THESIS

COUNTERACTING STUDENT RESISTANCE TO SPACED LEARNING USING THE THEORY OF PLANNED BEHAVIOR

Submitted by

Victoria Prescott Mattingly

Department of Psychology

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Fall 2015

Masters Committee:

Advisor: Kurt Kraiger

Matthew Rhodes
Margaret Beier
Thomas Chermack

ABSTRACT

COUNTERACTING STUDENT RESISTANCE TO SPACED LEARNING USING THE THEORY OF PLANNED BEHAVIOR

Despite the proven benefits of spaced learning, students are reluctant to use this study technique. I proposed that students do not space their studying because they lack basic competencies needed to successfully engage in this behavior. According to the Theory of Planned Behavior, behaviors are the product of one's intentions, which are derived from attitudes and beliefs. Using this theoretical framework, I designed and evaluated a classroom intervention with the goal of changing debilitating attitudes towards spaced learning. I hypothesized that students exposed to this spaced learning classroom intervention would have stronger intentions to space, higher rates of spaced learning behaviors, and consequently higher exam scores compared to the control group. Intentions to space and the beliefs and attitudes contributing to those intentions were improved by the classroom intervention. Students who spaced their studying also performed better on the exam compared to students who did not space. However, the classroom intervention did not significantly predict whether or not students would space their studying. Implications and future research directions based on the study's findings are also discussed.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

Students are more responsible now than ever for their own learning outside of the traditional confines of a classroom. The changing nature of knowledge and skill acquisition in the 21st century can be partially attributed to widespread use of technology-based learning tools (e.g., online training programs, the inclusion of e-leaning tools into blended learning environments, or the vast number of online classes and even entire degrees offered online), in which students must manage how they engage with the material through self-directed learning. Beyond e-learning, self-directed knowledge acquisition is also important to more traditional learning environments (Dunlosky & Ariel, 2011). Students are commonly required to spend time outside of the classroom to master material on their own and later demonstrate this mastery by performing on exams or assignments. Therefore, it is of utmost importance that learners of the 21st century are equipped with effective study strategies to better facilitate their self-directed learning (Sitzmann & Ely, 2010).

This is especially important because research shows that students are not good at assessing and managing their own learning (Dunning, Johnson, Ehrlinger, & Kruger, 2003). And although there are proven strategies that can be implemented to increase learning outcomes (Dunlosky, Rawson, Marsh, & Willingham, 2013), it is rare for students to engage in these techniques (Bjork, Dunlosky, & Kornell, 2013). For example, when deciding how to study, students are more likely to endorse non-effective study techniques (e.g., highlighting and flashcards) over strategies proven to increase recall (Daniel & Woody, 2010; Karpicke, 2009; Winne & Jamieson-Noel, 2002). One example of an effective study technique empirically proven to increase learning outcomes –yet still be widely rejected by students – is spaced learning (Kornell & Bjork, 2007).

Spaced Learning

Spaced learning occurs when studying is spread out over multiple intervals; simply put, it is the opposite of cramming. Researchers sometimes use the synonymous term “distributed practice” when describing spaced learning. The two terms will be used interchangeably throughout this paper. When learning is distributed, more information is retained when compared to learning in one massed session (e.g., Baddeley & Longman, 1978; Benjamin & Tullis, 2010). Dating back as early as 1885 (see Ebbinghaus, 1964) the positive effect of spaced learning on recall, otherwise known as the “spacing effect,” is nothing new to the science of learning. The benefit of segmenting studying over multiple sessions has been reliably demonstrated, as evidenced by a meta-analysis of 317 studies that found that spaced learning significantly improves recall compared to cramming (Cepeda, Pashler, Vul, Wixted & Rohrer, 2006). The spacing effect has been found to be one of the most “dependable and replicable phenomena in experimental psychology” (Dempster, 1988).

Spaced learning works because it capitalizes on the basic memory mechanisms of encoding and retrieval. Multiple exposures to the same learning material increases the number of retrieval pathways created (Glenberg, 1979). The same material is encoded not only more often, but also can be linked with multiple cues due to the variations in temporal, physical, or mental contexts (Estes, 1955). Son and Simon (2012) proposed that the spaced learning leads to improved learning outcomes compared to massing as the former does not result in habituation to the study material that would otherwise occur when focusing on the same stimulus in one prolonged learning session. In other words, the burnout that occurs when trying to study the same thing for a duration of time would not happen if studying occurred in shorter sessions during which the learner would be less likely to fatigue.

Physiological reasons as to why spaced learning works have also been identified. Sisti, Glass, and Shors (2007) found that spaced-trial trainings caused longer-lasting cells to be developed in the hippocampus, which resulted in more persistent memories of spaced versus massed training materials. The spaced training allowed for brain cells to regenerate between study sessions, which resulted in more permanent neural connections and stronger memories (i.e., increased learning).

Aside from its positive effect on learning, spaced learning has other benefits as well. For one, the total study time is equal regardless of whether it is massed or spaced. Obviously, if someone were to spend more time studying some stimulus it could be assumed that memory would be improved over time. The spacing effect is special because learning can be improved without adding any additional study time, but rather by increasing the number of study sessions that would still equal the same amount of total study time. Students in particular have much to gain from these findings, as they can reap the benefits of improved retention of course content, which could lead to higher exam scores, without increasing their overall study time (Rawson & Dunlosky, 2011).

Second, not only is spaced learning an excellent way to maximize learning without increasing total study time, but it is also effective across domains and individual differences. The benefits of distributed practice has been evidenced across learners of all ages (Kornell, Castel, Eich, & Bjork, 2010), both within and outside of the classroom. For example, spaced learning has been found to improve learning outcomes within organizational settings, such as training motor skills (Lee & Genovese, 1988; Savion-Lemieux & Penhune, 2005) and the use of technology (Huang, 2002). Benefits of distributed practice have even been demonstrated in the context of surgical training (Moulton et al., 2006). Moreover, the spacing effect has been found to improve creative learning endeavors associated with playing piano (Rubin-Rabson, 1940) and painting (Kang & Pashler, 2012). It is clear that learners across a wide variety of domains have much to benefit from engaging in spaced learning.

Statement of the Problem

Despite the utility and robustness of the spacing effect, students and trainees alike tend to prefer massing over distributed practice (Baddeley & Longman, 1978; Dunlosky & Nelson, 1994). Research shows that students in particular tend to be ignorant about what spaced learning is (Dempster, 1988), and are unable to articulate its effectiveness over cramming at increasing learning outcomes (Pyc & Rawson, 2012).

Increasing learner knowledge of distributed practice may not be sufficient to change study habits, however. Even those made aware of the positive effect of spacing on learning outcomes were still unlikely to endorse or utilize this study strategy (Kornell, 2009; McCabe, 2011). For example, Kornell and Bjork (2008) found that even after students directly observed the benefits of spaced learning on their exam performance, they still rated cramming as the more preferable study strategy.

In another study that aimed to increase the endorsement of spaced learning, Balch (2006) had his students complete a short, yet potent, memory task to demonstrate the power of the spacing effect on memory. To establish a baseline measure, students first rated how likely they were to space or mass their studying in general prior to participating in the spaced learning memory task. Once the task was completed, results were shared and students witnessed that the majority of the class had remembered more spaced than massed words. Students then provided ratings about how likely they would be to space their studying in the future. Even though the post-task self-report study ratings showed a statistically significant increase in intentions to space studying compared to the pre-task ratings, these findings were not practically significant insofar that students still endorsed cramming over spacing overall. Despite having experienced firsthand how spaced learning could directly improve their memory of studied material, students indicated that they would be more likely to cram than not.

Thus, although research supports explicitly instructing students on learning and memory topics as a means to improve academic performance (Hattie, Biggs, & Purdie, 1996; Tuckman, 2003), there is little evidence of permanent change in study behaviors or generalization to new topics. Therefore, the challenge is getting students to actually apply spaced learning to their own study behaviors. This study will address student reluctance to engage in spaced learning and propose a solution to counteract this resistance. In sum, while the available research evidence shows that distributed practice indeed works (e.g., Cepeda et al., 2006; Dempster, 1989), it has failed to change leaners' willingness to change their study habits to capitalize on these findings (Rohrer & Taylor, 2006). I propose that one reason for this is that past interventions focused more on mastery of content (i.e., defining what the spacing effect is) than actually *convincing* participants to adopt new learning strategies. Thus, a successful intervention would need to focus on convincing learners that spaced learning is a valuable, appealing, and easy strategy they could apply to their own study behavior. The research question this study aims to answer is: Can students be trained to successfully space their learning?

The field of Industrial/Organizational (I/O) psychology has developed a rich training literature that includes science-based techniques to maximize the transfer of trained behaviors, which for the purpose of this study will be increasing student engagement in spaced learning. I implemented these best practices to develop a classroom intervention with the purpose of increasing student endorsement and engagement in distributed practice.

Decades of research done in I/O psychology on the science of training can be used to inform how best train individuals on the competencies needed to be successfully space learning. According to Bloom's taxonomy of learning, maximum learning and transfer occurs when cognitive (or knowledge-based), psychomotor (or skill-based), and affective (or attitude-based) competencies of whatever is to be trained are all included (Krathwohl, Bloom, & Masia, 1964). Foremost, students may not *know* what spaced learning is and even if they do, they may not fully understand how much it could benefit their learning (Dempster, 1988). Regarding skills, students who lack the tools to effectively manage their time are likely to fail at attempts to space their studying. One reason for this may be that students were never properly trained on how to use effective study strategies in the first place. Indeed, one study found that 80% of undergraduates improvise their study strategies because they were never formally taught about the best practices of studying (Kornell & Bjork, 2007). Most importantly, students will continue to default to cramming if they do not believe they have the ability to successfully schedule spaced study intervals, which is largely dependent on their attitudes towards spaced learning. I argue that learner attitudes toward spaced learning are the most influential factor in predicting whether or not spaced learning will occur.

How do we identify the competencies needed to practice effectively spaced learning? The first step is to conduct a job or task analysis. As spaced learning is a specific task, it would be more appropriate to conduct a task analysis (Sackett & Laczo, 2003). The purpose of a task analysis is to identify the competencies needed successfully complete that task. What knowledge, skills, abilities, and other attributes (e.g., personality, individual differences), or KSAOs, does a student need to be effective at spaced learning? Therefore my approach is to identify the KSAOs of spaced learning, and then build an intervention around those competencies to help all leaners be more likely to use this technique.

In addition to building specific competencies to facilitate the transfer of training, the I/O literature suggests that for learning to stick, trainees must see the training as relevant and also be motivated to learn (Hicks & Klimoski, 1987; Quinones 1995). Moreover, trainee attitudes have been found to predict training success.

The well-established Theory of Planned Behavior (TPB) states that one's beliefs and attitudes towards a behavior determine the intention to engage in that behavior, which then predicts whether or not that behavior will be enacted (Ajzen, 1991). According to this theory, a student's choice to intentionally engage in spaced studying depends on their attitudes toward spaced learning. This concept of attitudes predicting study behaviors emphasizes the significant role metacognition plays in how students choose to learn, and how these decisions can either optimize or hinder one's learning process (Bjork, 1994). Indeed, research has found that the lack of metacognitive awareness people have about their learning might very well explain why students consistently endorse ineffective study techniques (e.g., Kornell & Bjork, 2008; Roediger & Karpicke, 2006b).

The volitional nature of spaced learning also makes it amenable to a TPB intervention, as TBP interventions are found to be most effective when participants have control over the target behavior. Ajzen and Fishbein (2005) hold that the more control one has over a behavior, the stronger of a predictor intention to behave is on that behavior actually being enacted. Because behavioral intentions are influenced by beliefs and attitudes about that behavior (Ajzen, 1991), leveraging student beliefs and attitudes about spaced learning could very well be the key to counteracting student resistance to engage in this study behavior.

The TPB has been used in a number of studies to successfully facilitate behavioral change (e.g., Brubaker & Fowler, 1990; Fishbein, Ajzen, & McArdle, 1980; Webb & Sheeran, 2006). Ajzen (2002a) prescribed an intervention design model which capitalizes on the principles of the TPB to maximize the likelihood of behavioral engagement. Ajzen (2002a) made a clear distinction between the two stages of a properly conducted TBP intervention. The goal of stage one is to change the antecedents of intentions to motivate people to engage in the target behavior. After these intentions are formed, it is then necessary to ensure that impediments to successful engagement in this behavior are removed to maximize the intervention's effectiveness. Therefore, for the purpose of counteracting student resistance to spaced learning, I will combine Ajzen's (2002a, 2002b) TPB intervention recommendations with the best practices of training to develop my spaced learning classroom intervention.

Contributions of the Current Study

The purpose of this study is to address why students do not space their learning, to counteract their resistance to spacing by developing and administrating a classroom intervention based on the TPB, and then to evaluate the effectiveness of this training program. The present study builds on work presently being done by cognitive psychologists to "bridge the gap" between the science of learning and educational contexts (Son & Simon, 2012). However, in this particular study, I attempt to tackle this problem from an I/O psychology perspective by applying best practices of training. Also, despite of the ample research conducted on the spacing effect, this is the first time the TPB has been utilized to attempt specifically to counteract student resistance to spaced learning. The study outcomes may have practical as well as scientific value.

Specifically, if the training program is effective, it can be applied in multiple educational and workplace training contexts.

This paper will be organized as follows. I will begin with a brief overview of the TPB, and then explain how the theory provides the framework for building my spaced learning classroom intervention. I will incorporate pilot study data and the empirical background information I used to inform the various components of an original structural model which predicts the relationships between student attitudes and additional factors (e.g., individual differences) that either facilitate or impede the likelihood that spaced learning will occur. Using this model as the framework for designing my classroom intervention, I will present my hypotheses about how I predict this intervention will increase not only engagement in spaced learning, but also have a main effect on exam scores as well. I will then describe my methodology for administering and evaluating the effectiveness of this training program, followed by a presentation of results. I will conclude with a discussion of my study's findings which will include future research directions, limitations to the study, and practical and theoretical contributions.

Theory of Planned Behavior Applied to Spaced Learning

The Theory of Planned Behavior states that one's beliefs and attitudes about a particular behavior predict the intention to engage in that behavior, which then predicts the behavior itself (Ajzen, 1991). Specifically, one's behavioral, normative and perceived behavioral control beliefs predict corresponding attitudes that in turn predict behavioral intentions. Other factors involved in this model are the background of the participant (i.e., individual differences), and actual behavioral control. I will use this model of the TPB as a framework to develop my own structural model which will include a wide-range of factors that predict whether spaced learning will occur.

Before I identify my model's components, however, I must first address the principle of compatibility. The principle of compatibility states when using the TPB for predicting behavioral change, it is essential that all behavioral and attitudinal items measure exactly the same action, target, context and time elements (Ajzen & Fishbein, 1977). For example, imagine that I wanted to use the TPB to determine the likelihood of whether my friend Diana will bike to school next Friday. It would not make sense for me to ask her if she drove to school last Friday, as these would be incompatible action items (driving vs. biking) although the context element (commuting to school) would indeed be compatible between items. Similarly, the target element would be incompatible between the two items if I were to assess her commuting preferences for travelling to non-school events (e.g., parties or coffee shops).

The principle of compatibility is particularly relevant in attempting to change student intentions about space learning. McCabe (2011) attributed her unsuccessful attempt at increasing engagement in spaced learning to not providing the students with an example of spacing that could be directly applied to their studying behaviors:

> "I predict that had I chosen a scenario describing more typical spacing versus massing situation (e.g., a student studying one hour per day over the course of seven days, versus seven hours in one day before an exam), participants who had learned about the spacing effect would have shown stronger endorsement of spacing" (p. 472).

Although the action (spacing) and the measurement of that action were compatible, the target items in McCabe's (2011) study were incompatible. Instead of using a spacing target specific to student study behaviors (e.g., preparing for an exam), McCabe used artwork as the target instead. She explained her study results as a limitation of students not being able to extrapolate what they learned about distributed practice via the artwork memorization example to adequately apply beliefs about spaced learning to their own study behaviors (i.e., the actual target of interest). McCabe concluded that the students' lack of awareness about the positive effects of spaced learning was due to their inability to make the connection between the two incompatible targets (paintings vs. exam material).

I will therefore intentionally align the components of my spaced learning model as closely as possible to the specific behavior of interest for my spaced learning intervention. In accordance with the principle of compatibility, my intervention specifically aims to increase student spaced learning behaviors (action) when studying for exam 3 (target) in Psy100 classes (context) during the week prior to exam 3 (time). Incorporating these specific elements of my spaced learning model with the core premises of the TPB, I pose the following hypotheses:

> ***Hypothesis #1:*** *There will be a main effect of exposure to the classroom intervention on spaced learning intentions. Compared to those in the control group, participants in the treatment group will have stronger intentions to space their learning when studying for exam 3.*

Although most applications of the TPB are used to model more general conceptualizations about how beliefs and attitudes can predict behaviors (Hardeman et al., 2002), a number of TPB interventions have been successful at significantly changing a variety of specific behaviors, ranging from the innocuous goal of increasing rates of riding the bus among college students (Bamberg et al., 2003), to the potentially life-saving implications of encouraging men to perform testicular self-examinations for cancer prevention (Brubaker & Fowler, 1990). I anticipate similar results as the aforementioned TPB intervention studies because I plan to intentionally design my classroom intervention to address and foster the most important beliefs about spaced learning identified to predict resistance to and endorsement of this behavior, respectively.

Hypothesis #2: *There will be a main effect of intention to space on spaced learning behaviors. The stronger one's intention is to space their learning when studying for exam 3, the more likely they will engage in this behavior.*

According to the TPB, the intention to perform a behavior is the most proximal and important determinant of that behavior (Ajzen 1991). The Theory of Reasoned Action, the predecessor theory to the TBP, provides the rationale to the assumption that intentions predict behaviors insofar that people in general are sensible and therefore take into account available information and consider the implications of their actions prior to deciding to behave one way or another (Ajzen & Fishbein, 1980). Therefore, the more one intends to space learning, the more likely it is that spaced learning behaviors will occur.

Hypothesis #3: *There will be an indirect effect of exposure to the classroom intervention on spaced learning behaviors. The effect of the intervention on spaced learning behaviors will be mediated by a stronger intention to space studying. Compared to those in the control group, participants in the treatment group will have higher rates of successfully spacing their learning when studying for exam 3, caused by a strengthened intention to space learning.*

The TPB explains behavior as a function of one's intention to perform that behavior, which can be predicted the congruence between one's attitudes are towards that behavior Therefore, because the goal of the classroom intervention is to convince students of the utility, value, and appeal of spaced learning, I intend to make their attitudes about spaced learning more favorable, which will increase their intention to space, and therefore increase their engagement in this study technique.

