Learning Before Teaching: Metacognitive Benefits of Teaching Expectancy

Elizabeth A. Green

Marietta College

A Thesis Submitted to the Faculty of

Marietta College

In Partial Fulfillment of the Requirements for the Degree of

Master of Arts in Psychology

December 2013
Learning Before Teaching: Metacognitive Benefits of Teaching Expectancy

Elizabeth A. Green

Marietta College

This thesis has been approved for the Department of Psychology
of Marietta College by

[Signature]

Dr. Christopher A. Klein, Ph.D.

Thesis Committee Advisor

[Signature]

Dr. Mark Sibicky, Ph.D.

Thesis Committee Member
CONTENTS

ACKNOWLEDGEMENTS ........................................................................................................... 3

ABSTRACT ................................................................................................................................. 4

1. INTRODUCTION .................................................................................................................. 5
   1.1 SELF-DETERMINATION THEORY ................................................................................. 6
   1.2 COGNITION .................................................................................................................. 16
   1.3 METACOGNITION ......................................................................................................... 18
   1.4 SELF-REGULATED LEARNING ..................................................................................... 20
   1.5 THE CURRENT STUDY .................................................................................................. 27

2. METHODOLOGY .................................................................................................................. 30

3. RESULTS ............................................................................................................................. 35

4. DISCUSSION ........................................................................................................................ 37

REFERENCES .......................................................................................................................... 45

TABLES ..................................................................................................................................... 51

FIGURES ..................................................................................................................................... 55

APPENDIX

A.1 APPLIED EXAMPLE OF WINNE & HADWIN’S (1998) COPES (4-PHASE) MODEL OF METACOGNITIVE MONITORING AND CONTROL ........................................... 61

A.2 HUMAN EAR TEXT .......................................................................................................... 63

A.3 HUMAN EAR DIAGRAM .................................................................................................. 67

A.4 LABELING TEST ............................................................................................................... 68

A.5 LEARNING ASSESSMENT ............................................................................................... 69

A.6 REVISED MSLQ ............................................................................................................... 71

A.7 PARTICIPANT BACKGROUND QUESTIONNAIRE .............................................................. 77
Acknowledgements

I feel blessed to have had support from several incredibly supportive individuals throughout this project. I would like to thank Dr. Christopher Klein, my committee chair, whose super-human patience, selfless dedication, and outward confidence in my ability often provided the push to keep me going through events that were always (in my mind) of “project-ending” proportion. I would like to thank Dr. Mark Sibicky, my committee member, who kept his sense of humor when I had all but lost mine, always boosting my spirit with a kind smile, a witty jab, and the occasional “atta-girl.”

I would like to thank my dear friend, Justin Barrett, for coming to my rescue when my best efforts at web-design weren’t enough, dedicating his time to helping me design the website for my research. I would like to thank Dr. Philip Winne, for allowing me to use his software for my research, and for lending me the support of his phenomenal software designer. I would like to thank Liam Doherty, software designer extraordinaire, for his dedication to tweaking, writing, patching, updating, and refreshing nStudy each and every time the our servers stopped “playing nice” with the software.

Last but not least, I would like to thank my family for sticking beside me for the duration of this oft-emotional project, for bragging on their daughter and her “what was that word again” research, and for their endless love and support.
Abstract

The design of this study took into account prior research from self-determination theory concerning how motivational orientation affects learning, as well as research from cognitive and metacognitive theories explaining how learners’ study strategy selection for a given task affect learning processes that occur during any given learning task. Participants were undergraduate students from Marietta College, randomly assigned to either a teaching expectancy condition or a testing expectancy condition. Participants studied a diagram of the human ear and read a short text on auditory processing. All information was presented within a web-based software program that recorded a detailed log of participants’ movements and specific study tactics and strategies as they moved through the learning unit. Task condition significantly affected the ease of learning judgments made before beginning the study session, and subsequently affected behavior on a studying task. Teaching-expectant participants spent longer durations studying, and selected and employed cognitive study strategies significantly more often than test-expectant participants. Analyses of motivational orientation effects and analyses of learning outcomes are also discussed.
Learning Before Teaching: Metacognitive Benefits of Teaching Expectancy

Time and again, research has confirmed that individuals learn factual and conceptual information more deeply and retain information for longer durations after teaching it. However, recent research suggests that cognitive benefits may begin developing when the teacher starts to prepare for the teaching experience, before any teaching has taken place. Three major theoretical orientations have proposed explanations for why individuals who expect to teach might learn and retain information better. Self-determination theorists suggest that learners who are preparing for a teaching episode study differently than learners who are preparing to take a test because of an innate intrinsic motivation oriented towards teaching (Benware & Deci, 1984; Deci, 1975; Hiller, Deichmann, & Pirkle, 1973; Ryan & Deci, 2000). Cognitive psychologists focus on the way that learners engage in studying tasks, suggesting that learners who are preparing for a teaching episode may encode information in a more organized, elaborative framework (Bargh & Schul, 1980; Renkl, 1995). Finally, metacognitive theorists suggest that differences in learning outcomes related to teaching expectancy situation stem from variations in how learners define goals for a given task; leading learners who are preparing for teaching episodes to select more effective learning tactics and strategies and engage in higher rates of metacognitive monitoring as studying progresses (Nelson & Narens, 1990; Pintrich, 2004; Winne & Hadwin, 1998).

The present study investigated how teaching expectancy may affect learners’ motivational orientation, cognitive processing, and metacognitive monitoring while studying. This research included multiple types of measurements, allowing for simultaneous investigation of the multiple theoretical viewpoints within a single experimental paradigm, yielding a more well-rounded view of how and why teaching expectancy might affect the learning process.
Self-Determination Theory

A major perspective in motivation research, Self-Determination Theory (SDT) explains that social and environmental conditions may promote and/or degrade self-motivation (Deci, 1975). SDT proposes that fulfillment of the innate psychological needs for autonomy, competence, and relatedness provide the driving force behind self-motivated growth (Ryan, 1995). SDT recognizes two categories of motivational drives, intrinsically driven motivation and extrinsically regulated motivation, and suggests that because these two motivational orientations affect the innate psychological needs differently, they produce unique behavioral effects (Ryan & Deci, 2000).

