurately.
15. What are some common current remedies to lens problems that come with age? Select all that apply.
    a. Bifocals
    b. Graduated lenses
    c. Cataract surgery
16. Select all true statements about the fovea.
    a. As you move outwards from the fovea, there are fewer cones, lower density and lower acuity.

    b. The light comes in from the top of the fovea.
    c. You have to move your eye around so you can see things in fine detail because of the high number of cones in the periphery.

17. What is the pigment epithelium?
    a. Single layer of cells that are pigmented and absorb any photons that reach it.
    b. Multiple layers of cells that filter out color from visual information.
    c. Reflects light so that as many photoreceptors are activated as possible to process visual information.
18. Why does the pupil look black?
    a. The pigment epithelium scatters so much light that it does not absorb any and therefore remains dark.
    b. The pigment epithelium absorbs all light so that there is no reflection and remains dark.
    c. The color of the pigment epithelium is a constant and light has no role.
19. Why are deer eyes reflective?
    a. They do not have a pigment epithelium.
    b. Their pigment epithelium is particularly absorptive.
    c. Their pigment epithelium has reflecting molecules that improve the ability to see.
20. How is the sight of deer and cats different from that of humans? Select all that apply.
    a. They have reflecting molecules called tapetum.
    b. Photons activate photoreceptors in one direction.
    c. Because light scatters in a directional manner, photoreceptors are activated when light bounces back.
21. Why do albinos have red eyes?
    a. The pupil is red from blood vessels and light reflects from them and is not absorbed.
    b. The iris is red from blood vessels and light is absorbed, making the blood more visible.
    c. They do not have pigment epithelia.
22. What proves that the pigment epithelium has to do with the ability to see?
    a. Albinos who lack it have poor vision.
    b. Non-pigmented eyes are too reflective and activate too many photoreceptors.
    c. Lower order animals do not have it and are not as sensitive to visual information as higher order animals.
23. Why is depth perception particularly interesting?
    a. The retina is arranged in a two-dimensional manner.
    b. It relies more on sound than sight.
    c. The brain functions in 2D but the eyes see 3D.
24. List the methods of understanding the system from least to most intrusive (to humans):
    a. Imaging, pharmacology, psychophysics, optogenetics, anatomy, pharmacology,

brain lesions

b. Psychophysics, imaging, anatomy, optogenetics, electrophysiology, pharmacology, brain lesions

c. Electrophysiology, pharmacology, anatomy, optogenetics, psychophysics, brain lesions, imaging

25. What is the main tool used in psychophysics?
    a. Amplifiers
    b. Microelectrodes
    c. Color monitor
26. How do psychophysics determine how well humans/animals can see?
    a. Discrimination tasks
    b. Illusion tasks
    c. Adaptation tasks
27. What is the main tool used in psychophysics?
    a. Amplifiers
    b. Microelectrodes
    c. Color monitor
28. Which are located at the back of the eye?
    a. Fovea
    b. Aqueous body
    c. Lens
29. What is unique about the fovea?
    a. High acuity
    b. High processing speed
    c. Contains blind spot
30. Why do we need to make multiple eye movements to see fine details?
    a. Low acuity in the periphery
    b. Compensate for blind spot overlap
    c. Dense distribution of cells
31. What is unique about the optic nerve?
    a. Projection point to nervous system
    b. High processing speed, consolidates photoreceptors and other cells
    c. High acuity
32. What is important about the blind spot?
    a. There is only one.
    b. There is one in each eye in the same location.
    c. There is one in each eye with no overlap.
33. How are cells labeled?
    a. In groups
    b. With stains

c. With microelectrodes

34. What is the difference between Nissl and Golgi stains?
    a. Nissl stains are more accurate.
    b. Nissl stains highlight cell bodies, dendrites and axons.
    c. Golgi stains label cell bodies, dendrites and axons.
35. What is the advantage of studying the brain electrophysiologically?
    a. You study it before staining, allowing you to study it before exploring what it does.
    b. You study it after staining, allowing you to learn more after the cells are already labeled.
    c. It is a slower process that gets a more accurate result.
36. How are microelectrodes used? Select all that apply.
    a. To record and make audible action potentials from single cells.
    b. To pass currents to mimic action potentials to elicit responses.
    c. To mute action potentials of certain cells to observe whole brain responses.
37. What does pharmacology entail?
    a. Stains are used in various combinations to allow for larger analyses.
    b. Glass pipettes inject neurotransmitters and responses are observed.
    c. The brain is stimulated or cooled with different chemical agents.
38. Brain lesions inspired work in brain inactivation. What are the two most commonplace methods used?
    a. Electronic cooling and anesthetics
    b. Injection of neurotransmitters and recording
    c. Sensitive substances are injected and interact with different types of cells
39. How do fMRI's work?
    a. Different neurotransmitters in the brain react to magnetic agents.
    b. In a large magnet, repeated stimuli visibly activate brain regions.
    c. A stimulus is presented once, and magnets continuously activate brain areas.