Hypothesis #4: *There will be a main effect of study behavior on exam 3 scores. Compared to those who do not space their learning when studying for exam 3, participants who did successfully space their learning will earn higher exam scores.*

As mentioned within the spaced learning section of this paper, distributed practice leads to better learning outcomes due to higher retention and better recall of the studied material compared to cramming (Benjamin & Tullis, 2010; Cepeda et al., 2006). As the spacing effect has been well-established, I would not expect my study to be any exception to the rule that spaced learning improves recall of the studied material. I therefore predict that spaced learning will result in higher exam scores on exam 3.

In sum, H1 – H4 propose how a classroom intervention on spaced learning intentions will affect those intentions and, in turn, affect student learning. Figure 1 depicts how I predict these variables will interact with one another, according to these hypotheses. In order to design a maximally effective intervention, I plan to integrate principles from both TPB and training effectiveness research in designing my spaced learning model and intervention. In the next section, I explain each component of the TPB in greater detail, directly applying spaced learning into this theoretical framework. I will also present additional hypotheses about how I expect this model to act based on my research about student attitudes towards spaced learning. The full conceptual model which integrates spaced learning with the TPB will be presented at the end of this section.

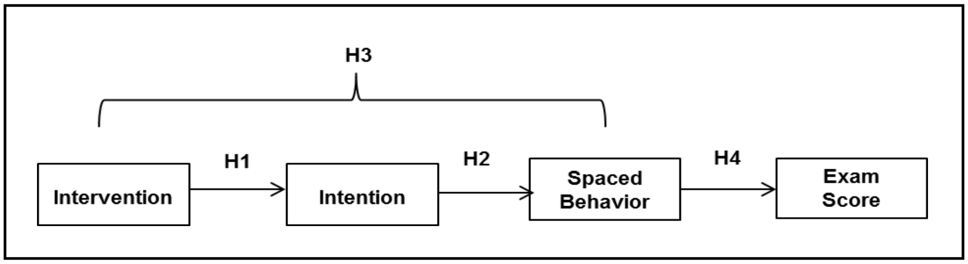

Figure 1. Conceptual model depicting hypotheses 1-4

Behavioral Beliefs and Attitudes toward Spaced Learning

Beliefs are the foundations of attitudes because we must first have some accessible belief about an object in order to make an evaluative judgment, and hence form an attitude, about that object (Fishbein & Azjen, 1975). The TPB categorizes three types of beliefs, the first of which is behavioral. Normative and control beliefs will be covered in the following sections.

A behavioral belief is the consideration of the possible outcomes of engaging in the target behavior (Ajzen & Fishbein, 1980). Therefore, a student's behavioral belief about spaced learning is determined by the perceived outcomes associated with that behavior. The subjective value placed on the outcome (i.e., favorable-unfavorable, valuable-not valuable, appealing-unappealing) determines the strength of the resulting attitude (Ajzen, 2005). For example, imagine if a student believed that the time required to space his learning would take away from spending social time with friends. Because this hypothetical student values being with friends, the perceived outcome of spaced learning would be unfavorable. The resulting behavioral attitude towards spaced learning would be that it is an unappealing behavior, and therefore will have a negative effect on his intention to engage in that behavior.

When investigating impediments to implementing spaced learning in the classroom, Dempster (1988) found that students lacked basic understanding of the psychological bases of the spacing effect. Comprehension of spaced learning by students has not improved because of Dempster's study, as research shows that students still do not understand that spaced learning leads to better recall compared to cramming (McCabe, 2011; Pyc & Rawson, 2012). Moreover, even if learners could accurately define spaced learning as the opposite of cramming, they may still be unaware of the positive effect distributed practice has over massing. Research shows that students generally do not perceive spaced learning as an effective memory-enhancing study strategy (Kornell & Bjork, 2008a).

Based on the aforementioned findings, I predict that students generally have unfavorable behavioral beliefs about spaced learning. This unfavorable behavioral belief baseline is particularly important as it can increase the potency of my classroom intervention according to recommendations about constructing an effective TPB intervention (Ajzen, 2002a; Ajzen, 2002b). A significant increase in a behavioral belief predictor can have a strong effect on intentions and behaviors when its strength is relatively low prior to the intervention (Ajzen, 2005). If students' beliefs about spaced learning were already favorable, it would not make sense to try to increase engagement in spaced learning by trying to improve already favorable beliefs.

Another important quality of behavior beliefs is saliency, or how available those beliefs are to the participant (Fishbein & Ajzen, 1975). Myriad outcomes could result from spacing one's learning, but only the most salient of these outcomes will come to mind when a student is considering spaced learning as a potential study method. This is especially important when attempting to change behaviors using the TPB, as it has been found that it is easier to introduce information that will lead to the formation of new beliefs compared to trying to change existing beliefs (Ajzen, 2005).

Inoculation Theory posits that resistance to change can be reinforced by attacking the motivational and cognitive psychological mechanisms in place to uphold cultural truisms, or widely shared ideas that are rarely questioned (McGuire, 1964). "Cramming for an exam is an easy and effective study method," would be an example of such a truism related to resistance to spaced learning. According to Inoculation Theory, when people have little or no practice defending truisms, their belief in this truism is more vulnerable to persuasion. Just as our immune systems can benefit from vaccinations that introduce a relatively harmless dosage of an otherwise threatening virus, one's psychological defense against persuasive counterarguments to present beliefs can also be strengthened through mild exposure. Therefore, it would not be advantageous for my training program to change the truism that "Cramming for an exam is an easy and effective study method," as research has found the majority of students already widely endorse this belief and it will therefore be resistant to change it (Kornell, 2009; McCabe, 2010). Instead, I will introduce new beliefs about spaced learning as opposed to trying to attack students' current beliefs about cramming.

For this reason, the focus of the training will be to highlight all of the advantages of spaced learning, and avoid any explicit statements about cramming being a poor study method. More specifically, I will emphasize the two most obvious consequences of spacing their studying for the exam: 1) students will more thoroughly learn the study material; and 2) students will earn a higher exam score. By presenting evidence for these two beliefs, I intend to make these beliefs more salient among the students, which will then strengthen their attitudes, enhance intentions, and therefore increase the likelihood that they will engage in this behavior. The resulting hypotheses are as follows:

Hypothesis #5: *There will be a main effect of exposure to the classroom intervention on one's behavioral beliefs about spaced learning. Compared to those in the control group, participants in the treatment group will have stronger behavioral beliefs about positive spaced learning outcomes.*

The classroom intervention will emphasize the positive outcomes of spaced learning, whereas the control group will not be made aware of this information. Therefore, because these beliefs about spaced learning will be more salient to those exposed to the classroom intervention, I predict that they will more strongly endorse the belief in the positive consequences of engaging in this behavior. As beliefs are the precursor to attitudes, and favorable attitudes predict intentions, two hypotheses logically follow:

***Hypothesis* #6**: *There will be a main effect of participants' behavioral beliefs about spaced learning on behavioral attitudes. The more salient participants' behavioral beliefs are about the positive outcomes of spaced learning, the more favorable their behavioral attitudes will be towards this behavior.*

Hypothesis #7: *There will be a main effect of participants' behavioral attitudes about spaced learning on the intention to engage in this behavior. The more favorable participants' behavioral beliefs are about spaced learning, the stronger their intention will be to space learning when studying for exam 3.*

Now that I have established the expected behavioral beliefs and attitudes I expect to predict spaced learning intentions, I will now address the second of the three belief-attitude categories of the TPB: normative beliefs and subjective norms.

Normative Beliefs & Subjective Norms

Normative beliefs are the perceived expectations that one believes influential people or groups have about engaging in a certain behavior (Ajzen & Fishbein, 2005). The resulting attitude, or "subjective norm," is determined by one's motivation to comply with these behavioral beliefs. An example of a subjective norm about spaced learning would be the perceived social pressure to engage in this study behavior. Social pressure can come in two forms in the case of spaced learning. First, students might feel pressure to conform to what their peers are doing, and choose study methods based on what they believe to be most endorsed by their classmates. Second, students may also feel more inclined to engage in certain study techniques if they believe their instructor endorses one study technique over another.

A popular way to change normative beliefs is by means of a social norm intervention. Commonly used in applied social psychology and health research, social norm interventions aim to capitalize on the powerful normative perceptions held by young adults and college students (Perkins & Berkowitz, 1986). Social norms interventions are based on the premise that decreasing one's perceptions that peers are participating in a certain behavior decreases participation in that behavior. The opposite premise should hold true as well: By informing students that their peers are utilizing spaced learning, students exposed to this information should be more likely to endorse and engage in this study technique themselves.

I collected pilot study data in the spring and fall semesters of 2013 in an attempt to capture Colorado State University (CSU) psychology students' attitudes towards spacing versus massing, and also investigate behavioral outcomes of spaced learning specific to my study population. Results from this pilot study can be viewed in Appendix A. These preliminary findings provided strong evidence for the positive effect spacing can have on studying for

Psy100 exams, as students in Pilot Study #1 who spaced their learning for exam 4 ($N = 13$, $M = 84.62\%$) earned a significantly better average score compared to students who crammed ($N = 110$, $M = 77.39\%$), $t(121) = 2.021$, $p = .045$. This information, in addition to quantitative and qualitative data explicitly endorsing spaced learning behaviors straight from the mouths of CSU undergraduate students, were shared during the classroom intervention. Therefore, I predict the following hypotheses about how normative beliefs and social norms will be affected by exposure to the classroom intervention:

> ***Hypothesis #8:*** *There will be a main effect of exposure to the classroom intervention on one's normative beliefs about spaced learning. Compared to those in the control group, participants in the treatment group will have more salient normative beliefs about spaced learning positive outcomes.*

The classroom intervention will emphasize the positive outcomes of spaced learning specific to CSU undergraduates and Psy100 exam performance, whereas the control group will not be made aware of this information. Therefore, because these normative beliefs will be more salient to those exposed to the classroom intervention, I predict that the treatment group will more strongly endorse the normative beliefs about spaced learning. Research from the training literature also supports H8, as socialization has also been found to influence trainees' goals, and in turn, increase training effectiveness (Campbell, 1988). As normative beliefs are the precursor to social norms, and social norms predict intentions, I propose the following two hypotheses:

> ***Hypothesis #9:*** *There will be a main effect of participants' normative beliefs about spaced learning on social normative attitudes. Specifically, I expect participants' endorsement of positive social norms towards spaced learning to increase as a function of normative belief saliency.*

Hypothesis #10: *There will be a main effect of participants' social norms about spaced learning on the intention to engage in this behavior. The stronger one endorses positive social norms are about spaced learning, the stronger their intention will be to space learning when studying for exam 3.*

Given that I have established the normative beliefs and social norms important to spaced learning, I now will address control beliefs and perceived behavioral control, the third and final behavior-attitude component of the TPB.

Control Beliefs and Perceived Behavioral Control

Control beliefs are the perceived presence of factors that may facilitate or impede performance of a behavior, whereas perceived behavioral control is the subjective evaluation of one's ability to perform a given behavior (Ajzen, 2005). Perceived behavioral control is determined by evaluations one has about: 1) the difficulty or ease of the control factors; and 2) the degree to which one believes he or she has power over these factors (Armitage & Conner, 1999; Manstead & van Eekelen, 1998). The ease-difficulty evaluation is closely related to one's confidence or self-efficacy to perform a behavior, whereas the power evaluation relates to the extent to which one has the adequate resources to successfully perform that behavior (Ajzen, 2002). Self-efficacy has been identified as an important factor to predict training effectiveness (Machin & Fogarty, 2004).

The increased presence of facilitating control factors and the decreased presence of debilitating factors will lead to increased behavioral control over the behavior. The facilitating control factors I will identify as being most important for spaced learning are scheduling study time, staying accountable to that study schedule and interest in learning the exam material. Debilitating control factors include workload, perceived difficulty of spaced learning, and perceived difficulty of the exam. One's control beliefs about these various factors will contribute to the three perceived behavioral belief items I will identify and further explain below: perceived ability to manage time, perceived available time, and motivation to space.

Time management. Spaced studying is an intentional act which requires careful scheduling to ensure that studying is successfully interspersed across multiple intervals. Therefore, students who are skilled at time management will be more likely to schedule the multiple study sessions necessary for spaced learning to occur. Research shows, however, that undergraduate students tend to have poor time management skills (Macan, Shahani, Dipboye, & Phillips, 1990). And although scheduling studying was found to predict student achievement, only about 13% of undergraduate students actually make the effort to schedule their studying (Hartwig & Dunlosky, 2012).

If students were to plan their time better, they could be more successful at balancing their spaced studying in one class with pressing deadlines in other classes. Moreover, strictly following a study plan would prevent work from being delayed until the last minute, as procrastination has been found to be positively correlated to poor time management and other perceived barriers to academic success (Kachgal, Hansen, & Nutter, 2001).

Moreover, results from the pilot study mentioned in the previous section further support my assertion that student perceptions of time management facilitate or impede the endorsement of, and engagement in, spaced learning. In the spring of 2013, CSU Psy100 students were asked to provide qualitative data to the question, "In general, why do you tend to choose one way of studying (cramming vs. spacing) over the other?" Two undergraduate RAs and I coded these responses to derive some themes about why Psy100 students are generally reluctant to space their learning. The most commonly mentioned impediments to spaced learning were obligations in other classes (29%), procrastination (22%), and having limited time in general (21%). These three excuses for not engaging in spaced learning all relate to effective time management and perceived available time.

The importance students place on time management facilitating their success at spaced learning became even more apparent after analyzing data of the second pilot study I conducted. In the fall of 2013, CSU students (n=58) in an undergraduate learning and memory class (Psy325) were asked to provide qualitative responses to what skills they would need to improve their intentions to space their studying in the future. 53% of the students explicitly mentioned the words “time management,” “scheduling,” or “planning,” further supporting my inclusion of time management as an important control belief related to spaced learning.

In sum, data from both pilot studies indicate that one’s ability at applying time management skills will significantly influence their perceived ability to space their studying. The specific control factors related to perceived ability to manage time are scheduling one’s study time and staying accountable to that study schedule. The more favorable the control beliefs are about these factors, the more perceived behavioral control students will have about their ability to engage in the time management skills that will facilitate their spaced learning intentions and, in turn, behaviors.

Perceived available time. Closely related to time management, the second perceived behavioral control item of my spaced learning model is perceived available time. Whether or not learners believe that they have the available time to space their learning can be quite influential in their decision to space or mass. Research shows that students are more likely to cram for an exam if they have a number of additional academic commitments the same week as the exam (Susser & McCabe, 2013). Similarly, Mathieu and Martineau (1997a) found that trainees were less likely to develop mastery beliefs about trained skills if they were faced with competing demands for their time.

Students in both pilot studies indicated that obligations in other classes in addition to responsibilities outside of school contribute to their inability to successfully space their studying. Therefore, workload has been identified as an important control factor insofar that more demanding workloads would impede on a student's ability to successfully space their learning.

Motivation to space. The third and final perceived behavioral control factor within my spaced learning model is motivation to space one's learning. Because perceived behavioral control is the perceived ease or difficulty to perform a behavior according to anticipated impediments and obstacles (Ajzen, 2005), one's motivation to space is an especially important factor contributing to one's intention to do that behavior. The more motivated one is to space studying, the stronger the intention will be to engage in this behavior. Moreover, as perceived behavioral control items are closely related to self-efficacy (Ajzen & Fishbein, 2005), and self-efficacy is positively related to motivation (Bandura, 1977), it can be concluded that one's motivation to perform a behavior significantly relates to their perceived ability to succeed at performing that behavior. Indeed, research shows that trainee motivation has been found to significantly correlate with learning and performance of the trained behavior (Baldwin, Magjuka, & Loher, 1991; Hicks & Klimoski, 1987). A number of control factors can contribute to one's motivation to space studying, including the perceived difficulty of spaced learning, the perceived difficulty of the study object (i.e., material to be learned for exam 3), and the interest in learning the study material.

Perceived difficulty of spaced learning. When students decide which study strategies to utilize, research shows that students tend to endorse ease over effectiveness (Daniel & Woody, 2010). Baddeley and Longman (1978) rationalized that learners might incorrectly conclude that massing is the more effective learning strategy because massed sessions appear to be easier and faster than spaced sessions. Therefore, students who perceive spaced learning as being difficult would be less likely to engage in this technique, and therefore resort to cramming. The difficulty of spaced learning should have a significant effect on one's perceived behavioral control because individuals tend to underestimate their abilities when the task is hard, and overestimate their abilities when the task is easy (Kruger, 1999). Students will be less motivated to space their learning if it is perceived as being difficult to do, therefore reducing their endorsement (i.e., intention) and engagement in this behavior.

Perceived difficulty of exam. Research shows that students choose between spacing or cramming based on whether the study object is perceived to be easy or difficult (Benjamin & Bird, 2006; Son, 2004.) Whether or not students choose to space their studying depends how on difficult they perceive the material to be (Susser & McCabe, 2013). Specifically, Susser and McCabe found that students were more likely to cram if they felt confident in their ability to master the to-be-learned material. Therefore, students will be more motivated to space their learning if they perceive exam 3 to be difficult. Accordingly, students who feel confident in their ability to do well on exam 3 as a result of perceiving the exam to be easy will be more likely to cram.

Interest in learning exam material. Research shows that students are more likely to space their studying if they perceive the study material to be interesting and valuable (Susser & McCabe, 2013). Therefore, the more interested a student is in learning the exam material, the more likely that he/she will be motivated to space studying for exam 3.

All of the control factors discussed above (i.e., scheduling study time, staying accountable to that study schedule, workload, interest in learning the exam material, perceived difficulty of spaced learning, and perceived difficulty of the exam) are not expected to change as a result of the spaced learning intervention. For example, nothing about my spaced learning intervention would result in change in a student's obligations outside of Psy100 (workload), or whether or not they are inherently interested in the exam 3 study material. Rather, one's perceived behavioral control over these various factors is predicted to change as a result of the intervention. For this reason, no hypotheses will be presented about control beliefs, but only about perceived behavioral control.

Hypothesis #11: *There will be a main effect of exposure to the classroom intervention on one's perceived behavioral control towards spaced learning. Compared to those in the control group, participants in the treatment group will have more favorable perceived behavioral control attitudes about spaced learning outcomes.*

The classroom intervention will build feelings of self-efficacy towards students' perceived ability to space studying by training students on a variety of time management tools, whereas the control group will not be trained on these strategies. As the treatment group will also know more in general about spaced learning and its positive effect on learning and exam scores (see section on behavioral control and attitudes), students in this group should also be more motivated to utilize spaced learning compared to the comparison (C) group.