Extrinsic regulation. Situational variables play a large role in people’s motivational orientation towards certain tasks. An individual’s behavior is regarded as being extrinsically regulated in situations where at least one external reward contingency is implemented as the driving motivator for performing the behavior. Extrinsic motivational orientations are based on an individual’s current perception of the task at hand and as such are inherently flexible.

Extrinsic motivation exists on a continuum. When individuals perceive that an extrinsically motivated behavior may also lead to fulfillment of psychological needs, their motivation shifts. They begin to focus on the rewarding feeling that they get after performing the behavior, as their psychological needs are met, rather than the previously applied extrinsic rewards. Researchers call the shift in an individual’s focus from external regulator to internal experience internalization (Ryan & Deci, 2000). As individuals internalize extrinsic regulators more deeply, they fulfill their need for autonomy and decrease their reliance on the implementation of an external reward.
The lowest level of extrinsic motivation, *extrinsic regulation*, does not involve internalization of reward contingency; behaviors that are performed only to satisfy the demands of a reward contingency and earn an extrinsic reward. Once the reward contingency is withdrawn, the individual will cease to engage in the behavior (Deci, Koestner, & Ryan, 2001).

The second level of externally regulated motivation impacts behavior through *introjection*. Behaviors driven by introjection are typically only slightly internalized, and are employed in order to avoid feelings of guilt, anxiety, or to maintain one’s sense of self-worth (Ryan & Connell, 1989). The third level of extrinsic motivation is regulated via *identification*. At this level, the individual consciously values the behavioral goal and engages in the behavior because it is regarded as personally important. The fourth and highest level of extrinsic motivation influences behavior via *integrated regulation* (Ryan, 1995). At this level the individual fully integrates the regulated value into their self-concept. Behaviors engaged in because of integrated regulation may appear similarly to intrinsically motivated behaviors, but are still deemed externally regulated because the actions are not performed for their inherent enjoyment.

Research has clearly demonstrated adverse effects of external reward contingencies on behavior and self-reported enjoyment of activities. Garbarino (1975) assigned a group of sixth grade girls into either a reward for teaching condition (extrinsic motivation), in which the girls received movie tickets for successfully teaching a sorting game to younger partners; or a no-reward condition (intrinsic motivation), in which the incentives for teaching were not mentioned. The extrinsically motivated “teachers” assigned to the reward condition gave more criticism, made greater demands of their pupils, and were less efficient with their teaching time than teachers in the no-reward condition. Garbarino suggests that the negative effects of extrinsic motivational orientation were particularly noticeable in this study because they contrasted with
the control condition participants’ “natural intrinsic motivation” to interact with their peers. On the other hand, control participants’ more socially appropriate behaviors were motivated by internal rewards stemming from the sense of relatedness they gained by interacting with their peers in the teaching paradigm.

However, SDT on the whole does not suggest that extrinsic motivation is always a poor method for regulating behavior; rather, extrinsically regulated behaviors may require more contextual elements to line up for an individual to continually engage in an extrinsically motivated behavior. Organismic Integration Theory (OIT), a sub-theory of SDT, explains how contextual factors affect internalization and integration of external regulators leading individuals to engage in specifically targeted behaviors (Ryan & Deci, 2000). Competence plays a large role, limiting the amount of internalization possible for certain behaviors. Individuals will only fully internalize behaviors when they are developmentally ready to understand the processes by which they could potentially master the task (Vallerand, 1997). OIT also suggests that the fundamental need of relatedness may promote an individual’s internalization of extrinsic regulators (Deci & Ryan, 1985). When others with whom an individual identifies value an extrinsically regulated behavior, the individual may reduce the amount of value they place on external rewards, internalizing behavioral outcomes more deeply because of the value the individual places on feeling related to the other individuals, leading the individual to continually engage in the externally regulated behavior (Ryan, Stiller, & Lynch, 1994).

Ryan and Connell (1989) designed a series of studies using 3rd through 6th grade school children to investigate how perceived locus of causality (PLOC), a related phenomenon, affects children’s self-reported experiences and performance outcomes during a variety of educational tasks. The researchers asked children to rate several given reasons for why they performed
certain behaviors on a four-point Likert scale. Analysis of the student’s responses revealed four hierarchical categories of PLOC: external regulation (rule following and avoidance of punishment), introjection (avoidance of disapproval and self-approval), identification (self-valued goal and personal importance), and intrinsic motivation (enjoyment and fun). In a second study, Ryan and Connell calculated the students’ levels of PLOC using measures of interest that included questionnaires assessing intrinsic/extrinsic motivation and perceived control/autonomy and collected ratings of motivation from the participating students’ parents and teachers. This research confirmed and extended the above findings applying the PLOC model to a range of school settings (urban-suburban-rural), and grades (3-6). Their findings show that parents and teachers rated children who believed that achievement-related behaviors were the result of internal characteristics as more motivated. In a third study, Ryan and Connell’s investigated specific relationships between self-reported experiences of coping, anxiety, effort, and enjoyment, and the ordered PLOC categories. Students who reported introjected motivations for behavior coped poorly with failure and reported feeling high levels of anxiety while expending large amounts of effort on given tasks. Surprisingly, students who reported feeling relatively autonomous (identified and intrinsic PLOC categories) reported expending more effort than introjected motivation students; however, they associated their expenditure of effort with more positive coping styles in failure situation and reported increased interest and enjoyment of school.

Ryan and Connell’s (1989) research supports OIT, suggesting that one’s interpretation of their motivation for performing certain behaviors is deeply personal experience. In each of the above studies, student’s reports had little to do with the behavior being performed; rather, the
same behaviors elicited different perceived loci of causality based on the student’s belief in their own autonomy.

**Intrinsic motivation.** Intrinsic motivation, the second motivational orientation described in SDT, explains self-authored behaviors, which need no external reward contingency to motivate individuals to continually engage the given tasks. Intrinsic motivation drives individuals to seek out challenges, learn new information, and develop and expanded their capabilities because of inherent interest or reward (Ryan & Deci, 2000).