Appendix C: Notes Condition Materials

Layout and Organization of the Visual System in Higher Mammals

- Topics of interest:
    - How we adapt in vision
    - How we perceive/process colors
    - How we analyze motion
    - How we perceive depth
    - How we recognize objects—faces
    - How we make [saccadic] eye movements

- Depth perception—retinal surface is 2D, but the brain allows us to see 3D
- Layout of lectures:
  - Basic layout of retina and lateral geniculate system
  - Visual system wiring
  - Visual cortex: ON and OFF channels
  - Retina—midget and parasol channels
  - Adaption and color, depth perception, form perception
  - Illusions and visual prosthesis
  - Neural control of visually guided eye movements
  - Motion perception and smooth eye movements
- Methods of understanding the visual system:
  - Psychophysics
  - Anatomy
  - Electrophysiology
  - Pharmacology
  - Brain lesions
  - Imaging
  - Optogenetics
- Psychophysics: study of behavior of humans/animals to determine how well they can see
  - Color monitor—trains participants to look at fixation spot where stimuli are presented; participant is then to make saccadic eye movement, verbally indicate location of stimuli, or press lever
  - Stimuli are varied to analyze how much contrast is necessary for perception—detection task
  - Discrimination task—unique, target stimulus amongst other distractor stimuli
- Anatomy – brain parts: central sulcus, lunate sulcus, arcuate, principalis, primary visual cortex, V1
- Fovea
  - Location: back of the eye
  - Special Characteristics: high acuity
  - Why? Dense distribution of photoreceptors and other cells in retina
  - Connection to saccadic eye movements: multiple necessary to see fine detail because periphery does not allow for detection of fine details
  - Why? Distribution of photoreceptors and cells are not dense
- Optic nerve
  - Location: back of the eye
  - Special Characteristics: fibers from retinal ganglion cells go to optic nerve where retinal fibers project onto nervous system
- Blind Spot

- Location: Back of eye
- Special Characteristics: one in each eye, different locations so no overlap

- Anatomical Procedure (2): Labeling Individual Cells
  - How
    - slice brain into thin sections and stain cells
    - record intracellularly and inject labeling substance
  - Stains: Nissl and Golgi
  - Nissl: only cell bodies
  - Golgi: cell bodies, dendrites, axons
  - Labeling
  - Advantage: studying it electrophysiologically prior to staining allows you to study it before staining and exploring what it does and what it looks like
- Electrophysiology
  - Method 1
    - How: microelectrodes into brain, connected to amplifiers & computer
    - What: records audible action potentials from single cells
  - Method 2
    - How: microelectrode in brain passes electric current to mimic action potentials
    - Why: to elicit responses
- Pharmacology
  - How: glass pipette into brain to inject neurotransmitters or other agents
  - Why: determine effects on brain
- Brain Inactivation
  - Method 1: electronic cooling with Peltier device to see what happens when it is cooled, and then warm up to see what happens to recovery
  - Method 2: inject anesthetics into particular regions for limited time to see effects on behavior and neurotransmitters
- Imaging
  - fMRI: functional Magnetic Resonance Imaging
  - How: person in magnet, stimuli presented repeatedly, active brain areas light up
- Optogenetics
  - How: selectively place light-sensitive substances into types of cells in brain and make them respond through light manipulation
  - Optogenetics > Electrical Stimulation
  - You can use substances that are sensitive to different kinds of light, so you can excite some while inhibiting others; two sides of coin rather than one

- Summary of techniques
  - Electrical recording using microelectrodes

- Electrical stimulation
- Injection of pharmacological agent
- Brain inactivation: permanently by lesions or reversibly by cooling/injecting various substances
- Optogenetics—activate/inhibit cells through light on brain

References

Allport, D. A. & Styles, E. A. & Hsieh, S. (1994). Shifting attentional set – Exploring the dynamic control of tasks. Attention and Performance XV. Vol. XV.