For the reason that perceived behavioral control predicts intentions, the following hypothesis will also be made:

Hypothesis #12: *There will be a main effect of participants' perceived behavioral control attitudes about spaced learning on the intention to engage in this behavior. The more* *favorable participants' perceived behavioral control attitudes are about spaced learning, the stronger their intention will be to space learning when studying for exam 3.*

Specific to academic outcomes, it was found that students who held favorable control beliefs about factors perceived to improve their grade (i.e., perceived behavioral control) had significantly stronger intentions to get a good grade (Azjen & Madden, 1986). Additional findings from this study provide important implications to my present study, as intentions to get an 'A' significantly predicted the actual grades attained by the students, further supporting H1 (i.e., students who intend to space their learning for exam 3 will be more likely to engage in this behavior).

In sum, the perceived behavioral control factors related to time management, perceived available time and motivation to space one's learning are predicted to have a significant influence on spaced learning intentions, and in turn, spaced learning behaviors (H2). A visual presentation of Hypotheses 5-12 can be viewing in Figure 2.

Actual Behavioral Control

Actual behavioral control (ABC) is the extent to which a person has the skills, resources, and other prerequisites needed to perform a given behavior (Ajzen & Fishbein, 2005). ABC has a significant moderating effect on the relationship between intention and behavior (Ajzen, 2005). The implication of ABC for my study is that apart from affecting intentions, the training will be successful to the extent that students correctly learn the correct knowledge of, and skills in, spaced learning. The specific learning objectives for training are provided in Table 8 within Appendix B.

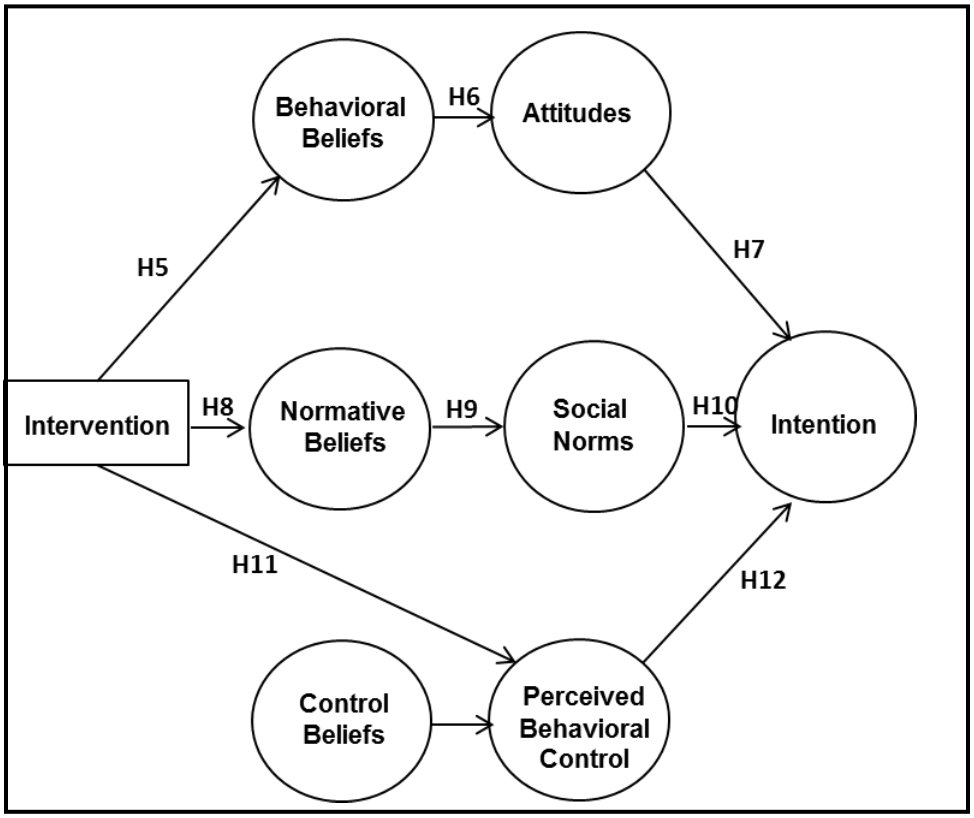

Figure 2. Conceptual model depicting hypotheses 5-12

Individual Differences

The final component of the TPB are the various background factors that could potentially influence one's behavioral, normative and control beliefs. Ajzen (2005) listed a variety of background factors, classifying them as either personal (e.g., personality, values, intelligence), social (e.g., age, gender, education), or informational (e.g., knowledge derived from sources such as the media or an intervention). The personal and social factors identified by Ajzen (2005) can be conceptualized as individual differences among participants. Individual differences are especially important within a training context, as research shows these trainee-related factors can have a significant effect on training outcomes (Cannon-Bowers, Salas, Tannenbaum, & Mathieu, 1995; Tracey & Tews, 1995).

There is no necessary relationship between background factors and beliefs (Azjen, 2005). There must be a theoretical justification to include background factors within a specific TPB model; and these relationships need to be tested empirically to determine whether a specified background factor significantly influences corresponding beliefs (Azjen, 2005). I expect a number of individual differences to affect my model, so I intend to explore whether these variables covary with the hypothesized model effects. These potential covariates include cognitive ability, conscientiousness and goal orientation.

Cognitive ability, or g, has been found to predict trainee success (Colquitt, LePine, & Noe, 2000; Hunter, 1986). I also expect g to strongly covary with one of my outcome measures, scores on exam 3. I would expect students high in cognitive ability to earn higher scores exam 3, holding all other variables constant.

Personality has also been found to matter in training (Wilson, Huang, & Kraiger, 2013). Conscientiousness in particular has been found to correlate highly with academic performance and learning (Ackerman, 2000; Beier & Ackerman, 2001, 2003). I therefore intend to control for conscientiousness. An additional personality trait I predict will affect relationships between my model variables is goal orientation. Goal orientation, the mental framework which influences interpretations and behaviors when one is engaged in learning activities, has been found to predict academic achievement and learning (Eison, 1981, 1986; Pintrich, 2003). Research shows that goal orientation is a strong predictor of training outcomes (Tziner, Fisher, Senior, & Weisberg, 2007). Goal orientation has two facets: 1) learning goal orientation, or the desire to achieve competence in a certain domain; and 2) performance goal orientation, or the desire to demonstrate ability as to be evaluated positively by others (VandeWalle, 1997). I expect student engagement in spaced learning for exam 3 will increase as a function of both types of goal orientation, as research shows that students are more likely to endorse spaced learning based on how heavily an exam is weighted in the course grade and their perceived value of the material (Susser & McCabe, 2013).

The final individual difference I intend to explore is gender. Gender has been found to have an effect on a variety of motivational and emotional regulation processes that could influence training and learning environments (Gully & Chan, 2010). Moreover, Dwyer and Johnson (1997) found that females tend to earn higher grades in high school and college, therefore leading me to expect a difference in exam 3 scores between genders.

These individual differences, in addition to all aforementioned model components described in this section, can be viewed in my model of spaced learning based on the TPB in Figure 3.

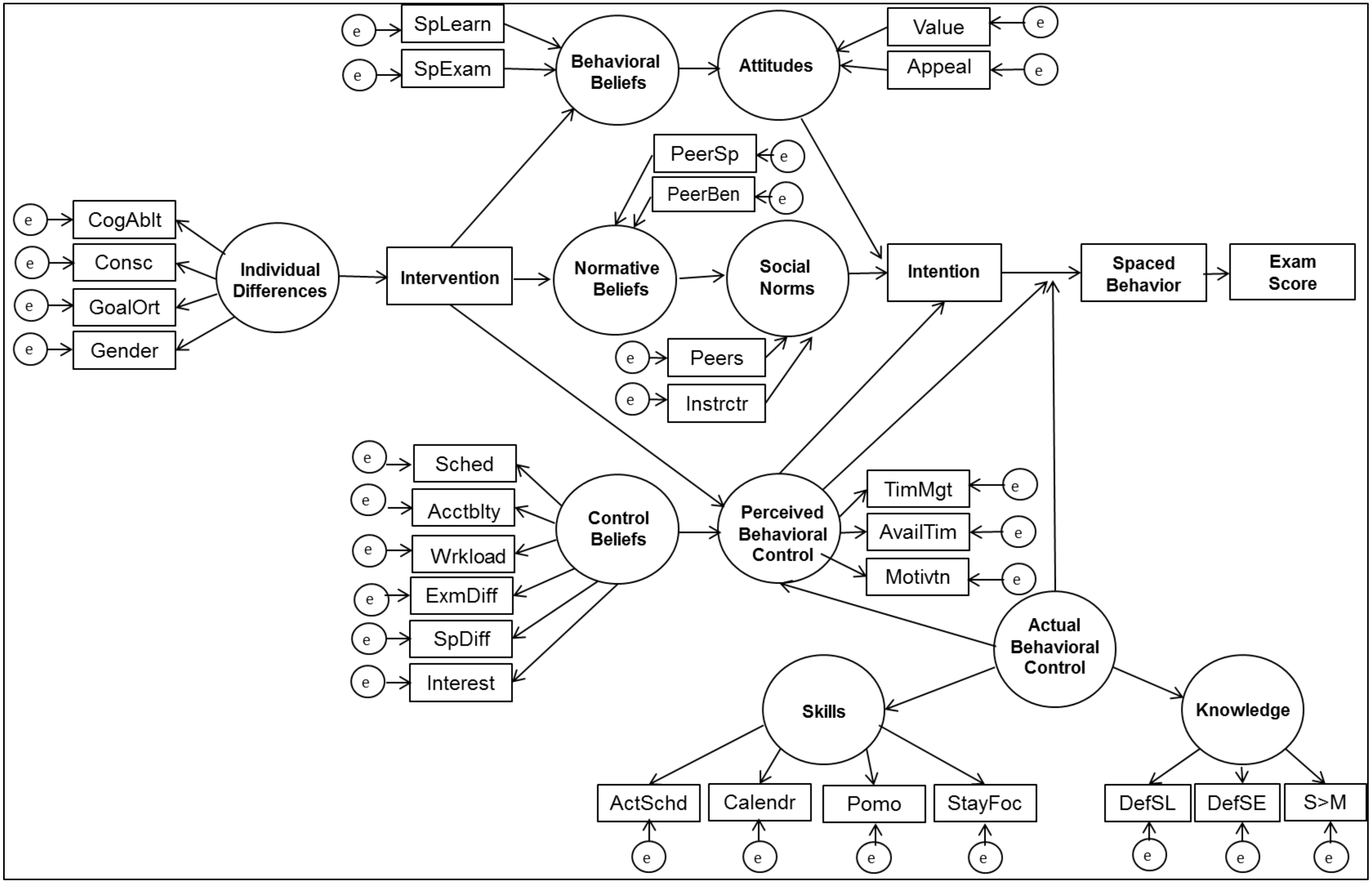

Figure 3. Full model of spaced learning based on the Theory of Planned Behavior

CHAPTER 2: METHODS

Sample

The potential sample was drawn from six Introduction to Psychology (Psy100) undergraduate classes (*N* = 705). The results can be generalized to a more diverse undergraduate population because the majority of students in this particular course are not psychology majors, as Psy100 is a general education class counting towards the degree requirements for all students in the College of Natural Science.

Participation was voluntary, so only students who provided written consent were included in the sample. Moreover, the student must have been present during the in-class training and post-training data collection sessions and have taken the third exam to be included in the study. The final sample (*N* = 364) resulted in a retention rate of 52%. Sixty-one percent of the participants were female, 78% were Caucasian, 84% were either freshman or sophomores, and the majority (94%) of the participants were between the ages 18-22.

Study Design

This study utilized a one-factor two-group design. The experiment took place over approximately two weeks, beginning one week before students took exam 3. Exposure to the classroom intervention was the independent variable, whereas the dependent variables were self-reported study behavior (i.e., space v. massed), exam 3 score, and measured attitudinal change.

Each classroom was assigned to either a treatment (T) or a control (C) group using randomized block sampling in order to control for instructor effects. The three instructors involved in this study each taught two sections using the same syllabus, covering the same content and administering exams on the same day in both sections. For these reasons, I believe that the two classes per instructor were equivalent enough to make reasonable comparison groups to one another. Therefore each instructor had one class randomly assigned to a T and C group.

The treatment group was exposed to the intervention one week prior to exam 3. See Appendix B for a detailed description of the training content and design. The timing of the intervention was decided due to a number of empirical findings. First, in a study assessing how students decide what to study next (Kornell & Bjork, 2007), 59% of participants responded with, "Whatever's due soonest/overdue," and only 11% responded with, "I plan my study schedule ahead of time, and I study whatever I've scheduled." Therefore, because exam 3 was only a week away, it was assumed that preparing for this exam would rank high on the students' priority list. Moreover, it has been found that training students on learning and motivation strategies will most likely enhance performance if those strategies can be applied as soon as possible (Hattie et al., 1996). With the exam occurring only one week after the training, students could immediately apply what they had learned from the training to their own study behaviors.

In order to have a true control or no treatment group, a control intervention was designed using the same format and structure of the treatment intervention. For example, both interventions began with an interactive class exercise, followed by a presentation of learning outcomes; the training content was presented both visually and aurally, lasting about twenty minutes in total. However, the control intervention did not include anything related to spaced learning or study strategies in general. Rather, the purpose of the control intervention was to inform participants on how lessons learned in Psy100 can be applied to later career paths and life in general.

Immediately before and after the treatment and control interventions, both groups completed a pre- and post-training survey, respectively. Both groups per each instructor took exam 3 on the same day. The post-exam survey was then administered to all participants at the beginning of the first class after exam 3. Finally, the intervention was made available to the C group the week following the conclusion of the study, as to not withhold the valuable study-behavior information from this group.

Measures

Three different surveys were administered, a pre-training survey (PreTS), post-training survey (PostTS), and post-exam survey (PES). The following measures within these various surveys will be described below. Unless otherwise noted, all measures were constructed specifically for this study as recommended when developing and evaluating a TPB intervention (Ajzen, 2002a & 2002b).

Spaced learning behavior and intention measures. Spaced learning behavior (i.e., if the student spaced their studying for exam 3) was assessed using a self-report item within the PES. Intention was assessed as self-report data and was included in all three surveys. Although items addressed specifically how students studied for exam 3, a global item of intention was also assessed within the PES as to evaluate the likelihood of transfer occurring to study behaviors beyond this specific exam. This is because even though I made sure to uphold the consistency principle (i.e., keeping the behavior of interest specific to this particular exam in this Psy100 class) when developing these measurement items, I was still genuinely interested in what effect the intervention might have had on the more general study behaviors of students. Therefore, a number of items were assessed at post-exam at a more global level—not specific to Psy100, exams in particular, or only undergraduate students at CSU.

Belief and attitudinal measures. All belief and attitudinal items, arranged by their respective behavioral, normative and control categories according to the Theory of Planned Behavior, can be found in Appendix C. All belief items were assessed on the PreTS, and the behavioral and normative belief items were reassessed on the PostTS and PES. Control beliefs were not reassessed after the PreTS, as these beliefs are assumed to be stable and not likely to change due to the intervention. All attitudinal items were assessed in all three surveys. Attitudes were measured using a six-point response scale, although the response option anchors varied by measure, per Ajzen's (2005) recommendations about constructing a TPB questionnaire.

Behavioral beliefs and attitudes. Behavioral belief strength was assessed using a six-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree." As behavioral attitudes can either be instrumental (e.g., valuable-worthless) or experimental (e.g., appealing-unappealing) in nature, both features were assessed (Ajzen & Driver, 1992; Crites, Fabrigar, & Petty, 1994). Scale reliabilities for this and all other scales are shown in the results.

Normative beliefs and social norms. Similarly, normative belief strength was assessed using a six-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree." Subjective norms can be either injunctive perceptions of what others think one should do or descriptive perceptions of what others are actually doing (Cialdini, 2003; Heath & Gifford, 2002). The two subjective norm items assessing both of these features, in addition to the two normative belief items, can be viewed in Appendix C.

Control beliefs and perceived behavioral control. Control beliefs and perceived behavioral control measures ask participants to indicate: 1) the perceived likelihood of the presence of a given control factor, and 2) the extent to which the control factor's presence will facilitate or impede performance of the behavior (Ajzen, 2002a). Therefore control beliefs and perceived behavioral control items captured both of these factors related to strength and power. Control beliefs were assessed on the PreTS only, whereas perceived behavioral control items were assessed on the PreTS and the PostTS. The items can be viewed in Appendix C.

Actual behavioral control. Actual behavioral control items assessed whether one had the necessary skills and knowledge to successfully space their learning.

Skills. Skills were assessed by a self-report measure on the PES. Students were asked if they: 1) scheduled their studying for exam 3, 2) used a specific calendar tool to schedule their study plan, and if they 3) utilized the Pomodoro Technique and/or 4) the Stay Focused application to stay accountable to their study schedule. I also attempted to collect behavioral data by viewing statistics on RamCT which indicated whether or not students accessed the study tool folder anytime during the week prior to exam 3. Unfortunately, due to technical difficulties, these data was only available for four of the six classrooms involved in this study.

Knowledge. Three multiple choice questions (see Appendix C) about spaced learning and42the spacing effect were presented on both the PostTS and PES to assess whether or not the student accurately could identify what spaced learning is.

Individual differences. The measurement of the individual differences predicted to potentially influence the relationships between variables within my spaced learning model were assessed on the PreTS.

Gender was assessed by an explicit self-report item. The additional individual differences measures are described below.

Cognitive ability. Cognitive ability was assessed using a self-report measure of SAT or ACT score. College admissions tests have also been have been determined as a valid and reliable measure of cognitive ability (Frey & Detterman, 2004), self-reported admission scores have been found to be relatively accurate (Mayer, 2006). CSU requires that incoming students have taken either test prior to being admitted to the university.

Conscientiousness. Conscientiousness was measured in the PreTS using the Big Five Factor III 10-item subscale (Goldberg, Johnson, Eber, Hogan, Ashton, Cloninger, & Gough, 2006). A cumulative score was calculated for subsequent analyses.

Goal orientation. Items from the goal orientation measure designed by VandeWalle, Cron, and Slocum (2001) were used. The four items measuring the dimension of learning goal orientation and four items for the dimension of performance goal orientation can be viewed in Appendix C. A cumulative score was calculated for each of the two sub-scales.

The use of covariates can help the researcher uncover hypothesized effects, but at the cost of loss of power. Before my primary analyses, I examined the correlations between any of these potential covariates and my dependent variables. Only covariates with correlations greater than .30 were then used in subsequent analyses (Tabachnick & Fidell, 2012). Based on these analyses, I used xxx as covariates in subsequent analyses.