Intrinsic motivation influences behavior by way of individuals’ perception of their competence and autonomy (Deci & Ryan, 1985; Ryan, 1995). For the positive benefits of intrinsic motivation to occur, the individual must perceive their behavior as self-determined. Cognitive Evaluation Theory (CET), another sub-theory of SDT, suggests that contexts which enhance individual’s feelings of competence, such as situations that provide immediate positive feedback on task engagement, facilitate intrinsic motivation (Deci et al., 2001). CET also suggests that contextual elements including tangible rewards, threats, deadlines, directives, and imposed goals diminish the positive effects of intrinsic motivation by reducing the individual’s feelings of competence and autonomy (Markman, Maddox, & Baldwin, 2005; Ryan, Mims, & Koestner, 1983; Sansone, Sachau, & Weir, 1989).

Deci’s (1975) original definition of intrinsic motivation established that individuals are internally driven to be self-determining while having a meaningful impact on their environment. Using this definition, Benware and Deci (1984) hypothesized that when students studied information that they could use to complete a teaching task, the students’ learning processes would be motivated intrinsically as studying would not only enhance the students’ perceptions of their ability to be autonomous, but would also provide students with an opportunity to have a
meaningful impact on their learning environment. Alternately, the researchers hypothesized that students who studied materials in order to prepare for a test would experience a feeling a relative powerlessness over their environment, resulting in a decrease in their perceived autonomy, leading the students to take a more passive orientation towards their studying. Benware and Deci suggested that intrinsic motivation would lead to increases in study quantity (as evidenced by increased amounts of study time) and study quality (as evidenced by students’ test scores and reported enjoyment of the task). The researchers hypothesized that passive learners would choose to study for less time and would only attend to memorization of facts rather than actively seeking to interpret and integrate the information with any prior knowledge.

To test their hypotheses, Benware and Deci (1984) gave college-aged participants an article to study over a holiday break. Participants in the control condition were told that they should study in preparation for an exam that they would take when they returned to the lab. Participants in the experimental condition were told that upon returning to the lab, they would be teaching the contents of the article to another student, who would then take an exam based on the article. Upon returning to the lab all participants completed a series of questionnaires. A motivation questionnaire measured participants’ interest in the study material, enjoyment of the experimental experience, and willingness to volunteer for future experiments. An activity/passivity questionnaire asked participants to rate how engaged they felt in previous “real life” classroom experiences in which they learned in order to teach information and in situations where they learned in order to prepare for a test. Participants’ learning of the information contained in the article was assessed using an examination that included a variety of question formats and assessed rote memory for facts from the studied text and conceptual understanding of the studied information.
This results of this experiment yielded several important conclusions. First, the manipulation of activity level between groups of participants was successful; participants in the teaching expectancy group rated their engagement in their current task at significantly higher than participants in the test-expectant group. Additionally, active learners expressed more interest in the material, more enjoyment of the experiment and more willingness to volunteer additional time for the research. The task manipulation also had a significant effect on participants’ responses to the “real life” experience questionnaire. Teaching-expectant participants reported that the task of learning in order to teach was significantly more engaging than learning in order to prepare for an examination. Alternately, test-expectant participants did not report perceiving any difference in level of engagement for the two activities, suggesting that students needed to have recent experience with active learning activities to be able to recognize the relative passivity of traditional examination-based learning.

Clearly, educational psychologists have devoted much time and effort to researching ways in which intrinsic and extrinsic motivation affect learning behaviors in a classroom setting. SDT suggests that studying in preparation for a future test will promote external motivational orientations because the majority of potential rewards are externally supplied and are contingent on performance on the test (Benware & Deci, 1984). Passive learning strategies can be observed on college campuses across the country; exam grades and GPA points extrinsically motivate students who “study to the test,” especially when subject material has little perceived practical relevance for the student. At the undergraduate level, course assignments often do not promote students’ perception of their autonomy. Rather than encouraging students’ engagement by highlighting the usefulness of studying subject material, many assignments’ only apparent purpose is their application to a later test.
Alternately, studying in preparation for future teaching activities may provide unique opportunities for increasing student engagement in learning activities. Activities involving teaching may bolster feelings of all three fundamental psychological needs thereby promoting intrinsic motivational orientation. Preparing to teach involves anticipating future social interaction, during which an individual may fulfill their need for relatedness. Preparing for and willingly participating in teaching activities may also increase individuals’ perceived autonomy given they are able to map out and plan current study strategies and future teaching activities. When successful, interacting with peers during a teaching activity has the potential to increase individuals’ perceived competence for both the teaching task itself and social interactions with peers.

Other studies into the effects of teaching expectancy have failed to find any positive effects on learning. Hiller, Deichmann, & Pirkle (1973) investigated whether teaching expectancy could be used as an incentive for “meaningful” learning but found no differences in teaching expectancy and test expectancy conditions. In two experiments, participants were told to study a short lecture to a in preparation for either taking a test on the lesson or teaching the lesson to another student. In both studies, expectancy to teach did not affect learning outcomes. Hiller et al. suggested that while teaching expectancy did not increase learning incentive beyond a threshold that would affect learning, the amount of time students would devote to study might be affected and should be investigated in future research.

Renkl (1995) investigated proposed that researchers’ inconclusive results were the result of their failure to fully examine both positive and negative meditational links between teaching expectancy and learning results. Participants in this research learned from worked probability calculus examples. In the teaching-demand condition, participants were told that they would
have to explain the material to a novice student while control-group participants were told that they would take a test on the demonstrated calculus techniques. The results confirmed that teaching expectancy had a dual effect on learning; teaching expectancy decreased the superficiality of studying, and also decreased intrinsic motivation and increased participant’s performance anxiety.