Altmann, E. M., & Trafton, J. G. (2007). Timecourse of recovery from task interruption: Data and a model. *Psychonomic Bulletin & Review, 14*(6), 1079-1084. doi:10.3758/bf03193094

Atkinson, R., & Shiffrin, R. (1968). Human Memory: A Proposed System and its Control Processes. *Psychology of Learning and Motivation,* 89-195. doi:10.1016/s0079-7421(08)60422-3

Baddeley, A. (1986). Working Memory, Reading and Dyslexia. *Advances in Psychology,* 141-152. doi:10.1016/s0166-4115(08)61202-9

Baddeley, A. D., & Hitch, G. (1974). Working Memory. *Psychology of Learning and Motivation,*

47-89. doi:10.1016/s0079-7421(08)60452-1

Baddeley, A. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences, 4*(11), 417-423. doi:10.1016/s1364-6613(00)01538-2

Bransford, J. D., & Johnson, M. K. (1972). Contextual prerequisites for understanding: Some investigations of comprehension and recall. *Journal of Verbal Learning and Verbal Behavior, 11*(6), 717-726. doi:10.1016/s0022-5371(72)80006-9

Forster, S., & Lavie, N. (2009). Harnessing the wandering mind: The role of perceptual load.

Cognition, *111*(3), 345–355. http://doi.org/10.1016/j.cognition.2009.02.006

Gould, S. J., Brumby, D. P., & Cox, A. L. (2013). What does it mean for an interruption to be relevant? An investigation of relevance as a memory effect. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting,57*(1), 149-153. doi:10.1177/1541931213571034

Logan, G. D. (2002). Parallel and Serial Processing. *Stevens Handbook of Experimental Psychology*. doi:10.1002/0471214426.pas0407

Mark, J. J. (2017, February 14). Mummification in Ancient Egypt. *Ancient History Encyclopedia*. Retrieved from https://www.ancient.eu/article/44/

Revlin, R. (2013). *Cognition: Theory and Practice*. New York, NY: Worth.

Mayr, U., & Kliegl, R. (2000). Task-set switching and long-term memory retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*(5), 1124-1140. doi:10.1037//0278-7393.26.5.1124

Monsell, S. (1996). Control of mental processes. In V. Bruce (Ed.), Unsolved mysteries of the mind: Tutorial essays in cognition (pp. 93- 148). Hove, England: Erlbaum, Taylor, & Francis.

Monsell, S. (2003). Task switching. *Trends in Cognitive Sciences*, *7*(3), 134-140. doi:10.1016/s1364-6613(03)00028-7

Monsell, S., & Mizon, G. A. (2006). Can the task-cuing paradigm measure an endogenous task-set reconfiguration process? *Journal of Experimental Psychology: Human Perception and Performance, 32*(3), 493-516. doi:10.1037/0096-1523.32.3.493

Nielsen NetView, June 2009-2010, http://blog.nielsen.com/nielsenwire/online_mobile/what-americans-do-online-social-medi a-andgames-dominate-activity

Rogers, R. & Monsell, S. (1995). Costs of a Predictable Switch Between Simple Cognitive Tasks. *Journal of Experimental Psychology*: General. 124. 207-231. 10.1037/0096-3445.124.2.207.

Rosen, L. D., Carrier, L. M., & Cheever, N. A. (2013). Facebook and texting made me do it: Media-induced task-switching while studying. *Computers in Human Behavior, 29*(3), 948-958. doi:10.1016/j.chb.2012.12.001

Rubinstein, J. S. & Meyer, D. & Evans, J. E. (2001). Executive Control of Cognitive Processes in Task Switching. Journal of experimental psychology. Human perception and performance. 27. 763-97. 10.1037/0096-1523.27.4.763.

Schiller, P. H., Sensory Systems, [9.04]. (Massachusetts Institute of Technology: MIT OpenCouseWare), http://ocw.mit.edu (March 12, 2018). License: Creative Commons BY-NC-SA

Schneider, D. W. (2016). Investigating a method for reducing residual switch costs in cued task

switching. *Memory & Cognition, 44*(5), 762-777. doi:10.3758/s13421-016-0590-2

Schneider, D. W. (2017). Phasic alertness and residual switch costs in task switching. *Journal of Experimental Psychology: Human Perception and Performance, 43*(2), 317-327. doi:10.1037/xhp0000318

Tamir, D. I., & Mitchell, J. P. (2012). Disclosing information about the self is intrinsically rewarding. *Proceedings of the National Academy of Sciences,109*(21), 8038-8043. doi:10.1073/pnas.1202129109

Vandierendonck, A. & Liefooghe, B. & Verbruggen, F. (2010). Task Switching:

Interplay of Reconfiguration and Interference Control. *Psychological bulletin*. 136. 601-26. 10.1037/a0019791.

Wylie, G., & Allport, A. (2000). Task switching and the measurement of "switch costs". *Psychological Research, 63*(3-4), 212-233. doi:10.1007/s004269900003