CHAPTER 3: RESULTS

Table 1 displays the means, standard deviations, and correlations for all study variables pertinent to the study plus potential covariates, with the exception of belief and attitudinal items (see Table 7 for the means, standard deviations, and correlations of these additional items). Prior to testing any hypotheses, I wanted to confirm that the nested nature of the data (i.e., classes grouped by instructor) did not present any reason to conduct a multi-level analysis. In order to ensure that differences did not exist across instructors, a MANOVA was conducted to test for significant differences between instructors across the study's outcomes variables (spaced intentions, spaced behaviors and exam scores). Results from this MANOVA demonstrated a significant multivariate effect for the relationship between instructors and the outcome variables, F (10, 728) = 2.40, p = .008; *Wilk's* Λ = 0.937. Univariate follow up tests found a significant effect for instructor on exam score, F (2,361)=8.49, $p < .001$. As exam score is only a variable of interest for testing Hypothesis 4, the procedure taken to account for this nested effect is further explained with the H4 sub-section of the results section. With the exception of exam score, no additional main effects were found across instructors, thus supporting the decision to aggregate data across instructors.

Table 1. Means, standard Deviations, and correlations among observed study variables

Variable	*M*	*min*	*max*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Intervention	0.53	0	1	.50	--													
2. Gender	0.61	0	1	.49	.08	--												
3. Cognitive ability-ACT	24.87	16	35	3.69	-.10*	-.07	--											
4. Conscientiousness	29.94	18	40	3.46	-.06	-.04	.07	(.32)										
5. Learning orientation	19.54	6	28	4.21	-.12*	.10*	.29**	.17**	(.85)									
6. Performance orientation	16.65	4	28	5.25	.09*	.18**	.03	.22**	.18**	(.81)								
7. Spacing intention-Pre-test	3.59	1	6	1.37	-.10*	.09*	-.14**	.07	.16**	.06	--							
8. Spacing intention-Exam 3	4.51	1	6	1.22	.22**	.15**	-.16**	.06	.11*	.09*	.56**	--						
9. Spacing intention -Psy100	4.28	1	6	1.41	.14*	.11*	-.28**	.04	.06	.09*	.53**	.59**	--					
10. Spacing intention -All classes	4.61	1	6	1.22	.15**	.08	-.10	.04	.12*	.06	.40**	.44**	.73**	--				
11. Spacing intention-All learning	4.59	1	6	1.15	.13**	.09*	-.15**	.06	.09*	.09	.43**	.47**	.79**	.84**	--			
12. Scheduling behavior	0.32	0	2	.83	-.04	.11*	-.04	.08	.11	.08	.30**	.20**	.25**	.23**	.19**	--		
13. Spacing behavior-Study three times	0.30	0	1	.46	-.04	.05	-.09	.14**	.11*	.05	.36**	.26**	.30**	.26**	.26**	.29**	--	
14. Spacing behavior-Study twice	0.69	0	1	.46	.04	.06	-.14**	.10*	.00	.05	.42**	.35**	.42**	.37**	.40**	.22**	.44**	--
15. Exam 3 score	80.20	37	100	12.71	-.04	.14**	.39**	.03	.19**	.11*	.02	-.04	-.15**	.02	-.05	.04	.07	.03

Note. For intervention, treatment = 1 and control = 0. For gender, female = 1 and male = 0. For scheduling behavior, yes = 1 and 0 = no. Variables #1-7 were measured at pre-training, variable #8 was measured immediately following training, and variables #8-16 were measured the first class after exam 3. Reliability alphas for scale variables are listed in parentheses.

* p .05 (one-tailed).

** p .01 (one-tailed). Pairwise deletion

A number of different analyses were conducted to test the hypotheses, specifically ANCOVA, binary logistic regression, OLS regression, and structural equation modelling (SEM). IBM SPSS, v. 20 was used to conduct the first set of non-SEM analyses which tested the effect of the intervention on spaced learning intentions (H1) and the effect of intentions on spaced behavior (H2-H3) and exam scores (H4). I then evaluated the fit of the various components of the spaced learning structural equation model (see Figure 3), specific to the measured belief and attitudinal items (H5-H12). It is important to note that the spaced learning structural equation model in Figure 3 was not tested in its entirety due to the complexity of the model. Only those relationships pertinent to the study's hypothesis were tested for fit. I used the analytical software Mplus (Muthén & Muthén, 2010) to specify the magnitude and direction of relations among the psychological constructs of spaced learning while also controlling for measurement error. Results for each set of analyses are presented below, organized by hypothesis.

Hypothesis 1

Hypothesis 1 stated that there would be a main effect of the intervention on spaced learning intentions, insofar that those in the treatment group would have stronger intentions to space their studying for exam 3 compared to the control group. To test H1, I conducted an ANCOVA which allowed me to control for spaced learning intentions assessed prior to the intervention (SpIntent_Pre), thus accounting for any differences in baseline intention ratings across treatment and control groups. Distribution plots were assessed and kurtosis and skew were evaluated to ensure that the assumptions of ANOCVA (independence of errors, that errors are normally distributed, and that variances across levels of the independent variable are equal) were not violated. The homogeneity-of-regression was tested by evaluating the interaction between the covariate (SpIntent_Pre) and independent variable (treatment) in the prediction of the dependent variable (spaced intentions). This interaction was not significant, F (1, 364) = 2.981, p = .085, thus confirming that the assumption of homogeneity-of-regression was not violated.

Hypothesis 1 was supported, as the ANCOVA revealed that the classroom intervention had a significant effect on spaced learning intentions, F (1, 365) = 43.59, $p < .001$, $R^2 = .383$, Participants in the treatment condition had stronger intentions to space their learning ($M_T = 4.84$) when studying for exam 3 compared to control group participants ($M_C = 4.17$), after controlling for pre-training intentions. Mean differences between spaced learning intentions across groups can be viewed in Figure 4.

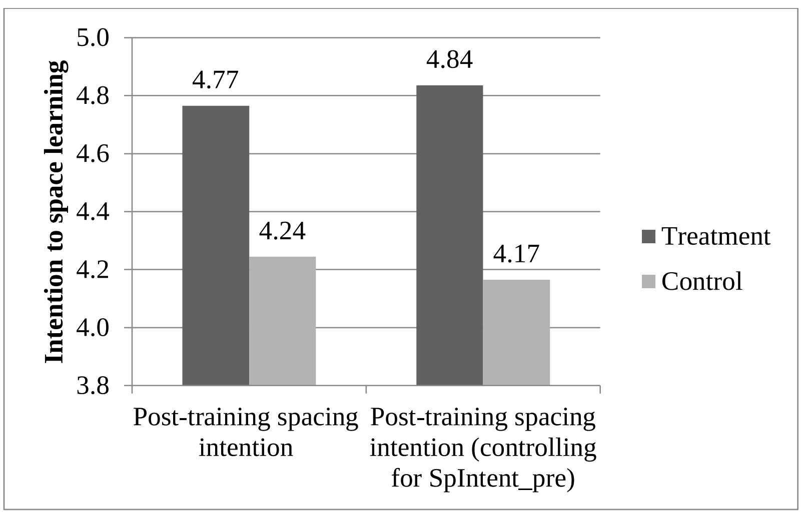

Figure 4. Mean difference in spaced learning intentions across groups

Hypotheses 2 and 3

Hypothesis 2 stated that there would be a main effect of intention to space on spaced learning behaviors, while Hypothesis 3 proposed that there would be an indirect effect of exposure to the classroom intervention on spaced learning behaviors. Thus, the second set of analyses tested the mediated effect of spaced learning intentions (H2) and treatment (H3) on spaced behaviors. I used binary logistic regression and simple logistic regression analyses to conduct the mediation analysis, as recommended by MacKinnon and Dwyer (1993). Binary logistic regression assumes that the dependent variable is categorical, that the desired outcome of the dependent variable has a factor level of one (i.e., engaging in spaced learning behavior = 1 and not engaging in spaced learning = 0), and that the data come from a large sample size. Prior to assessing the model, a number of additional assumptions were tested per the recommendations of Peng, Lee, and Ingersoll (2002). The error terms were independent and multicollinearity was minimal, thus satisfying the assumption of independence. Logistic regression also assumes a binomial distribution, implying that the same probability is maintained across the range of predictor values. This assumption was confirmed by conducting a normal z-test (Siegel & Castellan, 1988). Assumptions for simple logistic regression were also confirmed via exploratory analysis.

According to the mediation analysis (see Step 2 in Table 2), the log of the odds of a student spacing their studying was positively related to intention ($\beta = .598$, $p < .001$. $e\beta = 1.819$). In other words, the stronger the intention was to space, the more likely it was that a student would successfully space his/her studying. For a one unit increase in intentions to space, the odds of studying three or more times for exam 3 increased by a factor of 1.82. Therefore, Hypotheses 2, which predicted that intention would predict spaced behavior, was confirmed.

The indirect effect of the classroom intervention on spaced learning behaviors through intentions to space was significant (Sobel $z = 3.28$, $p < .001$). However, the direct effect of training on spacing was found to be negative ($\beta = -.505$, $p = .039$. $e\beta = .604$), meaning that those who attended the training were less likely to space their learning compared to those in the control group. In other words, for every one-unit increase in training we would expect a 0.505 *decrease* in the log-odds of spaced behavior occurring, holding all other independent variables constant. Therefore, Hypothesis 3 was not supported.

The percentage distribution of spaced learning behaviors can be viewed in Table 3. For those who spaced their learning three or more times when studying for exam 3, 12.5% (14 of 112) were predicted correctly. Of students who did not study three or more times, 94.6% (245 of 259) were correctly predicted.

Table 2. Mediation analysis of the effect of treatment and intentions on spacing behavior

Predictor	*β*	SEβ	Wald's χ^2	*df*	*t*	*p*	eβ (odds ratio)
Step 1. Independent variable (IV) to mediator							
Training → Spacing	.537	.125			4.293	.000	
Step 2. Mediator to dependent variable (DV)							
Intention → Spacing	.598	.118	25.630	1		.000	1.819
Step 3. IV on DV (total effect)							
Training → Spacing	-.178	.226	.618	1		.432	.837
Step 4. IV on DV (direct effect)							
Training → Spacing	-.505	.245	4.249	1		.039	.604

Note: Step 1 was analyzed as a simple linear regression model, since the dependent variable is continuous. Steps 2-4 were analyzed as logistic regression models since the dependent variable is dichotomous.

Table 3. Observed and predicted frequencies of spaced learning with a cutoff of 0.50

	Predicted spacing frequency		
Observed frequency of spacing	Yes	No	% correct
Spaced learning occurred			
Yes	14	98	12.5%
No	14	245	94.6%
Overall percentage correct			69.8 %

Hypothesis 4

Hypothesis 4 stated that there would be a main effect of spaced learning behaviors on exam scores, insofar that those who spaced their studying three or more times would earn higher exam scores compared to those who did not. To test Hypothesis 4, OLS regression was used to test the effect of study behavior on exam scores. OLS regression assumes linearity, normality, and continuity of the data; and all of these assumptions were verified prior to conducting any analyses.

As previously mentioned at the beginning of the results sections, a significant effect was found for instructor on exam score, $F\,(2{,}361) = 8.49$, $p < .001$. See Table 4 for exams scores across instructors by treatment and control classrooms. To correct for this instructor effect, the standardized residual exam score was computed as follows. I first created a dummy code for instructors to use as the predictor variable. I regressed the exam score on instructor to then output and save the residual. The resulting residual value was used as the exam 3 score outcome variable for the remainder of the analysis.

Table 4. Average exam score by instructor and condition

	Both Classrooms		Treatment Classroom		Control Classroom	
	M	*N*	*M*	*n*	*M*	*n*
Instructor #1	79.3%	167	78.2%	83	80.4%	84
Instructor #2	83.1%	141	83.0%	58	83.2%	83
Instructor #3	75.3%	56	77.1%	31	73.1%	25

To test Hypothesis 4, I ran an ANCOVA to test the effect of spacing on exam score while also controlling for cognitive ability. Because cognitive ability, as measured by ACT scores, was correlated with exam score at a value greater than .30, I had empirical support to control for this variable (Tabachnick & Fidell, 2012). After controlling for cognitive ability, I found that those who spaced their studying for exam 3 were predicted on average to have an exam score 3.65 points higher than those who did not space their studying, and this finding was statistically significant, $F(1,291) = 29.71$, $p < .001$, $R^2 = .17$. Thus, support was found for Hypothesis 4.

Hypotheses 5-12

SEM was used to evaluate the goodness of fit of various components of the spaced learning model specific to testing Hypotheses 5-12 (see Figure 5). Assumptions for SEM using the maximum likelihood method include a multivariate normal distribution and continuous data. Normality was assessed by evaluating the kurtosis of each individual variable. Per the recommendation of Yuan and Bentler (2000), all kurtoisis values fell within the +3 to -3 range, thereby satisfying the assumption of normality.

Missing data were handled using maximum likelihood estimators. This method has been empirically found to work better than alternative methods for dealing with missing data in SEM models (e.g., Enders & Bandalos, 2001; Gold, Bentler, & Kim, 2003). Mplus sufficiently handles missing data by computing the standard errors for the parameter estimates using the observed rather than the expected information matrix (Kenward & Molenberghs, 1998).

Testing the entire spaced learning model presented in Figure 3 was beyond the scope of this paper. Although all model components were measured across multiple time points, not all relationships between these variables were hypothesized. Thus, the variables of interest for H5-H12 were isolated and used to create the SEM model presented in Figure 5. The majority of the latent factors were constructed using observed variables from the post-intervention measure. As this time point occurred immediately following the intervention, beliefs and attitudes about spaced learning were expected to be most salient at this stage of data collection. Post and PES measures were not combined due to low reliability across time points. For example, SpExam_Post and SpExam_PES had an alpha of .195. The one exception to this was the intention items at the post and PES time points, with intercorrelations ranging from .40 to .84 (see highlighted section Table 1), and an alpha of .88. Thus, these items were converted into a scale to create the latent variable – Intention. The observed variables for the control beliefs factor were only collected at the pre-intervention time point, as these variables were not expected to change over time, nor as a result of the intervention. A summary of the specific items used to create the SEM model in Figure 5 is presented in Table 5. The column marked with an "X" indicates from which time point the item used to create the SEM model in Figure 5 was drawn

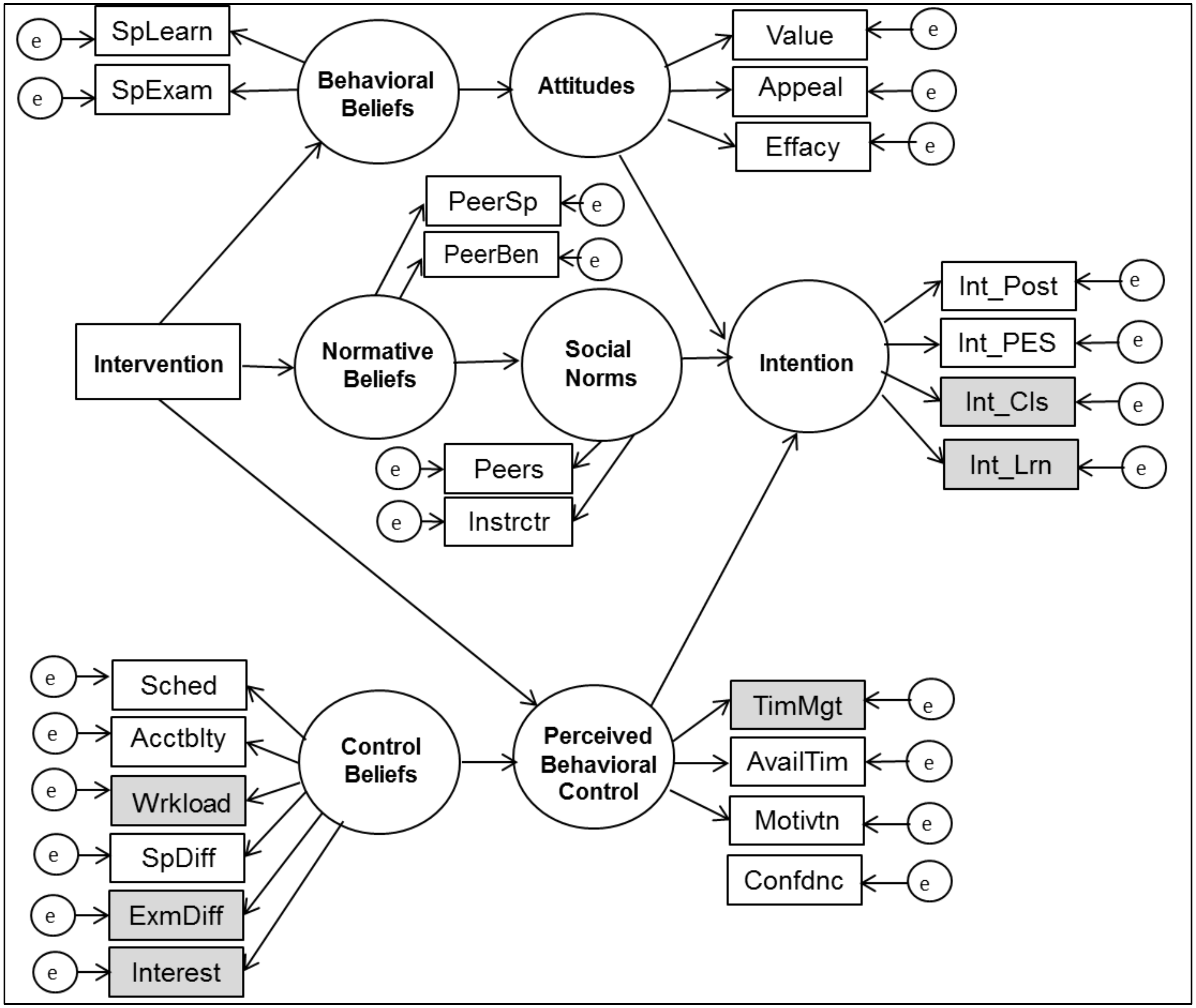

Figure 5. Initial SEM model designed to test H5-H12

Note. Shaded items were dropped prior to evaluating the structural model in order to establish good measurement fit.