It is concerning that there has yet to be a satisfactory explanation for the conflicting findings among SDT experimental literature. One primary shortcoming of this vein of research may lie in the operational definition of intrinsic motivation. It is difficult to identify a single operational definition for intrinsic motivation. Deci’s (1975) definition of intrinsic motivation suggested that intrinsic motivation stems from an individual’s feelings of self-determination. Later, noting that the original definition did not fully capture the processes involved in intrinsic motivation, Ryan (1995) revised the definition to the version accepted today, where intrinsic motivation relates to three psychological needs (competence, relatedness, and autonomy). In a later collaboration, Ryan and Deci (2000) suggest that intrinsic motivation is a “fully natural” inclination, supporting their new definition using Csikszentmihalyi’s (1975) flow theory. While many components of flow experiences may seem similar to concept of intrinsic motivation, much of flow theory directly conflicts with Ryan and Deci’s supposition. Flow theory explains motivation in terms of the impact on an individual’s ongoing stream of consciousness during an activity rather than any innate interests; intrinsic motivation results from an individual’s interaction with an environment in a fulfilling way (Csikszentmihalyi & Rathunde, 1993). In this way, flow experiences are better qualified as sources of emergent motivation than innate motivation.
Flow theory defines intrinsic motivation as a state rather than as an innate, enduring trait. This explanation is more applicable to real life situations as it explains how and why some behaviors that are “intrinsically motivated” persist, yet others cease by accounting for the interaction of boredom, anxiety, and apathy during a task experience. When presented challenges and personal skills are balanced and above average, one’s intrinsic drive to demonstrate competence often leads to an experience of flow. During such an experience the person feels fully autonomous and capable of performing the task at hand, the behavior becomes autotelic – worth performing for its own sake. Once this has occurred, the experience itself becomes a strong motivational drive for the individual to continually take on and master more difficult tasks in order to maintain the intrinsically rewarding balance between challenge and skill. This drive may also be quickly extinguished when tasks become too difficult or too easy and no longer provide the individual with the sought-after sense of autonomy and competence. It is clear that in terms of flow theory, intrinsic motivation is not driven by any combination of innate interests; rather intrinsic motivation is self-propelled by an equitable presence of skills and challenges during the pursuit of a goal.

Given the lack of a consensus on a definition of intrinsic motivation, it is not surprising that the variety of measures and conceptualizations of intrinsic motivation yield highly inconsistent results. Without refining operational definitions and experimental procedures, it is premature to conclude research into the role of intrinsic motivation in the teaching expectancy paradigm.

The failure of self-determination theorists’ research to yield consistent results may also be the consequence of somewhat one-sided experimental designs. Typical SDT research manipulates contextual variables and observes any effects on thoughts/emotions and behavioral
manifestations that result from proposed internal changes. These experiments primarily measure changes in thoughts and emotions using self-report measures and occasionally collect anecdotal behavior data to support their conclusions. This experimental design provides significant information that can be used to guide our understanding of motivational factors effects on learning, but does not provide an adequate model for fully investigating all of the processes and interactions that are simultaneously involved in learning.

**Cognition**

While self-determinist experiments on the effects of teaching expectancy often incorporate memory tests, evaluating the results of these tests, they largely ignore cognitive processes responsible for encoding, storing, and retrieving the information; stubbornly focusing direct effects of motivational orientation on learning. Alternately, cognitive research attempts to explain the effects of teaching expectancy by focusing on cognitive and metacognitive processes that may affect learning strategies and outcomes. In cognitive research, observation of changes in behavior serve as observable indicators of underlying internal processes which must be systematically investigated.

Bargh and Schul (1980) noted that despite the popular opinion that teaching is an excellent method of learning, there was very little systematic investigation of why these gains occur. They hypothesized that participants assigned to be teachers would perform better on later recall tasks and suggested that these gains could be attributed to either content-specific or generalized learning gains. Content-specific gains would indicate that the teachers developed stronger memory traces for the learned information, making the information more easily accessible in memory. Such gains would be observable in the participants’ organization and elaboration of specific subject matter. Alternately, generalized learning gains would suggest that
the teachers benefitted from “learning-to-learn,” developing greater mastery of specific content, while also increasing their learning capabilities. Generalized learning gains would be evident if the teachers were better able to learn related materials more quickly and easily.

Bargh and Schul’s (1980) study demonstrated several undeniably cognitive effects of teaching expectancy occurring during the preparation stage of the teaching process. Even without having actually taught, participants in the teaching expectancy condition showed content-specific gains, performing significantly better on detail and conceptual response questions than participants who learned with the goal of taking a test. These results suggest that there are qualitative differences in the way that “teachers” studied the experimental passage. Bargh and Schul suggested that selection of different study strategies resulted in the teachers developing a more organized cognitive structure to contain the contents of the passage.

Research on the cognitive benefits of reciprocal peer tutoring (RPT), which inevitably involves teaching, has also contributed important information about the interplay of cognition and teaching expectancy. Studying and preparing for RPT is procedurally and conceptually similar to preparing for unidirectional teaching episodes. Data from RPT research demonstrates that the interaction of tutors and tutees shapes learning (Roscoe & Chi, 2007). However, while several individual studies have shown strong tutor learning affects, the overall magnitude of the tutor learning gains is low. Most research in this field is focused on tutor/tutee learning outcomes, but very little RPT research has examined tutors behaviors during initial studying and preparation for tutoring, resulting in a volume of literature describing effective tutoring interventions, with little-to-no information about how and why interventions contributed to the tutors learning. Without understanding the mental processes underlying evidenced learning gains, further research into tutor intervention strategies may provide only a partial understanding.
Research combining quantitative measures of learning as well as qualitative data on learning processes is critical for determining what leads to tutors’ achievements and resolving the inconsistent findings of RPT research.

**Metacognition**

Alongside emerging cognitive research, educational and developmental psychologists have also investigated how learners’ knowledge about cognition and cognitive phenomena affect the way they monitor their memory and comprehension for materials. Cognitive psychologist John Flavell first coined the term “metacognition” and proposed a model in which the interactions of four phenomena: metacognitive knowledge, metacognitive experiences, goals (tasks), and actions (strategies) can be involved in ongoing monitoring of cognitive functioning affecting several learning processes including comprehension, memory, problem-solving, self-control, and self-instruction (Flavell, 1979). Since Flavell’s original definition, metacognitive researchers have refined the definition of metacognition and expanded it to include several well-researched subcomponents. Today, it is generally accepted that metacognition involves three major components: metacognitive knowledge, metamemory processes, and metacognitive control/regulation (Pintrich, Wolters, & Baxter, 2000).

The first component of metacognition, metacognitive knowledge, includes individuals’ knowledge of declarative, procedural, and conditional variables that influence cognitive processing of information (Pintrich et al., 2000). Possessing high amounts of declarative metacognitive knowledge, knowledge about one’s personal learning styles, enables a person to use what they know about learning situations and cognitive strategies to achieve better learning outcomes (Garner, 1987; Winn, 1997). For example, a learner with a large amount of declarative metacognitive knowledge will be able to recognize that reading and comprehending a technical
article will take longer than reading a short story of the same length and will allocate appropriate amounts of time to each task. Procedural metacognitive knowledge, working knowledge about how to enact cognitive strategies, helps individuals better select appropriate strategies and tactics for problem solving and appropriately sequence their selected cognitive strategies (Schraw & Moshman, 1995; Winne, 2010). Lastly, conditional metacognitive knowledge includes information about the situational appropriateness of particular cognitive strategies (Pintrich et al., 2000). Conditional knowledge is continually developed through childhood and adulthood as learners collect information about the utility of various cognitive strategies (Miller, 1985).

Metamemory processes, the second component of metacognition, are active processes, reflecting ongoing metacognitive monitoring and metacognitive judgments that individuals engage in while performing learning tasks (Pintrich et al., 2000). Nelson and Naren’s (1990) metamemory framework includes four primary metamemory processes: ease of learning judgments (EOL), judgments of learning (JOL), feelings of knowing (FOK), and confidence judgments. EOL judgments combine information from the learner’s definition of the current task and the learner’s declarative, procedural and conditional metacognitive knowledge to make decisions about the relative ease or difficulty of the task at hand to determine their preparedness for the task. These judgments can be made before a task begins as well as during the task itself. JOLs are made when learners ask themselves questions in order to monitor their reading comprehension and memory for information; learners use their ability to answer the self-generated questions to make predictions about whether the learner knows information well enough to quit studying a given text (Pressley, Snyder, Levin, Murray, & Ghatala, 1987). JOLs are often made on an ongoing basis during a learning task. FOK judgments, often experienced by learners as “tip of the tongue” memory loss, arise when learners fail to recall a piece of
information but still strongly feel that they know the information. FOK judgments force the learner to make a decision as to whether or not they will be able to remember the currently non-recallable information on a subsequent memory test (Koriat, 1993). Lastly, confidence judgments involve learners’ retrospective judgments of the correctness of a given response (Pressley, Ghatala, Wooshyn, & Pirie, 1990). Consciously utilizing and monitoring appropriately selected metamemory processes quickly results in fine-tuning of metamemory skills (Nelson & Narens, 1990; Winne, 1997). It is important to note that EOL, JOL, and FOK are not necessarily correlated, learners may selectively engage in one metamemory process, but not others suggesting that these three kinds of judgments monitor somewhat different aspects of memory and learning (Leonesio & Nelson, 1990).

**Self-Regulated Learning**

The final element of Pintrich et al.’s (2000) model of metacognition is comprised of regulatory activities that individuals use to (1) pre-plan strategies for a task and (2) adapt behavior during a task (Schunk & Zimmerman, 1994). When engaging self-regulated learning processes, learners draw information from metacognitive knowledge during planning phases and from ongoing metamemory processes during task activity to attain each of their hierarchically organized task goals. Self-regulatory learning (SRL) behaviors include planning for learning, learning strategy selection and use, allocation of mental and situational resources, and volitional control of motivation and emotion.

Winne and Hadwin’s (1998) COPES model of metacognitive monitoring and control in four stages of studying tasks (4-phase model) identifies facets of a learning task that learners “cope” with while studying and learning. This model of self-regulated learning explains how both motivation and learning goals affect cognitive and metacognitive processes involved in
learning. Winne and Hadwin suggest that this model is particularly useful in the context of studying because studying involves a uniquely self-regulated environment, setting learners up to engage in metacognitively-driven, goal-directed cognitive and motivational processes in order to complete studying tasks. Individuals are not born “programmed” to use applicable cognitive strategies for every task, rather, over a period of time learners develop a set of heuristics from which they select what they deem to be appropriate tactics and strategies for specific learning contexts. Thus, this model also explains how learners’ “best” judgments about study techniques may still lead them to select inadequate strategies.

The 4-phase model for studying tasks includes lists of conditions, operations, products, evaluations, and standards that may be involved in each of four phases of learning. During phase one, learner begins charting their current “study space,” defining the current task as a set of cognitive and task conditions to which they need to attend (Winne, Jamieson-Noel, & Muis, 2001). Task conditions may include given directions, time constraints, testing conditions, or defined expectations. Cognitive conditions are defined using information the student retrieves from long-term memory including prior knowledge about similar tasks, memories of past experiences (ex. self-efficacy and topic interest), and memories about the utility of tactics and strategies previously used for similar tasks (Winne, 1997). Other factors such as task ambiguity and varying levels of familiarity with studied information may affect how learners define the task at hand (Winne & Hadwin 1998). Given the highly individualized nature of the defining tasks, learners often vary in their perception of what a particular task entails even in identical situations.

Having defined the conditions for the current task, the learner enters into the second phase of learning. During the second phase, the learner develops a set of goals that serve as
standards by which the learner can judge progress in the current task (Winne & Hadwin, 1998). Learners may select a single goal or they may select multiple goals that they organize hierarchically.

Once the student has prioritized their goals, they begin selecting tactics and/or strategies that can be applied to the task in order to achieve their goals. For learners to select effective tactics and strategies they must consider information about the current task, information about potentially useful tactics and strategies, and information about any metacognitive monitoring processes that will be necessary to use during the course of the activity (Boekaerts & Niemivirta, 2000). Tactics are metacognitive mechanisms that function as single condition-action (if-then) rules (Winne et al., 2001). More complex metacognitive strategies are developed over time as the learner gains experience with various tactics and scenarios in which certain tactics are most useful. Learners form strategies by combining strings of tactics to form conditional networks (if-then-else rules). During strategy selection, previously used tactics and strategies may be retrieved from long-term memory (metacognitive knowledge) or strategies can be constructed in-the-moment based on the student’s predictions for how well certain combinations of tactics and strategies will function in current task.