Table 5. Time points and full item description of variables within final SEM model

Factor	Variable	Pre	Post	PES	Item text
Behavioral beliefs	SpLearn		X		If I space out my studying over multiple sessions I will learn [much less…much more] of the material I plan to study for exam 3.
Behavioral beliefs	SpExam		X		If I space out my studying over multiple sessions I will earn a [much lower…much higher] score on exam 3.
Normative beliefs	PeerSP		X		CSU undergraduates space out their studying.
Normative beliefs	PeerBen		X		CSU undergrads benefit from spacing out their studying over multiple sessions.
Control beliefs	Sched	X			It is [uncommon…common] for me to schedule my study sessions in advance when preparing for Psy100 exams.
Control beliefs	Acctblty	X			If I make a plan to study at a certain time, it is [very unlikely….very likely] that I follow through with this plan.
Control beliefs	SpDiff	X			It is [very difficult…very easy] to space out my studying when studying for Psy100 exams.
Attitudes	Value		X		Spacing out my studying for exam 3 over multiple study sessions would be a [worthless…valuable] study strategy.
Attitudes	Appeal		X		Spacing out my studying for exam 3 over multiple study sessions would be an [unappealing…appealing] study strategy.
Attitudes	Effacy		X		Spaced learning is a [far less…far more] effective study strategy compared to cramming
Social norms	Peers		X		I feel inclined to space out my studying over multiple sessions because that is what other CSU undergrads do.
Social norms	Instrctr		X		I feel inclined to space out my studying over multiple sessions because that is what my Psy100 instructor expects me to do. [strongly disagree…strongly agree]
Perceived beh. control	AvailTim		X		I will have the available time to successfully space out my studying over multiple sessions when preparing for exam 3 in this course.
Perceived beh. control	Motivtn		X		I am [not at all…very much] motivated to space out my study sessions as I prepare for exam 3 in this class
Perceived beh. control	Confdnc		X		I am [not at all…very much] confident that I can successfully space out my studying as I prepare for exam 3.
Intention	Int_Post		X		I intend to study at least three or more separate times as I prepare for exam 3 in this class.
Intention	Int_PES			X	I intend to study at least three or more separate times as I prepare for future exams in Psy100.

.

Prior to testing the structural model, the measurement model was assessed for fit (Byrne, 2013). As the full model contained complex multiple mediation relationships, I began by using factor analysis to test a more simplified model and then building the more complex model from there. The first simplified model I assessed represented the relationship between control beliefs, perceived behavioral control and intentions (see Figure 6).

The overall fit of the first simplified model was poor, χ^2= 473.62, df = 74, p<.001, CFI = .78, RMSEA = .12. Thus, I attempted to improve measurement fit as follows. First, I considered dropping items that had a poor factor loading (< .30) and residual discrepancies with other variables greater than an absolute value of .10. In addition to this empirical support to drop such items, I also considered theoretical justification for dropping items. Three of the dropped items were observed variables with the Control Beliefs construct (Workload, ExamDiff and Interest). It is interesting to speculate why these items did not fit in the original measurement model. Perhaps the dropped observed variables did not necessarily have good construct validity with the Control Beliefs latent variable. As a reminder, Azjen (2005) defined Control Beliefs as the perceived presence of factors that may facilitate or impede performance of a behavior. For example, Workload was dropped from the model due to the fact that spaced studying takes no more time than cramming, so workload considerations may not have mattered when deciding how to study. I also felt justified in dropping the TimMgt item from the PBC scale because this variable may perhaps fit more appropriately within the actual behavioral control latent variable, which was not included in the simplified SEM model (Figure 5).

As for the intention latent variable, although the four-item scale of observed intention items had reasonably high reliability (α =.88), it did not make theoretical sense to include Int_Cls

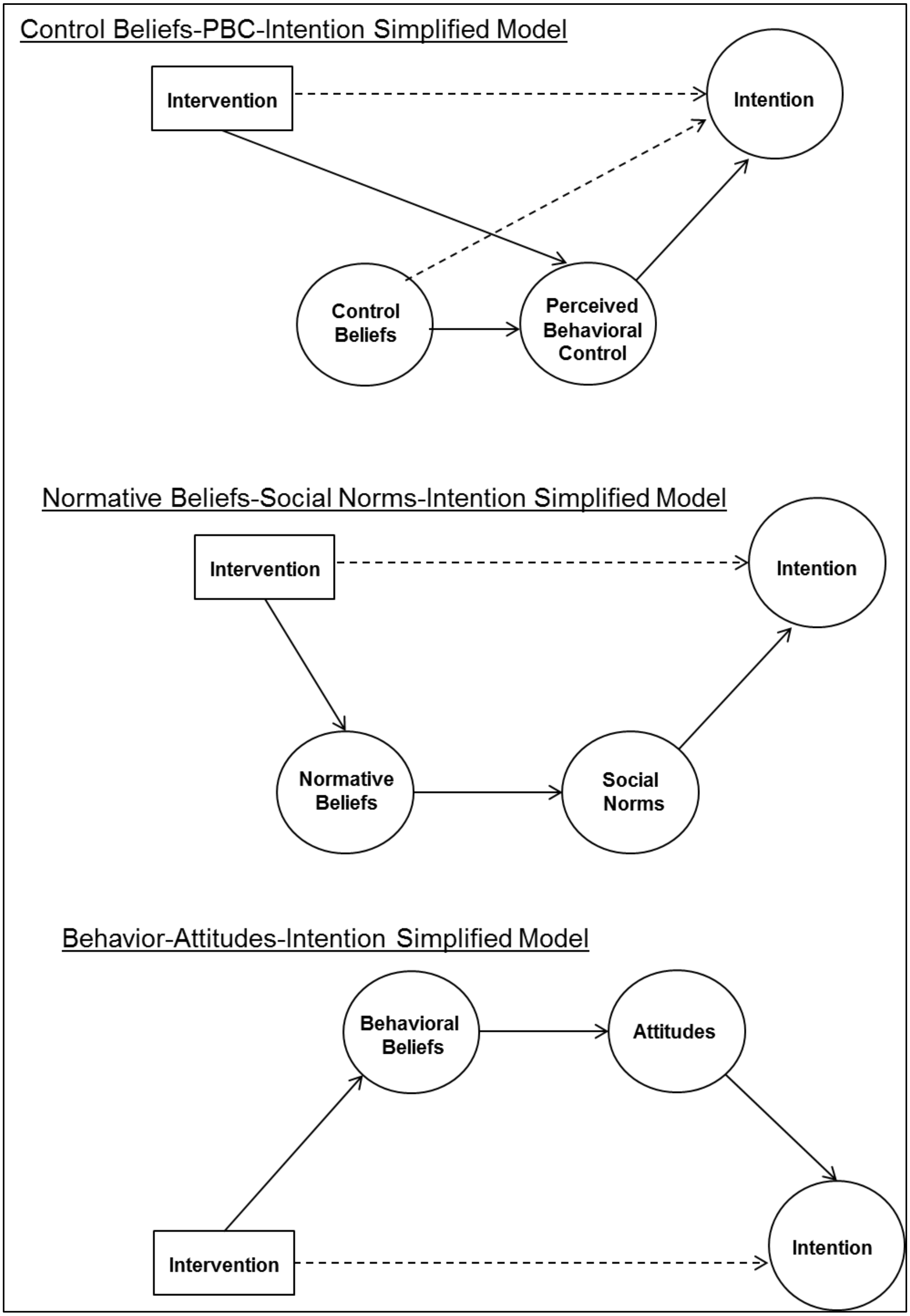

Figure 6. Simplified mediation models
Note. Dotted lines represent indirect effects.

and Int_Post due to the compatibility principle which emphasizes congruency between behavioral and attitudinal items and the same action, target, context and time elements (Ajzen & Fishbein, 1977). The purpose of the intervention was to have students space their studying for their Psy100 exam, and more importantly, this was the outcome variable of most interest to this study. Therefore, I felt justified in dropping the intention variables associated with studying for other classes and learning in general.

Six items in total were dropped to improve model fit. The resulting revised measurement model fit the data well (χ^2= 73.70, df = 17, p<.001, CFI = .95, RMSEA = .09), and also significantly fit better than the initial model in which this updated model was nested ($\Delta\chi^2$= 399.92, Δdf = 57, p<.001). Thus, this revised measurement model representing the Control Beliefs-PBC-Intention mediation path was used in later SEM analyses.

Two additional simplified measurement models were tested (see Figure 6), the first following the path from normative beliefs to social norms to intention and the second following the path from behavioral beliefs to attitudes to intention. The revised measurement structure for the Intention latent variable (i.e., only including the SpIntent_post and SpIntent_PES variables) was used within both of the simplified measurement models. Both models demonstrated good measurement fit (see Table 7 for fit statistics).

Once a good measurement fit of all three simplified models was established, the full model was then built. When the three smaller measurement models were combined to form the full model in Figure 5, however, a number of issues arose. First, I found that the residual covariance matrix was not positive definite. This tends to occur when two latent variables are so highly correlated that they would perhaps be better identified as one latent variable. Indeed, after assessing measurement fit of the full model, it was found that the factor-level correlation

Table 7. Fit statistics for all measurement and structural models

Model	χ^2	*df*	CFI	RMSEA	SRMR
Control Beliefs-PBC-Intention Model					
Initial Model-*Measurement Fit*	473.62*	74	.78	.12	.07
Revised Model-*Measurement Fit*	73.70*	17	.95	.09	.04
Revised Model-*Structural Fit*	90.34*	25	.95	.08	.04
Normative Beliefs-Social Norms-Intention Model					
Measurement Fit	39.87*	6	.94	.12	.04
Structural Fit	66.54*	12	.92	.11	.06
Behavior-Attitudes-Intention Model					
Measurement Fit	116.72*	11	.93	.16	.06
Structural Fit	137.82*	18	.92	.13	.06
Full Model					
Measurement Fit	424.95*	108	.90	.09	.06
Structural Fit	781.73*	127	.80	.12	.21

Note. CFI = Comparative Fit Index. RMSEA = Root Mean Square Error of Approximation. SRMR = Standardized Root Mean Square Residual.
* $p < .001$

between Behavioral Beliefs and Attitude was .988, and .980 between Behavioral Beliefs and Normative Beliefs. Due to these high correlations, these latent variables from one another were empirically indistinguishable. This is why the structural fit of the full model was significantly poorer than the measurement model. One option to correct for this problem would be to collapse the highly correlated factors to simplify the full model accordingly. However, this would not make sense for the purpose of my study, which was to test how well the data fit into my spaced learning model based on the pre-established latent variables of the TPB. Plus, collapsing latent variables of the full model would prohibit my ability to test specific hypotheses related to distinct mediation paths. Thus, the results from the previously mentioned simplified models in Figure 6 were used to test hypotheses. In addition to the results of the SEM mediation analyses, *t*-tests were also conducted on the composite scores of the observed variables in order to assess statistical differences between the treatment and control groups on latent variables. Means and scale reliabilities of the composite scales, including correlations with the dependent variables, can be viewed in Table 6.

To test H5-H12, I assessed the structural fit of all simplified models. The structural model of the Behavior-Attitudes-Intention relationship demonstrated good fit ($\chi^2 = 137.82$, df = 18, $p < .001$, CFI = .92, RMSEA = .13), meaning that the model is explained well by the data. Mediation was established, as all direct and indirect paths in the structural model were significant (see Figure 7 for coefficient estimates). The intervention was found to significantly predict behavioral beliefs, thus supporting Hypothesis 5. Further support for H5 was provided by a *t*-test which found a significant effect for the intervention on behavioral beliefs, $t\ (368) = 5.32$, $p < .001$, with the treatment group ($M_T = 10.8$) indicating stronger endorsement of favorable behavioral beliefs towards spaced learning compared to the control group ($M_C = 10.0$). Behavioral Beliefs were found to predict Attitudes, and Attitudes in turn predicted Intention, thus supporting Hypotheses 6 and 7.

Table 6. Correlations and descriptives of composite variables

Variable	*M*	*min*	*max*	*SD*	1	2	3	4	5	6	7	8
1. Intervention	.53	0	1	.50	--							
2. Behavioral Beliefs	10.46	2	12	1.64	.27**	(.87)						
3. Behavioral Attitudes	15.19	4	18	2.48	.34**	.79**	(.76)					
4. Normative Beliefs	8.53	3	12	1.55	.40**	.49**	.57**	(.35)				
5. Social Norms	7.26	2	12	2.58	.20**	.34**	.44**	.42**	(.81)			
6. Control Beliefs	10.80	3	18	2.84	-.02	.32**	.35**	.21**	.27**	(.66)		
7. Perceived Behavioral Control	13.52	4	18	2.99	.31**	.52**	.67**	.48**	.45**	.48**	(.78)	
8. Intentions	8.79	2	12	2.37	.19**	.46**	.64**	.36**	.48**	.44**	.71**	(.73)

Note. For intervention, treatment = 1 and control = 0. Reliability alphas are listed in parentheses.
* p .05 (one-tailed).
** p .01 (one-tailed).

The structural model of the Normative Beliefs-Social Norms-Intention relationship also demonstrated good fit ($\chi 2 = 137.82$, df =18, $p < .001$, CFI = .92, RMSEA = .13). All direct and indirect paths in the structural model were significant (see Figure 8), thus confirming that mediation occurred. Hypothesis 8 was supported because the intervention was found to significantly predict normative beliefs. A significant *t*-test also provided further support for H8, t (348.61) = 8.26, $p < .001$, with the treatment group ($M_T = 9.1$) indicating stronger endorsement of favorable normative beliefs towards spaced learning compared to the control group ($M_C = 7.9$). According to the SEM analysis, Normative Beliefs were found to predict Social Norms, and Social Norms in turn predicted Intention, thus supporting Hypotheses 9 and 10.

Lastly, the structural model of the Control Beliefs-PBC-Intention relationship demonstrated a very good fit (see Table 7). Mediation was established, as all direct and indirect paths in the structural model were significant (see Figure 9 for coefficient estimates). The intervention was found to significantly predict PBC, thus supporting Hypothesis 11. Further support for H11 was provided by a *t*-test which found a significant effect for the intervention on PBC, t (358.08) = 6.14, $p < .001$, with the treatment group ($M_T = 14.4$) indicating stronger endorsement of favorable perceived behavioral control beliefs towards spaced learning compared to the control group ($M_C = 12.6$). According to the SEM analysis, PBC was found to predict Intention, thus supporting Hypothesis 12.

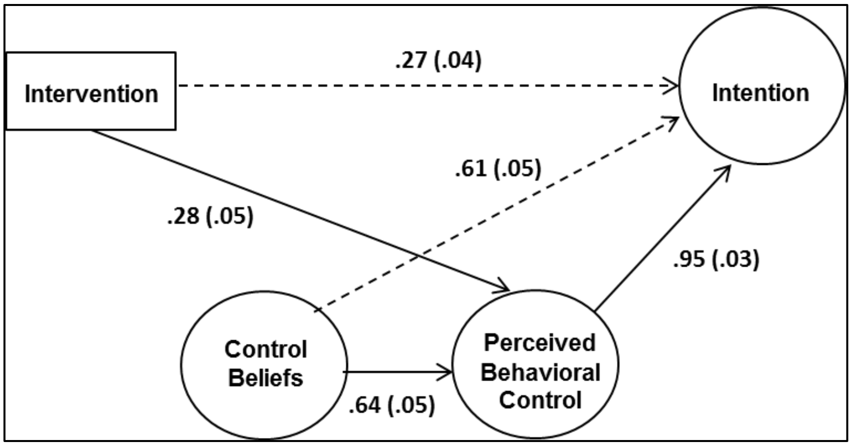

Figure 7. Standardized coefficients for Control Beliefs-PBC-Intention Model

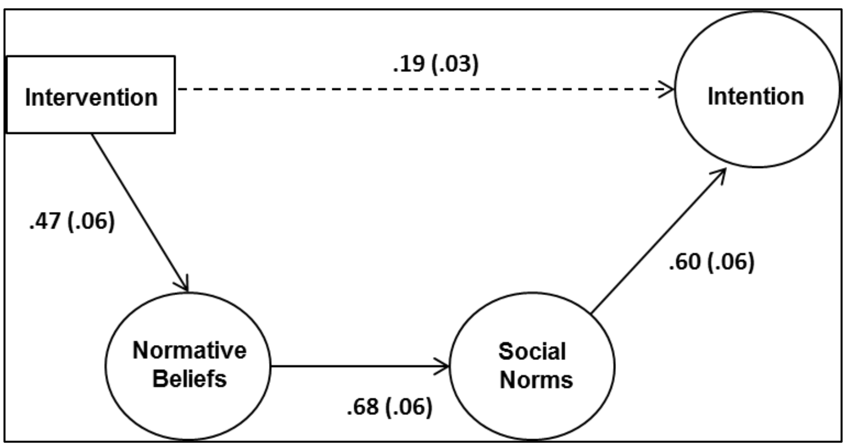

Figure 8. Standardized coefficients for Normative Beliefs-Social Norms-Intention Model

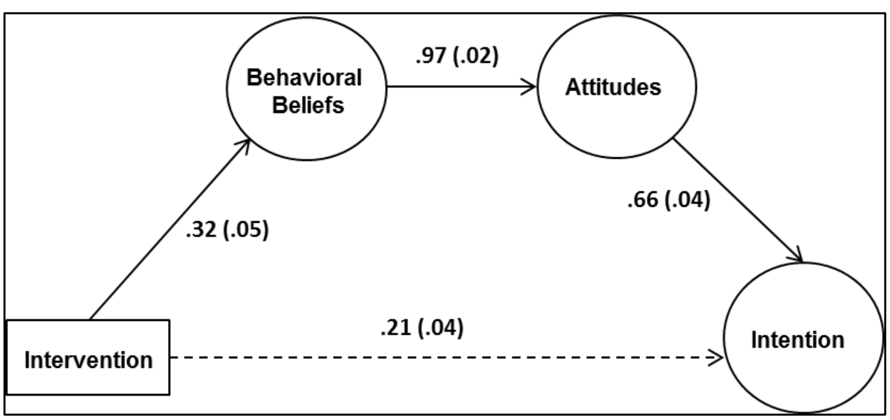

Figure 9. Standardized coefficients for Behavior-Attitudes-Intention Model

CHAPTER 4: DISCUSSION

The purpose of this study was to test if Psy100 students could be effectively trained to space their studying for an upcoming exam. It was predicted that students exposed to a spaced learning classroom intervention would be more likely to space their studying compared to students in the control group. The classroom intervention was designed based on the Theory of Planned Behavior (TPB), which posits that behaviors are caused by intentions and those intentions are in turn caused by the attitudes and beliefs towards the target behavior. Therefore, I designed my classroom intervention with the purpose of changing students' beliefs and attitudes about spaced learning insofar that they would perceive this study strategy as being preferable to cramming, socially acceptable, and practically possible.

The results indicate that student intentions to space studying can be significantly enhanced by exposure to a spaced learning classroom intervention (H1). A main effect also occurred between intention and spaced behavior, insofar that whether or not students spaced their studying for exam 3 was significantly predicted by their intention to space (H2). The empirical support of H1 and H2 are consistent with findings of previous research, which demonstrate that intentions to behave a certain way can be altered by administering a TPB intervention (e.g., Bamberg et al., 2003; Brubaker & Fowler, 1990). However, this was the first study to use a TPB intervention to improve study techniques by attempting to train students to space their learning. Thus, this study provides evidence that a TPB intervention can be applied to a new context (i.e., improving study strategies).