Should learners find themselves unable to define a plan of action for the task during phase two, they may chose to return back to phase one and attempt to re-define the task. Otherwise, learners will continue sequentially to phase three. During phase three, the learner enacts selected tactics and strategies. As the learner engages in the task multiple forms of feedback may be generated depending on the cognitive strategies and metamemory processes the student selected. Internal feedback may include EOL judgments, JOLs, and FOK judgments. These metamemory judgments provide the learner with information about the state of the task.
METACOGNITIVE BENEFITS

itself (ex. How many lines have I read?) and about their progress towards their goals (ex. Can I recite the assigned text? How much time has elapsed?). Additional external feedback from teachers and peers may provide evidence that adaptation is needed.

If the student’s inspects their progress at the end of the third phase and deems their progress unsatisfactory, they may chose to edit their study strategy plan in an optional fourth phase. In the fourth phase, learners often reconsider their goals to determine whether they will need to exert more effort to achieve their defined goals. After re-investigating their goals, the student may chose to disengage from the current strategy and search for new strategies (Boekaerts & Niemivirta, 2000). Common self-regulated learning adaptations include editing a strategies by adding or deleting tactics, tuning conditional knowledge triggers for tactics and strategies to improve how tactics are articulated within strategies, restructuring task definitions, goals, and/or plans for the and selecting new tactics and strategies, devoting additional energy to planned strategies, implementing self-handicapping behaviors, or abandoning the task altogether (Winne, 1997; Winne & Hadwin, 1998).

Winne and Hadwin’s (1998) 4-phase model of metacognitive monitoring and control is a recursive system; the products of earlier stages update the conditions on which metacognitive processes operate during the next phase of the model. The model is weakly sequenced, meaning that while learners usually proceed through phases one through four sequentially, variables such as familiarity with a task or task definition may lead learners to skip phases or cycle through previously completed phases multiple times (Boekaerts & Niemivirta, 2000; Winne, 1998). See Appendix 1 for a narrative application of the sequenced nature of the Winne & Hadwin’s 4-phase model and Figure 5 for a diagram of the applied 4-phase model.
The final element in SRL that may play a role in explaining why teaching-expectant learners select different study strategies is calibration. Calibration of study strategy reports is an important topic for research, as the effects of poor calibration during any single task may extend well beyond the immediate task. Research has shown that when students do not receive instructions on strategies to use for study, they will inherently try to “bootstrap” their own forms of SRL, using their previous experience with tasks to select what they believe will be effective tactics and strategies (Winne, 1997; Winne, 2010). It is likely that students who report inaccurate strategy use also have inaccurate memory for strategy use and will use these inaccurate memories to make future strategy and tactic selection decisions.

Winne and Jamieson-Noel (2002) defined calibration as the match between self-reported study behaviors and observed study behaviors. Their research looked into students’ calibration of reported study tactics as well as calibration of student’s confidence in their achievement on a learning task. The researchers used a software program that recorded behavioral patterns habits while students studying a given text. The creation of software tools that allow for trace data to be collected simultaneously during studying has allowed researchers to begin more accurately investigating and explaining the processes that learners use to select and enact tactics and strategies. Winne and Jamieson-Noel found that students’ calibration of reported strategy and tactic use was extremely poor, as indicated by extreme discrepancies between traces collected the software program and students’ self-reported responses on a learning strategies questionnaire. However, the research found that not all self-reports were poorly calibrated; students were able to calibrate their confidence for achievement correctly to their actual achievement on a learning test.
Howard-Rose & Winne (1993) noted differences in accuracy or calibration of learners’ self-reported use of tactics and strategies related to conceptual differences in unit grain size. Strategies are much more complex than tactics; they add large amounts of information to the learning scene and have the potential to produce much more feedback than tactics.

Winne and Hadwin’s (1998) model allows for incorporation of the effects of teaching expectancy’s interaction with motivational and emotional factors to form a well-structured model of cognitive and metacognitive learning processes. SRL theory is unique in that it explains cognitive processes and products with regards to learner’s individualized definition and selection processes emphasizing that even when these processes appear automatically regulated, they are very much deliberately defined (Pintrich, 2004). Using Winne and Hadwin’s SRL model structure it is possible to investigate how teaching expectancy is affected by emotional pressure (ex. anxiety) and motivational orientation resulting in changes in ongoing cognitive functioning and metacognitive processing during studying tasks (Winne et al., 2001; Nelson & Narens, 1990; Pintrich et al., 2000).

As previously mentioned, learners develop heuristic learning strategies as they gain experience with educational tasks. While these heuristics may decrease the amount of effort required during phase two of the four-phase model, they may lead learners to select inappropriate strategies. Chase, Chin, Oppezzo, and Schwartz (2009) found that students who were preparing to take a test spent less time working on learning tasks (reading, outlining concept maps, developing quiz questions) than students who were studying in order to teach and artificial intelligence teachable agent. Students who studied in preparation for familiar testing situations believed that they would be able to learn and perform adequately on the test without spending additional time and effort engaging in multiple study methods and metacognitive monitoring
because of their confidence in their ability to “work through” the kind of questions that might be given on a test. Chase et al. (2009) found that, compared to students preparing for a test, students who prepared to teach a teachable agent were more motivated to spend additional time working on concept maps for their teachable agents, resulting in the students making meaningful improvements in the concept maps and performing significantly better on subsequent tests.

Csikszentmihalyi’s flow theory conceptualization of intrinsic motivation best applies to Winne and Hadwin’s four-phase model to explain how motivation interacts with cognition, driving individuals to develop more complex and effective behaviors. Cognitive monitoring, which is essential for skill development, is promoted by the learner’s intrinsic motivation in situations where the learner feels challenged, but capable of performing the task at hand. The learner will elect to monitor and practice skills with careful attention until they have perfected the skill to a degree that it can be performed without conscious monitoring. Persisting intrinsic motivation prompts the learner to add higher levels of cognitive monitoring to existing strategies for use in similar, but necessarily more difficult future tasks. Even incremental progress in skill development gives the learner brief tastes of the internal rewards that they can gain from persistence at their task. In this way, intrinsic motivation is truly self-propelling as it increases not only persistence, but encourages more effective use of cognitive and metacognitive processing skills.

Individuals who have little experience with teaching or with the subject matter at hand most likely have not developed heuristic tactics and strategies for the task at hand and may not perceive the activity of preparing to teach as one that will produce feelings of competence or autonomy. In these cases, while intrinsic motivation will not be immediately evidenced, the novelty of the task may still lead the student to selectively engage in metacognitive monitoring.
In such a situation, effective use of metacognitive monitoring and or correctly guessing useful tactics and strategies may allow for the individual to begin to perceive themselves as more competent at the task at hand. Learners who experience this “glimpse” of their psychological needs being fulfilled will possess and increased drive to continue improving at the task and will continually engage in metacognitive monitoring. These learners are more likely to notice when tactics and strategies are ineffective and take appropriate corrective action.

The combination of the four-phase model structure and Csiksentmihayli’s (1975) flow theory predicts what will happen when the learner’s selected tactics and strategies immediately fail (Csikszentmihalyi & Rathunde, 1993). In this situation, the learner will not have a chance to develop any intrinsic motivation for the task increasing the chance that (in phase 4) the individual will employ protective self-handicapping strategies (such as making poor metacognitive judgments or eliminating metacognitive monitoring) or abandon the task all together.

The Current Study

The current study addressed a number of hypotheses regarding the effects motivational orientation, cognitive processing, and metacognitive monitoring, on study strategy selection and learning assessment performance. The foundation of this research was that task condition would affect ease of learning judgments (EOL) made during phase one Winne and Hadwin’s (1998) COPES model of studying tasks, in turn affecting participants’ (1) selection of appropriate study tactics and strategies, and (2) monitoring of selected study tactics and strategies.

By the time students reach college; they typically have had many experiences studying in preparation for tests. Experienced test-takers are more likely to select pre-formed heuristic study strategies rather than evaluating potential alternatives. When learners define their studying task
using a familiar test preparation goal may become overconfident in their selected tactics and strategies, making them less likely to select to engage in metacognitive monitoring and less likely to notice and revise their strategies in response to learning shortcomings.

The hypothesis of the current research was that participants who studied with an expectation to later take a test would allocate less effort to the task and select less effective tactics and cognitive and metacognitive strategies (during phase 2 of SRL) based on their existing heuristic learning strategies and declarative metacognitive knowledge. This research also predicted that the test-expectant learners’ lower levels of metacognitive monitoring would lead them to make less accurate self-reported reflections of study behaviors.

Learners who are familiar with tasks involving preparing to teach may also select heuristic study strategies; however, these strategies are more likely to include engaging in ongoing metacognitive monitoring. Commonly used heuristics in preparing for teaching reduce overconfidence during studying as learners cannot rely on their ability to “figure out” problems placed in front of them; rather, they must think about how their student will receive and retain the material. Alternately, learners who have little experience with studying in preparation for teaching will not be able to rely on heuristic study strategies. It was expected that the novelty of the teaching expectancy task should lead these learners to engage in higher levels of metacognitive monitoring including ongoing judgments of learning (JOL) and engagement in regular confidence judgments.

The current research proposed that including a teaching directive in task instructions would lead learners to demonstrate several observable changes during phase 2 (goal setting, tactic/strategy selection and enactment) and phase 4 (adaptation of strategy selection). It was hypothesized that learners who studied in preparation for a teaching task would select and
engage a greater variety of types of metacognitive monitoring and cognitive study strategies at higher frequencies than learners preparing to take a test and predicted that the teaching-expectant learners’ higher levels of metacognitive monitoring would lead them to make more accurate self-reported reflections of study behaviors.

This research also investigated the effect of motivational orientation on study strategy selection and learning outcome assessment performance. The current research proposed that in the teaching expectancy paradigm, motivational orientations would function as a secondary set of processes that interacted with the primary cognitive and metacognitive processes to either enhance or hinder learner’s effort and persistence at studying.

The majority of college students are not intimately familiar with preparing for teaching tasks. Based on Csikszentmihalyi and Rathunde’s (1993) conceptualization of intrinsic motivation the current research predicted that the unfamiliar task of teaching would not promote intrinsic motivation, as it was unlikely that students would have sufficiently high self-efficacy beliefs for teaching tasks to balance out the challenging nature of the task and fully create a flow experience.

The inclusion of a teaching directive was expected to affect learners’ reactions to selected tactic/strategy failure. While both teaching-expectant and test-expectant learners were expected to find themselves faced with an increase in arousal from failure (confidence judgments), test-expectant learners were expected to be less likely to interpret this failure as an indication of their later performance ability, as they may be heavily reliant on overconfidence. Alternately, teaching-expectant learners who are engaging in regular metacognitive monitoring were expected to be more likely to interpret confidence judgment failure as an early warning signal that closer monitoring of learning is needed (Boekaerts & Niemivirta, 2000).
The current research also hypothesized that interpretations of failure during confidence judgments would lead teaching-expectant participants to increase their task-relevant monitoring while reflecting on the source of their difficulty. These participants were expected to be more likely to identify and adjust their study pacing to allow the amount of effort needed to successfully complete the current task (phase 4).

Method

Participants

Participants were 82 undergraduate students in introductory psychology classes who completed the experiment in exchange for one-hour worth of course credit. The sample included 40 men and 37 women ranging in age from 17 to 22 years ($M = 18.79$). Due to participant error on the short-answer and multiple-choice learning assessments, data for 21 participants was lost (for those measures only). Analyses of these learning assessments include 61 participants. Further participant demographic information can be found in Table 1.