Moreover, I chose to create a *spaced learning* classroom intervention (as opposed to training students on some other study strategy) as previous research has reliably found the spacing effect to improve learning outcomes (Cepeda et al., 2006). For the purpose of this study, I operationalized learning by exam scores. The results indicated that those who spaced their studying earned significantly higher exam scores compared to those who did not (H4), after controlling for cognitive ability. Thus, not only can student intentions to space be improved by exposure to a spaced learning classroom intervention, but this study provides additional empirical support to the premise that those who space their studying have better learning outcomes compared to those who do not.

According to the TPB, intentions to engage in a behavior are preceded by the beliefs and attitudes towards that behavior. Using the structural components of the TPB (i.e., behavioral, normative and control) as a framework, I designed my intervention with the goal of increasing positive beliefs and attitudes towards spaced learning. Thus, I predicted that behavioral beliefs (H5), normative beliefs (H8) and perceived behavioral control (H11) would be positively enhanced by spaced learning intervention. Indeed, it was found that those in the treatment group had significantly more favorable beliefs across all three components towards spaced learning compared to the control group, thus supporting H5, H8 and H11. It was also found that behavioral beliefs towards spaced learning predicted attitudes toward spaced behaviors (H6), which in turn predicted intentions (H7). Similarly, the results showed that normative beliefs predicted social norms (H9), and social norms predicted intentions (H10). There was also a significant main effect of perceived behavioral control on intentions to space, thus supporting H12. All these significant relationships support the structural relationship of Azjen's (1991. 2005) TPB, thus adding empirical evidence to the validity of the TPB.

The arguably most important hypothesis of this study—that there would be a main effect of treatment on spaced learning behaviors (H3)—was not supported. Exposure to the spaced learning intervention did not significantly predict whether or not a student would space his/her studying for exam 3. In other words, there was not a direct effect of the spaced learning intervention on study behaviors. I would be reluctant to conclude, however, that students cannot be trained to space their learning instead of cramming based on these findings. Rather, the effects of the intervention appear to be indirect – a function of attitude change. Specifically, this study provides evidence that spaced learning intentions can be positively influenced by exposure to a classroom intervention designed to improve beliefs and attitudes toward this study technique. This study supports the notion that a classroom intervention based on the TPB can successfully alter one's *intentions* to engage in spaced learning, although these intentions did not translate to an actual behavioral change in this particular sample.

The discordance between intention and behavior can be attributed to a number of alternative explanations. Within their critical review of the TPB, Conner and Armitage (1998) suggested that although a person may intend to pursue one behavior, a stronger intention may simultaneously be expressed to pursue an alternative behavior. So even though the students had intended to space their studying, their intention to cram may have been stronger, which resulted in them engaging in this study strategy instead.

Moreover, Bagozzi (1992) proposed that attitudes may first be internalized as desires (e.g. "I *want* to perform behavior x"), before becoming the intentions that in turn cause behaviors. It has been subsequently demonstrated that the impact of attitudes on intentions was almost entirely mediated by desires (Bagozzi & Kimmel, 1995). It is possible that the intervention merely taught students that they ought to space over cram as opposed to actually causing a change in students' desire to space. Following this logic, because students knew they should space their learning but still lacked the desire to do so, the resulting intention was not strong enough to actually cause a change in behavior.

It could also be that given the time interval between the intervention and exam 3, even if students *intended and desired* to space, there was not sufficient time for them to conduct multiple study sessions, particularly if they had other tests requiring studying. Perhaps their schedule was already set for the week between the intervention and exam 3, thus prohibiting them from finding the time to study over multiple sessions. Therefore, I propose that delivering the intervention earlier in the semester may have been more effective at changing student studying behavior.

The results of this study prove that intending to behave in a certain way does not necessarily result in that actual behavior occurring. In retrospect, I may have erred by relying too heavily on the TPB as the sole theoretical framework. Other theories posit that behaviors do not necessarily follow intentions. For example, theories of action differentiate between explaining behavior by what people say (defined as espoused theories), and what people do, or theories-in-use (Argyris, 1974). The conflict that occurs between espoused theories and theories-in-use implies that people commonly to do something *different* than what they say. An example of this would be a child who witnesses a parent engage in some behavior which that parent commonly instructs the child not to do. The parent then states, “Do as I say, not as I do.” Participants in this study said that they would engage in spaced studying, but then indicated that they did not actually do so when preparing for exam 3. In this case, the intention was the espoused theory and the behavior was the theory-in-action. Thus, the data in this study may be better explained by theories in action rather than by the TPB. Future research should explore how TPB interventions can better align intentions with theories-in-action, as opposed to allowing intentions to be merely espoused theories that will not result in true behavioral change.

Another theory that may explain the discrepancy between intentions and behaviors is Self-Discrepancy Theory (SDT). SDT posits that people have three self-domains: the ideal, the ought and the actual (Higgins, 1987). The ideal self represents the person we aspire to be, but based on a standard on which we tend to fall short. Similarly, the ought self is the person we think we *should* be according to our perceived expectations of others. And the actual self is who we really are, how we live our lives on a daily basis. The discrepancy occurs when the three self-images do not align, which is commonly the case (Strauman, 1996). Perhaps when participants in this study indicated that they intended to space their studying for exam 3, their response derived from their ideal or ought self-domain, and was not representative of their actual selves. It would be interesting to explore how the various self-domains of STD align with the intention and behavior constructs of a specific TPB model. Specifically, are intentions more so driven from our ought or ideal selves, whereas behaviors are the product of our actual selves? Future research on utilizing the TPB for behavioral change interventions could explore these relationships between intention and behavior with the self-domains of the STD. Specifically, researchers could explore ways to better ensure that the intentions enhanced by a TPB intervention truly represent one's actual self-image, and not just that of one's ought or ideal self.

The incongruence between intention and behavior may also be attributed to a potential social desirability bias. Participants tend to behave in socially desirable ways when trying to gain approval by means of acting in a culturally acceptable or appropriate way (Crowne & Marlowe, 1964). After I delivered the spaced learning classroom intervention, perhaps participants felt obliged to indicate that they would space their learning for exam 3 as to validate my efforts in trying to convince them to do so. Thus, it is possible that their response was not based on their actual intention, but rather their desire to be loyal participants in my study. Future research on behavioral change interventions based on the TPB should measure and control for social desirability in order to control for this potential confound.

Limitations

A number of limitations occurred in this study. For example, the use of self-report data may have also inflated socially desirable responding. Indeed, self-report data are susceptible to self-presentation biases (e.g. Gaes, Kalle, & Tedeschi, 1978). Compared to more objective sources, self-report data are also prone to measurement error due to possible carelessness of respondents, survey fatigue, or misinterpretation of survey items. Moreover, with the exception of exam scores, all variables pertinent to the study's analyses were collected using self-report data which potentially introduced bias due to common method variance (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

Another possible introduction of measurement error could be due to the fact that the vast majority of the surveys were completed on pen and paper and then entered electronically by undergraduate research assistants (RAs). Although data entry was double-checked by both an additional RA and myself, the introduction of human error is more likely to have occurred compared to the alternative method of collecting all data electronically. One study which empirically tested the accuracy of data entry strategies among undergraduates found that a mere 5.5% of participants in the single-entry group demonstrated 100% accuracy, and only 77.4% of the double-entry group had perfect accuracy (Barchard & Pace, 2011). Thus, if I were to conduct a study of this nature again, I would collect data using an online survey as to eliminate human error introduced by having RAs enter hard data into an electronic database.

Additionally, I could have done a better job operationalizing the most important variables of my study: intention, behavior, and treatment. First, I operationalized intention by using a one-measure item on the post-test immediately following the intervention and control presentation. I made this design decision in order to keep the survey from becoming too lengthy, and by consequence, causing poor participant reactions such as frustration and fatigue. Researchers, however, commonly advise against using single-item measures because they tend to lack content validity due to criterion deficiency and are often deemed unreliable for the reason that internal consistency cannot be tested (Cronbach & Meehl, 1955; Nunnally, 1978). I attempted to correct for these concerns by creating a composite variable of intention, but unfortunately the psychometric properties and theoretical justification for creating a four-item scale for intention did not hold up in this study. If I were to conduct a study of this nature again, I would either use a standardized measure of intention or create a theoretically grounded scale for intention and then validate that scale using my sample prior to conducting any analyses.

Second, I operationalized behavior using a one-item measure assessed during the first class following exam 3. In addition to the criticisms about using single-item measures presented in the previous paragraph, my operationalization of spaced behavior posed a series of additional potential flaws. Whether or not students spaced their learning is a dichotomous variable—they either spaced or they did not. However, the single-item assessing spaced behavior was not dichotomous, but nominal. Participants could indicate whether they studied three or more times, two times, once, or not at all. Although I defined spaced learning throughout my intervention as studying the same material three or more times, I wanted to be able to make the distinction between those who crammed (i.e., studied only once) and those who did not by measuring all possibilities. What if my spaced learning intervention was able to convince a student who always crammed for Psy100 exams to study not just once, but twice for exam 3? I attempted to account for these multiple conceptions of spaced behavior (i.e., studying three or more times v. more than once) by running identical analyses using both operational definitions when testing Hypotheses 2 and 3. However, I should have been clearer in both my intervention and within the measure itself that spaced learning is defined as studying the same material three or more times, as this was the core lesson I wanted students to take from the intervention. Moreover, as spaced behavior was assessed on the final of three surveys I administered, the participants may have been burnt out on filling out their responses and have not taken the time to read all items and answer truthfully. If I were to have had administered a shorter PES measure or had only assessed spaced behavior using a one-item measure on the exam itself, I could be more confident that this variable was properly operationalized and measured.

Third, I operationalized treatment by whether or not someone was exposed to the treatment intervention. All students who were present in the treatment classrooms during the day of the intervention were labeled as though they received the treatment intervention, and those who were in the control classrooms were assumed to have not. However, what if a student in the treatment group did not pay attention to the intervention, although he/she was physically present for the training? Or what if a student in the control group had a roommate in the treatment group who explained what spaced learning is and why it works to this "control" participant, which in essence provided a dose (albeit a less potent dose) of the intervention? Hunter and Schmidt (2015) propose that even assessing control participants at pre-test could lead to undesired testing effects by cueing them into the purpose of the study. By the mere act of answering questions about spaced learning, students in the control group were made aware of this study technique. It is possible that exposure to the topic through assessment could have increased the likelihood of control participants spacing their learning for exam 3. Thus, I cannot be sure that treatment was operationalized without error.

The potency of the intervention could also been enhanced by applying some additional research-based strategies from the training effectiveness literature. First, I could have passed out a paper handout prior to delivering the intervention that included an outline of my presentation, learning objectives, and/or key concepts, as research shows that providing advanced organizers helps motivate trainees (Mayer, 1979). Second, training content is more likely to stick when trainees are provided with opportunities to practice the learned material (Salas et al., 2012). Therefore, I could have had participants practice completing a clear action plan on how they would add spaced study sessions to their weekly schedule as part of the intervention. Third, what if the intervention was not delivered as a classroom training but rather as a one-on-one advising or mentoring session? Research shows that mentoring relationships can lead to increased performance and motivation of the protégé (Eby, Allen, Evans, Ng, & DuBois, 2008). Perhaps the intervention would have been more effective if students were to have learned about spaced learning from the course instructor during office hours or from some other one-on-one advising source (e.g., a graduate student who serves as mentor to the undergraduate student).

The brevity of the intervention also posed a limitation to the potency of the training. It was perhaps too ambitious to believe that a 20-minute training would be enough to cause really behavioral change amongst the treatment group. However, longer sessions would not have been feasible because the Psy100 instructors were already generous enough to allow me to take 20 minutes of their classroom time to conduct my study. Even though a lengthier training was most likely not possible, I could have perhaps split the training into two 10-minute or four 5-minute training sessions. In other words, I could have practiced what I preach about the benefits of distributed practice by designing a multi-phase intervention. Although I tried to integrate a number of best practices from the training literature when designing my intervention, there is clearly more that could have been done to have increased overall potency. Future research should investigate what specific techniques are most effective when trying to teach students better study skills.

Theoretical and Practical Implications

The present study attempts to bridge the gap between what we know about science of learning and how learning occurs in the real world by leveraging the science of training to equip students with effective study strategies to better facilitate their self-directed learning. According to the Theory of Planned Behavior, behavior is the product of beliefs and attitudes which then lead to the intention to engage in that behavior. Although I was successful at creating a change in students' attitudes, beliefs and intentions to space their learning by means of implementing the classroom intervention, this did to result in a significant change in study behaviors. Perhaps the power of intention on behavior is overstated by the Theory of Planned Behavior, as the results of this study demonstrate that intentions do not always lead to behavior. I would recommend future researchers who may consider using the Theory of Planned Behavior as a theoretical framework for creating change in study behaviors to proceed with caution, as this theory may not be as generalizable as previous research suggests (e.g., Armitage & Conner, 2001).

Although the spaced learning classroom intervention did not successfully change student study behaviors, other findings from this study have important practical implications for educators and training practitioners. The intervention did influence behavioral, normative, and perceived behavioral control beliefs and attitudes toward spaced learning, which in turn increased intentions to space. Therefore, instructors should do all in their power to strengthen positive beliefs and attitudes towards effective study strategies among students early and often throughout the semester if attempting to convince students to adopt these behaviors. This is especially important as evidence is beginning to accumulate suggesting that instructors should frequently discuss study skills with their students (Morehead, Rhodes, & DeLozier, in press). Students need to believe that a study behavior is appealing, valuable, socially acceptable, and physically possible in order to establish the intention to engage in that behavior in the first place. If an instructor is attempting to convince students/trainees to apply spaced learning to their study strategy, I recommend emphasizing the behavioral and attitudinal factors I identified when designing my spaced learning intervention (see Appendix B) as a strategy of increasing buy in among learners, and thus improving intentions to space.

Even though I did not find strong support for this specific intervention as an effective means of changing study behaviors, I did add to the spaced learning literature by providing further evidence that those who space their learning have better learning outcomes compared to those who do not. The Science of Learning literature is relevant to improving study behaviors, and educators should be aware of this literature and incorporate it into their instructional processes in different ways. Instructors should not assume that students know best when deciding how to study. It is time to take what we know to be true from the Science of Learning and better equip students and trainees with the skills to become more effective self-directed learners; and this study provides one example of such an application.

REFERENCES

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes, 50*, 179-211.

Ajzen, I. (2005). *Attitudes, personality and behavior*. New York: Open University Press.

Ajzen, I. (2002a). Behavioral interventions based on the theory of planned behavior. Retrieved from: http://people.umass.edu/aizen/pdf/tpb.intervention.pdf

Ajzen, I. (2002b). Constructing a theory of planned behavior of questionnaire. Retrieved from: http://people.umass.edu/aizen/pdf/tpb.measurement.pdf

Ajzen, I. (2002c). Perceived behavioral control, self-efficacy, locus of control, and the Theory of Planned Behavior. *Journal of Applied Social Psychology, 32*, 665–683.

Ajzen, I., & Driver, B. L. (1992). Application of the theory of planned behavior to leisure choice. *Journal of Leisure Research, 24*, 207-224.

Ajzen, I., & Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of empirical research. *Psychological Bulletin, 84*, 888.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior.* Englewood-Cliffs, NJ: Prentice Hall.

Ajzen, I., & Fishbein, M. (2005). The handbook of attitudes. In D. Albarracín, B. Johnson, M Zanna (Eds.), *The influence of attitudes on behavior* (pp. 173–221). Mahwah, NJ: Erlbaum.

Ames, C., & Archer, J. (1988). Achievement goals in the classroom: students' learning strategies and motivation processes. *Journal of Educational Psychology, 80*, 260-267.

Armitage, C. J., & Conner, M. (1999). Distinguishing perceptions of control from self-efficacy: Predicting consumption of a low-fat diet using the Theory of Planned Behavior. *Journal of Applied Social Psychology, 29*, 72-90.

Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology, 40*, 471-499.

Arthur, W., Bennett, W., Edens, P., & Bell, S. (2003). Effectiveness of training in organizations: a meta-analysis of design and evaluation features. *Journal of Applied Psychology, 88*, 234-245.

Baddeley, A., Lewis, V., Eldridge, M., & Thomson, N. (1984). Attention and retrieval from long-term memory. *Journal of Experimental Psychology: General, 113*, 518-540.

Baddeley, A. D., & Longman, D. J. A. (1978). The influence of length and frequency of training session on the rate of learning to type. *Ergonomics, 21*, 627-635.

Bagozzi, R. P. (1992). The self-regulation of attitudes, intentions and behavior. *Social Psychology Quarterly, 55*, 178–204.

Bagozzi, R. P., & Kimmel, S. K. (1995). A comparison of leading theories for the prediction of goal-directed behaviours. *British Journal of Social Psychology, 34*, 437–461.

Balch, W. R. (2006). Encouraging distributed study: A classroom experiment on the spacing effect. *Teaching of Psychology, 33*, 249–252.

Baldwin T. T., Magjuka, R. J., Loher, B. T. (1991). The perils of participation: Effects of choice of training on trainee motivation and learning. *Personnel Psychology, 44*, 51-66.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191-215.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Barchard, K. A., & Pace, L. A. (2011). Preventing human error: The impact of data entry methods on data accuracy and statistical results. *Computers in Human Behavior, 27*, 1834-1839.

Barrick M., Mount, M., Strauss, J. (1993). Conscientiousness and performance of sales representatives: Test of the mediation effects of goal setting. *Journal of Applied Psychology, 78*, 715–722.

Beier, M. E., & Kanfer, R. (2010). Motivation in training and development: A phase perspective. In S. Kozlowski, & E. Salas (Eds.), *Learning, training, and development in organizations* (pp: 65-97). New York: Taylor & Francis.

Benjamin, A. S., & Bird, R. (2006). Metacognitive control of the spacing of study repetitions. *Journal of Memory & Language, 55*, 126-137.

Benjamin, A. S., & Tullis, J. (2010). What makes distributed practice effective? *Cognitive Psychology, 61*, 228-247.

Bjork, R. A. (1994). Memory and metamemory considerations in the training of human beings. In J. Metcalfe & A. Shimamura (Eds.), *Metacognition: Knowing about knowing* (pp. 185–205). Cambridge, MA: MIT.

Bjork, R., Dunlosky, J., & Kornell, N. (2013). Self-regulated learning: beliefs, techniques, and illusions. *Annual Review of Psychology, 64*, 417–44.

Brett, J. F., & VandeWalle, D. (1999). Goal orientation and goal content as predictors of performance in a training program. *Journal of Applied Psychology, 84*, 863–873.

Brubaker, R. G., & Fowler, C. (1990). Encouraging college males to perform testicular self-examination: Evaluation of a persuasive message based on the revised theory of reasoned action. *Journal of Applied Social Psychology, 20*, 1411-1422.

Byrne, B. M. (2013). *Structural equation modeling with EQS: Basic concepts, applications, and programming.* New Jersey: Lawrence Erlbaum Associates.

Cepeda, N. J., Pashler, H., Vul, E., Wixted, J. T., & Rohrer, D. (2006). Distributed practice in verbal recall tasks: A review and quantitative synthesis. *Psychological Bulletin, 132*, 354-380.

Cepeda, N. J., Vul, E., Rohrer, D., Wixted, J. T., & Pashler, H. (2008). Spacing effects in learning: A temporal ridgeline of optimal retention. *Psychological Science, 19*, 1095-1102.

Cialdini, R. B. (2003). Crafting normative messages to protect the environment. *Current Directions in Psychological Science, 12*, 105-109.

Colquitt, J. A., LePine, J. A., & Noe, R. A. (2000). Toward an integrative theory of training motivation: a meta-analytic path analysis of 20 years of research. *Journal of Applied Psychology, 85*, 678-707.

Conner, M., & Armitage, C. J. (1998). Extending the theory of planned behavior: A review and avenues for further research. *Journal of Applied Social Psychology, 28*, 1429–1464

Cirillo, F. (2006). The Pomodoro Technique. Retrieved from: http://www.pomodorotechnique.com.

Craik, F. I., Govoni, R., Naveh-Benjamin, M., & Anderson, N. D. (1996). The effects of divided attention on encoding and retrieval processes in human memory. *Journal of Experimental Psychology: General, 125*, 159-180.

Crites, S. L., Fabrigar, L. R., & Petty, R. E. (1994). Measuring the affective and cognitive properties of attitudes: Conceptual and methodological issues. *Personality and Social Psychology Bulletin, 20*, 619-634.

Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological Bulletin, 55*, 281-302.

Crowne, D., & Marlowe, D. (1964). *The approval motive: Studies in evaluative dependence.* New York: Wiley.

Cuddy, L. J., & Jacoby, L. L. (1982). When forgetting helps memory: An analysis of repetition effects. *Journal of Verbal Learning and Verbal Behavior, 21*, 451-467.

Cull, W. L. (2000). Untangling the benefits of multiple study opportunities and repeated testing for cued recall. *Applied Cognitive Psychology, 14*, 215–235.

Daniel, D. B., & Woody, W. D. (2010). They hear, but do not listen: Retention for podcasted material in a classroom context. *Teaching of Psychology, 37*, 199-203.

Dempster, F. N. (1988). The spacing effect: A case study in the failure to apply the results of psychological research. *American Psychologist, 43*, 627-634.

Dempster, F. N. (1989). Spacing effects and their implications for theory and practice. *Educational Psychology Review, 1*, 309-330.

Dempster, F. N. (1996). Distributing and managing the conditions of encoding and practice. *Memory, 10,* 317-344.

Dunning, D., Johnson, K., Ehrlinger, J., & Kruger, J. (2003). Why people fail to recognize their own incompetence. *Current Directions in Psychological Science, 12*, 83–87.

Dunlosky J, & Ariel, R. (2011). Self-regulated learning and the allocation of study time. In B. Rodd (Ed.), *The Psychology of Learning and Motivation: Advances in Research and Theory,* (pp. 103–40). San Diego, CA: Elsevier.

Dunlosky, J., & Nelson, T. O. (1994). Does the sensitivity of judgments of learning (JOLs) to the effects of various study activities depend on when the JOLs occur? *Journal of Memory and Language, 33*, 545-565.

Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). Improving students' learning with effective learning techniques promising directions from cognitive and educational psychology. *Psychological Science in the Public Interest, 14*, 4-58.

Ebbinghaus, H. (1964). *Memory: A contribution to experimental psychology* (H. A. Ruger, C. E. Bussenius, & E. R. Hilgard, Trans.). New York, NY: Dover Publications.

Eby, L. T., Allen, T. D., Evans, S. C., Ng, T., & DuBois, D. L. (2008). Does mentoring matter? A multidisciplinary meta-analysis comparing mentored and non-mentored individuals. *Journal of Vocational Behavior, 72*, 254-267.

Eison, J. A. (1981). A new instrument for assessing students' orientations towards grades and learning. *Psychological Reports, 48*, 919–924.

Enders, C. K., & Bandalos, D. L. (2001). The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling, 8*, 430-457.

Estes, W. K. (1955). Statistical theory of distributional phenomena in learning. *Psychological Review, 62*, 369–377.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Fishbein, M., Ajzen, I., & McArdle, J. (1980).Changing the behaviour of alcoholics: Effects of persuasive communication. In Ajzen, & M. Fishbein (Eds.), *Understanding attitudes and predicting social behavior* (pp. 217-242). Englewood Cliffs, NJ: Prentice-Hall.

Frey, M. C., & Detterman, D. K. (2004). Scholastic assessment or g? The relationship between the Scholastic Assessment Test and general cognitive ability. *Psychological Science, 15*, 373–378.

Friendly, M. (1996). Paivio et al. Word List Generator, Online application, http://www.datavis.ca/online/paivio/, Accessed: 10/17/2013.

Gaes, G. G., Kalle, R. J., & Tedeschi, J. T. (1978). Impression management in the forced compliance situation: Two studies using the bogus pipeline. *Journal of Experimental Social Psychology, 14*, 493-510.

Glenberg, A. M. (1979). Component-levels theory of the effects of spacing of repetitions on recall and recognition. *Memory & Cognition, 7*, 95–112.

Gobbo, F., & Vaccari, M. (2008). The pomodoro technique for sustainable pace in extreme programming teams. In P. Abrahamsson, R. Baskerville, K. Conboy, B. Fitzgerald, L. Morgan, X. Wang (Eds.), *Agile Processes in Software Engineering and Extreme Programming* (pp. 180-184). Berlin, Heidelberg: Springer.

Gold, M. S., Bentler, P. M., & Kim, K. H. (2003). A comparison of maximum-likelihood and asymptotically distribution-free methods of treating incomplete nonnormal data. *Structural Equation Modeling, 10*, 47-79.

Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. C. (2006). The International Personality Item Pool and the future of public-domain personality measures. *Journal of Research in Personality, 40*, 84-96.

Goldstein, I. L., & Ford, J. K. (2002). *Training in organizations: Needs assessment, development, and evaluation* (4th ed.). Belmont, CA: Wadsworth.

Gully, S., & Chan, G. (2010). Individual differences, attribute-treatment interactions and training outcomes. In S. W. J. Kozlowski & E. Salas (Eds.), *Learning, training, and development in organizations* (pp. 3-64). New York: Routledge.

Hartwig, M. K., & Dunlosky, J. (2012). Study strategies of college students: Are self-testing and scheduling related to achievement? *Psychonomic Bulletin & Review, 19*, 126-134.

Hattie, J., Biggs, J., & Purdie, N. (1996). Effects of learning skills interventions on student learning: A meta-analysis. *Review of Educational Research, 66*, 99-136.

Heath, Y., & Gifford, R. (2002). Extending the theory of planned behavior: predicting the use of public transportation1. *Journal of Applied Social Psychology, 32*, 2154-2189.

Hicks, W. D., & Klimoski, R. J. (1987). Entry into training programs and its effects on training outcomes: A field experiment. *Academy of Management Journal, 30,* 542-552.

Higgins, E. T. (1987). Self-discrepancy: a theory relating self and affect. *Psychological Review, 94*, 319-340.

Hill, S. G., Lavecchia, H. P., Byers, J. C., Bittner, A. C., Zaklad, A. L., & Christ, R. E. (1992). Comparison of four subjective workload rating-scales. *Human Factors, 34*, 429-439.

Huang, A. H. (2002). A three-tier technology training strategy in a dynamic business environment. *Advanced Topics in End User Computing, 2*, 263-321.

Hunter, J. E. (1986). Cognitive ability, cognitive aptitude, job knowledge, and job performance. *Journal of Vocational Behavior, 29*, 340-362

Hunter, J. E., & Schmidt, F. L. (Eds.). (2015). *Methods of meta-analysis: Correcting error and bias in research findings*. Sage: Los Angeles.

Kachgal, M. M., Hansen, L. S., & Nutter, K. J. (2001). Academic procrastination prevention/intervention: Strategies and recommendation. *Journal of Developmental Education, 25*, 14-24.

Kang, S.H.K, & Pashler, H. (2012). Learning painting styles: Spacing is advantageous when it promotes discriminative contrast. *Applied Cognitive Psychology, 26*, 97-103.

Karpicke, J. D., Butler, A. C., & Roediger, H. L., (2009). Metacognitive strategies in student learning: Do students practice retrieval when they study on their own? *Memory, 17,* 471–479.

Kenward, M. G., & Molenberghs, G. (1998). Likelihood based frequentist inference when data are missing at random. *Statistical Science, 12*, 236-247.

Kornell, N. (2009). Optimising learning using flashcards: Spacing is more effective than cramming. *Applied Cognitive Psychology, 23*, 1297-1317.

Kornell, N., & Bjork, R. A. (2007). The promise and perils of self-regulated study. *Psychonomic Bulletin & Review, 14*, 219-224.

Kornell, N., & Bjork, R. A. (2008a). Learning concepts and categories: Is spacing the "enemy of induction"? *Psychological Science, 19*, 585–592.

Kornell, N., & Bjork, R. A. (2008b). Optimising self-regulated study: The benefits—and costs—of dropping flashcards. *Memory, 16*, 125-136.

Kornell, N., Castel, A., Eich, T., & Bjork, R. (2010). Spacing as the friend of both memory and induction in young and older adults. *Psychology and Aging, 25*, 498–503.

Kraiger, K., & Culbertson, S. S. (2012). Understanding and facilitating learning: Advancements in training and development. In I. Weiner, N. Schmitt, & S. Highhouse (Eds.), *Handbook* *of Psychology, Industrial and Organizational Psychology (2nd ed.),* 244-261. New Jersey: Wiley.

Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1964). Taxonomy of educational objectives: The classification of educational goals. *Handbook 11: The affective domain*. New York: David McKay.

Kruger, J. (1999). Lake Wobegon be gone! The" below-average effect" and the egocentric nature of comparative ability judgments. *Journal of personality and social psychology, 77*, 221-232.

Lee, T. D., & Genovese, E. D. (1988). Distribution of practice in motor skill acquisition: Learning and performance effects reconsidered. *Research Quarterly for Exercise and Sport, 59*, 277–287.

Macan, T. H. (1994). Time management: Test of a process model. *Journal of Applied Psychology, 79*, 381-391

Macan, T. H., Shahani, C., Dipboye, R. L., & Phillips, A. P. (1990). College students' time management: Correlations with academic performance and stress. *Journal of Educational Psychology, 82*, 760-768.

Machin, M. A., & Fogarty, G. J. (2004). Assessing the antecedents of transfer intentions in a training context. *International Journal of Training and Development, 8*, 222-236.

MacKinnon, D. P., & Dwyer, J. H. (1993). Estimating mediated effects in prevention studies. *Evaluation Review, 17*, 144-158.

Manstead, A. S., & Eekelen, S. A. (1998). Distinguishing between perceived behavioral control and self-efficacy in the domain of academic achievement intentions and behaviors. *Journal of Applied Social Psychology, 28*, 1375-1392.

Mathieu, J. E., & Martineau, J. W. (1997a). Individual and situational influences on the development of self-efficacy: Implications for training effectiveness. *Personnel Psychology, 46*, 125-147.

Mathieu, J. E., & Martineau, J. W. (1997b). Individual and situational influences on training motivation. In J. Ford and Associates (Eds.), *Improving training effectiveness in work organizations* (pp. 193-221). NY: Psychology Press.

Mayer, R. E. (1979). Can advance organizers influence meaningful learning? Review of *Educational Research, 49*, 371-383.

Mayer, R. E., Stull, A. T., Campbell, J., Almeroth, K., Bimber, B., Chun, D., & Knight, A. (2006). Overestimation bias in self-reported SAT scores. *Educational Psychology Review, 19,* 443-454.

McCabe, J. (2011). Metacognitive awareness of learning strategies in undergraduates. *Memory & Cognition, 39,* 462-476.

Morehead, K., Rhodes, M. G., & DeLozier, S. (In press). Instructor and student knowledge of study strategies. *Memory*.

Moreno, R., & Mayer, R. (2007). Interactive multimodal learning environments. *Educational Psychology Review, 19*, 309-326.

Moulton, C., Dubrowski, A., MacRae, H., Graham, B., Grober, E., & Reznick, R. (2006). Teaching surgical skills: what kind of practice makes perfect?: A randomized, controlled trial. *Annals of Surgery, 244*, 400.

Muthén, L. K., & Muthén, B. O. (2010). *Mplus user's manual*. Los Angeles: Muthén & Muthén.

Nelson, T. O., Dunlosky, J., Graf, A., & Narens, L. (1994). Utilization of metacognitive judgments in the allocation of study during multitrial learning. *Psychological Science, 5*, 207-213.

Noe, R. A., & Colquitt, J. A. (2002). Planning for training impact: Principles of training effectiveness. In K. Kraiger (Ed.), *Creating, implementing, and managing effective training and development (pp.* 53-79). San Francisco, CA: Jossey-Bass.

Nunnally, J. C. (1978). *Psychometric theory (2nd ed.).* New York: McGraw-Hill.

Pashler, H., Kang, S.H.K., & Ip, R. (2013). Does multitasking impair studying? Depends on timing. *Applied Cognitive Psychology*, 27, 593-599.

Peng, C. Y. J., Lee, K. L., & Ingersoll, G. M. (2002). An introduction to logistic regression analysis and reporting. *The Journal of Educational Research, 96*, 3-14.

Perkins, H. W., & Berkowitz, A. D. (1986). Perceiving the community norms of alcohol use among students: some research implications for campus alcohol education programming. *Substance Use & Misuse, 21*, 961-976.

Petraitis, J., Flay, B. R., & Miller, T. Q. (1995). Reviewing theories of adolescent substance use: organizing pieces in the puzzle. *Psychological bulletin, 117*, 67-86.

Phan, H. P. (2011). Interrelations between self-efficacy and learning approaches: a developmental approach. *Educational Psychology, 31*, 225-246.

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology, 88*, 879-903.

Postman, L., & Phillips, L. W. (1965). Short-term temporal changes in free recall. *The Quarterly Journal of Experimental Psychology, 17*, 132-138.

Pyc, M. A., & Rawson, K. A. (2012). Why is test-restudy practice beneficial for memory? An evaluation of the mediator shift hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 737–746.

Quiñones, M. A. (1997). Contextual influences on training effectiveness. In M. Quiñones, & A. Ehrenstein (Eds.), *Training for a rapidly changing workplace: Applications of psychological research* (pp. 177-199). Alexandria, VA: American Psychological Association.

Rawson, K. A., & Dunlosky, J. (2011). Optimizing schedules of retrieval practice for durable and efficient learning: How much is enough? *Journal of Experimental Psychology-General, 140*, 283-302.

Roediger, H. L., & Karpicke, J. D. (2006). The power of testing memory: Basic research and implications for educational practice. *Perspectives on Psychological Science*, *1*, 181-210.

Rohrer, D., & Pashler, H. (2007). Increasing retention without increasing study time. *Current Directions in Psychological Science, 16*, 183-186.

Rohrer, D., & Taylor, K. (2006). The effects of overlearning and distributed practise on the retention of mathematics knowledge. *Applied Cognitive Psychology, 20*, 1209-1224.

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

Ross, B. H. (1989). Distinguishing types of superficial similarities: Different effects on the access and use of earlier problems. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 15*, 456-468.

Rubin-Rabson, G. (1940). Studies in the psychology of memorizing piano music: II. A comparison of massed and distributed practice. *Journal of Educational Psychology, 31*, 270-284.

Ryman, D. H. & Biersner, R. J. (1975). Attitudes predictive of diving training success. *Personnel Psychology, 28,* 181-188.

Sackett, P. R., & Laczo, R. M. (2003). Job and work analysis. In W. C. Borman, D. R. Ilgen, & R. J. Klimoski (Eds.), *Comprehensive handbook of psychology: Industrial and organizational psychology* (Vol. 12, pp. 21-37). New York: John Wiley & Sons.

Salas, E., Tannenbaum, S., Kraiger, K., & Smith-Jentsch, K. The science of training and development in organizations: What matters in practice. *Psychological Science in the Public Interest, 13(2),* 74–101.

Savion-Lemieux, T., & Penhune, V. B. (2005). The effects of practice and delay on motor skill learning and retention. *Experimental Brain Research, 161*, 423-431.

Siegel, S., & Castellan, N. J. (1988). *Nonparametric statistics for the behavioral science (2nd ed.)*. New York: McGraw-Hill.

Sisti, H. M., Glass, A. L., & Shors, T. J. (2007). Neurogenesis and the spacing effect: learning over time enhances memory and the survival of new neurons. *Learning & Memory, 14*, 368-375.

Sitzmann, T., & Ely, K. (2010). Sometimes you need a reminder: the effects of prompting self-regulation on regulatory processes, learning, and attrition. *Journal of Applied Psychology, 95*, 132-144.

Son, L. K. (2004). Spacing one's study: Evidence for a metacognitive control strategy. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 30*, 601-604.

Son, L. K., & Simon, D. A. (2012). Distributed learning: data, metacognition, and educational implications. *Educational Psychology Review, 24*, 379-399.

Strauman, T.J. (1996). Stability within the self: A longitudinal study of the structural implications of self-discrepancy theory. *Journal of Personality and Social Psychology, 71*. 1142-1153.

Susser, J. A., & McCabe, J. (2013). From the lab to the dorm room: metacognitive awareness and use of spaced study. *Instructional Science, 41*, 345-363.

Tabachnick, B. G. & Fidell, L. S. (2012). *Using multivariate statistics (6th ed.).* Boston MA: Pearson.

Tormala, Z. L., & Petty, R. E. (2004). Source credibility and attitude certainty: A metacognitive analysis of resistance to persuasion. *Journal of Consumer Psychology, 14*, 427-442.

Tuckman, B. W. (2003). The effect of learning and motivation strategies training on college student achievement. *Journal of College Student Development, 44*, 430-437.

Tziner, A., Fisher, M., Senior, T. & Weisberg, J. (2007), Effects of trainee characteristics on training effectiveness. *International Journal of Selection and Assessment, 15*, 167–74.

VandeWalle, D. (1997). Development and validation of a work domain goal orientation instrument. *Educational and Psychological Measurement, 57*, 995-1015.

VandeWalle, D., Cron, W. L., & Slocum, J. W. (2001). The role of goal orientation following performance feedback. *Journal of Applied Psychology, 86*, 629–640.

Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin, 132*, 249-268.

Wilson, C. L., Huang, J. L., & Kraiger, K. (2013). Personality and the analysis, design, and delivery of training. In N. D. Christiansen & R. P. Tett (Eds.) *Handbook of personality at work* (pp. 543-564). New York: Routledge.

Winne, P. H., & Jamieson-Noel, D. (2002). Exploring students' calibration of self-reports about study tactics and achievement. *Contemporary Educational Psychology, 27*, 551–572.

Yuan, K. H., & Bentler, P. M. (2000). Inferences on correlation coefficients in some classes of nonnormal distributions. *Journal of Multivariate Analysis, 72*, 230-248.

APPENDIX A: PILOT STUDIES

Pilot Study #1

Method

During the 2013 spring semester at Colorado State University, I gave a presentation on spaced learning to a classroom of Psy100 students (n=112). The training was intentionally delivered during the class immediately following their fourth exam as to increase the criterion-related validity of the administered self-report data. In other words, I wanted to ensure their recollection of their studying behaviors for exam 4 were as salient as possible. During the presentation I defined spaced learning, illustrated empirical examples of the powerful effect spacing has on learning outcomes, and encouraged students to space their studying for their final exam. Students were then instructed to answer the following questions:

1. Which statement is most true:
    a. I spaced my studying for Exam 4 (3+ study sessions)
    b. I crammed for Exam 4 (1-2 study sessions)
2. Which statement is most true:
    a. I plan to spaced my studying for the Final Exam (3+ sessions)
    b. I plan to cram before the Final Exam (1-2 study sessions)
3. Why did you not space your studying on Exam 4?

Results

Consistent with findings of Balch's (2006) classroom demonstration study, the intervention increased student intentions to space studying. Whereas only 11% indicated that they spaced their studying on Exam 4, 86% of students reported that they intended space their studying for the Final Exam.

A number of students reported poor time management as an impediment to spaced learning. Indeed, procrastination, limited time, and obligations in other classes were the three most frequency reasons provided for not spacing study and could have been alleviated if time was better managed (Figure 10). If students were to better plan out their time, they could be more successful at balancing out their spaced studying in one course with pressing deadlines in other classes. Moreover, strictly following a study plan would prevent work from being delayed until the last minute, as procrastination has been found to be positively correlated to poor time management and other perceived barriers to academic success (Kachgal, Hansen, & Nutter, 2001).

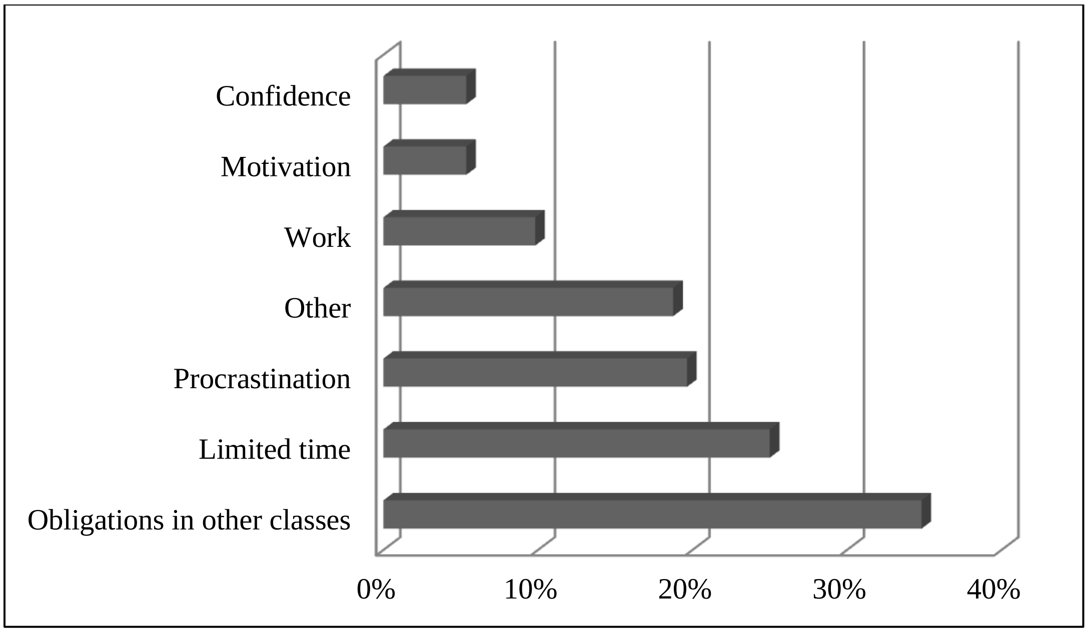

Figure 10. Reasons for not spacing studying on exam 4 (n=112)

Pilot Study #2

Method

In order to explore student beliefs and attitudes towards spaced learning, a second pilot study was conducted. Fifty-eight students from an undergraduate Learning and Memory class were given a lecture on spaced learning. At the beginning of the lecture, the spaced learning memory task was delivered as a means to validate this classroom demonstration. Evidence demonstrating the efficacy of spaced learning on learning outcomes was also presented throughout the lecture. Afterwards, students were instructed to answer the following questions:

1) Using the scale below, how would you rate your typical study behaviors PRIOR to today's class? (0 = Always cram, never space….10 = Always space, never mass)

2) Using same scale, how would you rate your intention to study in the FUTURE?

3) What skills and/or attitudes would you need for a "9" or "10" rating?

Results

Fifty-three percent of the students explicitly mentioned the words "time management," "scheduling," or "planning," further supporting my inclusion of time management as an important control belief related to spaced learning. Moreover, the spaced learning memory task was found to be effective, as students recalled significantly more spaced words (50%) than massed words (34.5%), thus validating my decision to include this memory task within my final intervention.

APPENDIX B: TRAINING CONTENT

The 20 minute classroom intervention was designed as an attitudinal training program, incorporating the various elements that have been found to influence attitudes towards spaced learning (e.g., evidence that spaced learning is effective, time management skills, etc.) discussed in the previous section. The learning objectives (Table 9) were determined according to these empirically-supported, theoretically-based solutions to increasing student engagement in spaced learning.

Table 9. Learning Objectives

By the end of the training, students will be able to:
1) Define spaced learning
2) Define the spacing effect
3) Conclude that spaced learning is a more effective study strategy compared to cramming.
4) Recognize that CSU undergrad psychology students space their learning
5) Write up a spaced learning study schedule for exam 3
6) Utilize the Pomodoro Technique to stay accountable to their spaced learning study plan
7) Access study tools on RamCT
8) Feel confident that they can successfully space their learning for exam 3

Moreover, specific decisions made about the intervention design (e.g., context, delivery) were made according to best practices prescribed by top training researchers (e.g., Goldstein & Ford, 2002; Kraiger & Culbertson, 2012; Noe & Colquitt, 2002; Salas, Tannenbaum, Kraiger, & Smith-Jentsch, 2012) as to make the intervention as effective as possible. Well-designed training programs can greatly affect learning outcomes (Salas et al., 2012). As one example of a best practice, the intervention was delivered by credible presenter established as an expert source (Tormala & Petty 2004). Additional practices are discussed below.

Training effectiveness has been found to be a function of the match between the training delivery method and the skill or task to be trained (Arthur, Bennett, Edens & Bell, 2003). Specifically, in their meta-analysis of the relationship between design and training effectiveness in organizations, Arthur et al. found lectures to be a surprisingly potent delivery method. Accordingly, the spaced learning training program was delivered as a lecture-based classroom intervention, using a PowerPoint presentation as an instructional supplement and also support multi-modal learning. Specifically, as research shows that students learn best when presented with multiple types of stimuli (Moreno & Mayer, 2007), both audio and visual (including both text and pictures) instructional materials were utilized.

How the training is framed, or how it is initially presented to the trainees, can also boost learner motivation (Beier & Kafner, 2010). Features such as the title of the training (Quiñones, 1995) and the organizational climate (Mathieu & Martineau, 1997b) have been found to affect trainee motivation to learn the training material. Motivational elements of the training design contribute to learning and positive reactions to the training may encourage transfer of training (e.g., successfully engaging in spaced learning in future studying). It is therefore important to ensure that training is perceived as relevant and useful. Therefore, the trainer emphasized the various ways in which the intervention could benefit the student participants. In order to grab their attention for the purpose of engaging trainees at the very onset of the intervention, the training began with a modified version of Balch's (2006) spacing effect demonstration.

The spacing effect demonstration was also intended to increase self-efficacy among participants. Training programs should be designed to build self-efficacy, promote a learning orientation, and boost one's motivation to learn (Salas et al., 2012). Research has found that individuals high in self-efficacy are more likely to engage in learning and respond more positively in the face of challenges or difficulties (Bandura, 1997; Phan, 2011). Based on these findings, Salas and et al. recommended reminding trainees of past successes and ensuring early successful learning experiences as a good way to increase self-efficacy. For this reason, the spaced learning demonstration was used as evidence that the spacing effect actually *does* improve learning outcomes either within themselves or among the majority of their classmates. Participants were reminded of this spaced learning "success" throughout the training, as a means to build self-efficacy. The design and implementation of this demonstration will be described below.

Spacing Effect Demonstration. The purpose of this memory task was to illustrate the benefits of spaced learning to motivate students to engage in this study technique (Balch, 2006). Students were instructed to observe a list of words appearing one by one on a screen and try to remember as many words as possible.

To select the words for my demonstration, I used the Paivio, Yuille, and Madigan Word Pool generator (Friendly, 1996) which contains 925 nouns scaled for word frequency in printed text, according to the Kucera-Francis word counts. This allowed me to ensure consistency in the number of syllables and letters, as well as variables widely used in memory research to control for the effects of imagery, concreteness, and meaningfulness of word list items. Table 2 displays the generated words and ratings of frequency, imagery, concreteness and meaningfulness.

Table 8. Generated Word List with Control Characteristics

Word	K-F	Imagery Rating	Concreteness Rating	Meaningfulness Rating
artist	50	5.9	6.1	6.7
creature	50	4.6	6.0	5.5
forehead	41	6.3	6.9	5.1
fortune	50	4.6	3.8	6.0
insect	40	6.1	6.8	6.3
maiden	45	6.1	6.5	5.0
marriage	50	5.8	3.9	6.3
pressure	48	4.1	3.6	5.8
series	50	4.5	3.9	5.4
shadow	50	5.6	4.9	5.3
volume	50	4.5	5.1	6.2

Note: K-F = Kucera-Francis word frequency score

Words were randomly assigned to either the massed, spaced, or primacy control groups. Massed words will appear on the screen once for 2.25 seconds each. Spaced words, on the other hand, appeared on the screen three times for 0.75 seconds each. Therefore, all words appeared on the screen for a total of 2.25 seconds. This was determined as the ideal exposure time as a result of an a priori pilot study I conducted. Specifically, I learned that 1 second per spaced word was too long, and 0.5 seconds was too little based on feedback from my pilot study participants. I also wanted to control for primacy and recency effects—the tendency to recall the first and last words, respectively, more readily compared to other words in a list (Postman & Phillips, 1965). To control for the primacy effect, the first three words presented in the demonstration were not counted towards the experiment. To control for recency effects, students were instructed to count backwards by threes stating at the number "86" for twenty seconds after all of the words are presented.

Students were then given 30 seconds to write down as many words as they could remember. The word list was then presented, including labels of which words were massed, spaced, or controlled for primacy. Students were then asked to share whether they remembered more massed or spaced words by a show of hands. The majority of students in all three classes remembered more spaced than massed words, therefore reinforcing the potency of the spacing effect at the classroom level.

After the spacing effect demonstration, learning objectives were presented. Then spaced learning and the spacing effect was defined. Empirical evidence supporting the positive effect spacing has on learning outcomes compared to cramming was presented in the form of graphs and charts, and these data were thoroughly explained. Students were then presented with real data from the two pilot studies, providing evidence that not only do CSU psychology students space their learning, but that it also improves their learning outcomes (i.e., exam scores) as well.

Then students were trained on how to space their learning by scheduling multiple study intervals before exam 3. Students were instructed to schedule three to five study sessions within the week preceding the exam, based on how many days they plan to study for exam 3. This is because it has been found that the ideal lag time between study intervals should be 10-20% of the desired retention interval (Cepeda et al., 2008). For example, if the student intended to study over the four days leading up to exam 3, it would be most advantageous to schedule study sessions 10-20 hours apart. As it is unreasonable to assume a student will study for exam 3 more than once per day, I erred on the higher end of this range and encouraged students to study once per day over a four day period. Moreover, students were advised to make study sessions as similar in length as possible, as uniform intervals have been found to result in the highest percentage of recall compared to variable time intervals (Cull, 2000). Students were instructed to estimate the total amount of time they expect to study for exam 3 and then divide that number by four to determine how much they should study per session. Students were also provided with a hard-copy, date-specific calendar page which they will be encouraged to use to make their spaced learning study plan.

Time management training alone does not significantly predict that trainees be successful at sticking to their study plan (Macan, 1994). Therefore, in order to make abbreviated study sessions as potent as possible, students were encouraged to concentrate solely on the task at hand (Pashler, Kang, & Ip, 2013). Millennial students in particular report being very easily distracted when trying to study (Rosen, Carrier, & Cheever, 2013). Additionally, research shows that multitasking while studying substantially impairs later memory for the studied material (e.g., Baddeley, Lewis, Eldridge, & Thomson, 1984; Craik, Govoni, Naveh-Benjamin, & Anderson, 1996). For this reason, students were also be trained on an attention-focusing strategy referred to as the Pomodoro Technique (Cirillo, 2006). This technique has been found to increase the efficiency of individual work, by making a clear distinction between when it is time work without distraction (e.g., checking emails, getting coffee, etc.) and using breaks to complete these otherwise interrupting tasks (Gobbo & Vaccari, 2008).

Also to increase the likelihood that students would be successful at using the Pomodoro Technique, students were trained on how to use an internet browser killing app called StayFocused. This application allows the user to completely block internet accessibility for any given period of time, helping to counteract the excessive media multi-tasking that today's generation of undergraduate students often fall victim to (Rosen, Carrier, & Cheever, 2013).

Online links to StayFocused and Pomodoro Technique resources, in addition to a few online scheduling tools (e.g., Google Calendar, Evernote) were provided within a folder on RamCT labelled "Exam 3 Study Tools" to which all participants had access as they prepared for exam 3.

Lastly, all post-training and post-exam surveys were administered using a paper-pencil method as to reduce attrition and capture immediate responses after the training was administered. A number of well-trained undergraduate RAs assisted with survey distribution and collection as to make this process flow as smoothly as possible. Pre-training surveys were administered online 24 hours prior to the intervention as to preserve valuable in-class time for four of the six classrooms. Pre-training hard copy surveys were completed immediately prior to the training by one T (n=25) and one C group (n =31), both taught by the same instructor.

APPENDIX C: MEASURES

Behavioral Belief Items

B1: If I space out my studying over multiple sessions I will learn [much less…much more] of the material I plan to study for exam 3.

B2: If I space out my studying over multiple sessions I will earn a [much lower…much higher] score on exam 3.

A1: Spaced learning is an [worthless…valuable] study strategy.

A2: Spaced learning is an [unappealing…appealing] study strategy.

Normative Belief & Social Norm Items

N1: CSU undergraduates space out their studying. [strongly disagree…strongly agree]

N2: CSU undergrads benefit from spacing out their studying over multiple sessions. [strongly disagree…strongly agree]

S1: I feel inclined to space out my studying because that is what other CSU undergrads do. [strongly disagree…strongly agree]

S2: I feel inclined to space out my studying because that is what my Psy100 instructor expects me to do. [strongly disagree…strongly agree]

Control Belief & Perceived Behavioral Control Items

CB1: It is [uncommon…common] for me to schedule my study sessions in advance when preparing for Psy100 exams.

CB2: If I make a plan to study at a certain time, it is [very unlikely….very unlikely] that I follow through with this plan.

CB3: I have a [very easy…very demanding] workload outside of my responsibilities for Psy100.

CB4: I am [very much…not at all] interested in the material that will be covered on exam 3 for this class.

CB5: It is [very easy…very difficult] to space out my studying when studying for Psy100 exams.

CB6: I expect exam 3 in this class to be a [very easy…very difficult] exam.

: perceived ability to manage time, perceived available time, and motivation to space.

PBC1: I have the time management skills to successfully to space out my studying over multiple sessions when preparing for exam 3 in this course.

[strongly disagree…strongly agree]

PBC2: I will have the available time to successfully to space out my studying over multiple sessions when preparing for exam 3 in this course.

[strongly disagree…strongly agree]

PBC3: I am [very much…not at all] motivated to space out my study sessions as I prepare for exam 3 in this class

Spaced Learning Knowledge Items

K1: Spaced learning is defined as: [a: learning something mindlessly; b: when learning occurs in an open area, c: segmenting learning over multiple sessions; d: learning about the universe]

K2: Consider the following two study techniques: 1) you study once for four hours straight; and 2) you study four times for one hour each. Which answer is correct? [a: you will remember more information if you use study technique #1; b: you will remember more information if you use study technique #2; c: you will remember the same amount of information if you use either study technique]

K3: The spacing effect is when [a: you remember more information when studying is spaced out over multiple sessions; b: you remember less information when studying is spaced out over multiple sessions; c: you remember more information when studying in one session only (i.e., "cramming"); d: you remember less information when studying is spaced out over multiple sessions (i.e., "cramming")]

Conscientiousness Items* (Goldberg, et al. 2006)

C1: I am always prepared.

C2: I pay attention to details.

C3: I get chores done right away.

C4: I like order.

C5: I follow a schedule.

C6: I leave my belongings around.

C7: I make a mess of things.

C8: I often forget to put things back in their proper place.

C9: I prefer to take shortcuts when completing tasks.

**items were modified for reading comprehension*

Goal Orientation Items (VandeWalle at al., 2001)

Learning orientation items:

G1: I prefer challenging and difficult classes so that I'll learn a great deal.

G2. I truly enjoy learning for the sake of learning.

G3. I like classes that really force me to think hard.

G4. I'm willing to enroll in a difficult course if I can learn a lot by taking it.

Performance orientation items:

G5. It's important that others know that I am a good student.

G6. I think that it's important to get good grades to show how intelligent you are.

G7. It's important for me to prove that I am better than others in the class.

G8: To be honest, I really like to prove my ability to others.