Materials

Participant learning material. Participants studied expository text and images about the anatomy and function of the human ear. Text and images were adapted from Kalat’s (2013) Biological Psychology and an auxiliary study guide for an earlier edition of the textbook (Hull, 2007). Concepts from the textbook and study guide were reduced to basic definitions, concepts, and examples. The resulting text, including titles, was 55 sentences in length (894 words). The 18-paragraph excerpt was organized into 4 topics that were presented with descriptive headings (Appendix A.1). Readability was assessed using Microsoft Word, indicating a Flesch Reading Ease score of 47.9 and a Flesch-Kincaid Grade Level score of 10.7.

The domain of the text covered the structure and function of the human ear. Prior studies on tutor learning and test expectancy used physiology domains (Roscoe, 2007) so this choice
allowed for comparability between research projects. The text described tone and pitch perception via the outer ear, middle ear, inner ear, and related structures, and gave a basic description of pitch perception. The text also included a basic explanation of the causes and consequences of conductive deafness and nerve deafness, two major categories of hearing impairments. The information in the text included both familiar, everyday topics (basic ear structures) and unfamiliar, technical concepts (translation of frequency into pitch and hearing impairments). All participants viewed a labeled cross-section diagram of the ear (Appendix A.2).

Learning assessments. Learning was assessed using two written measures. The Labeling Test (Appendix A.3) asked participants to label a blank human ear diagram. There were 10 targets on the ear cross-section diagram. The Labeling Test measured participants’ recall of factual information about the ear, representative of participants’ conceptually shallow learning.

The second learning assessment was a question-based test (Appendix A.4). This assessment asked participants to answer a set of question as completely and accurately as possible. The first 5 items on the Questions Test were multiple choice and fill-in the blank items. The remaining 6 short-answer items on the Questions Test required both recall and application of studied material. For example, one question asked participants to explain the circumstances that would change the limit of frequencies that an individual could hear. To answer correctly, participants needed to (a) identify that the given frequency was within the normal range of human hearing, (b) recall information about natural degradation in hearing range, and (c) recall information about unnatural causes of hearing impairment and (d) apply appropriate answers to the given context. Factual memorization questions assessed participant’s rote learning, novel, conceptually oriented questions provide a measure of participants’ deeper learning.
nStudy. nStudy (Winne & Hadwin, 2009) is a web-based Internet application for personal learning. In nStudy, participants were in control of how active or passive they wished to be in their learning processes. nStudy allowed participants to create several types of learning objects including bookmarks, tags, definitions, “snip” notes, elaborative notes, goal notes, reflections, term nets, and concept maps.

nStudy was particularly valuable for this research because it simultaneously monitored participants’ actions, creating an output log of learners’ interactions with the information in the learning space. nStudy software logged the time and type of two main types of learning events: model events and view events. Model events were logged when participants created, modified, deleted, or linked objects on the website or objects within the nStudy side window. View events were logged when participants clicked on items or navigated between webpages and sections of the website. nStudy logged the type of information involved (ex. which button was pressed), the containment window of the component, and the learning object that was captured in the view event (ex. content of an opened/edited note). nStudy logs were output as .XML files, allowing for analyses of events’ occurrence, frequency, sequence, and pattern (indicating strategies). The amount of detail included in the output files also allowed for content analyses of participants’ learning activities.

Metacognitive Strategies for Learning Questionnaire. Participants’ motivational orientation and perceived use of metacognitive strategies was assessed using the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich, Smith, Garcia, & McKeachie, 1991).

Pintrich and DeGroot (1990) noted that while self-regulated learning certainly plays a role in student learning outcomes, learners’ perceptions of the classroom, the current task, and their self-efficacy also play a large role in cognitive engagement and classroom performance.
The MSLQ conceptualizes motivation as a dynamic construct that is highly individualized and situationally oriented (Duncan & McKeachie, 2005).

The MSLQ consists of two sections. The motivation section consists of 31 items that assess participants’ goals and value beliefs for a course. The motivation section is comprised of six scales: intrinsic goal orientation, extrinsic goal orientation, task value, control of learning beliefs, self-efficacy for learning and performance, and test anxiety. The learning strategies section consists of 31 items regarding participants’ use of metacognitive strategies and yields scales for rehearsal, elaboration, organization, critical thinking, and metacognitive self-regulation. The learning strategies section includes 19 items concerning participants’ management of various learning resources yielding scales for time and study environment management, effort regulation, peer learning and help seeking behaviors.

The MSLQ is a modular measure that can easily be used to fit a variety of research needs; because the peer learning, help seeking and time and study environment scales were irrelevant to the current study and were not used. Several researchers have argued that student interest and motivation are task specific (Pajares, 1996; Roscoe, 2007; Schiefele, Krapp, & Winteler, 1992). For the purpose of this study, items have been reworded to reflect participants’ current learning task. The final version of the MSLQ used in this study included 66 items, yielding scores for 13 scales (Appendix A.8). Each item on the MSLQ is one sentence in length. The MSLQ asks participants to read each sentence carefully and respond as honestly as possible by rating their agreement using a 7-point Likert scale.

**Conditions and Procedure**

Participants accessed all study related activities via an online server. Participants completed the experiment in a single session, lasting approximately 1 hour. At the beginning of
the study, participants were randomly assigned to one of two conditions: teaching expectancy or testing expectancy. In order to limit the opportunity for participants to begin planning and selecting strategies prior to the beginning of the experimental observation, all participants received identical instructions until after watching a video familiarizing them with the nStudy software. Teaching expectancy participants were told that after studying the materials they would teach the information that they have just learned to a peer via webcam, who would then be tested on the material. Testing expectancy participants were told that after studying the materials they would be tested on the information they had just studied. Both groups were informed that the final test would require both rote memory and conceptual understanding of the materials included in the study program. All participants were instructed to use whichever study tools that most closely resemble strategies and processes that they would routinely use when preparing for the given task. Participants were then given 25 minutes to study the text and diagrams using the nStudy software. After the conclusion of the study period, teaching expectancy participants were told that their student has not shown up and that instead, they would be taking the final test. All participants then completed the Labeling and Questions Test. After completing the learning assessments, participants completed the MSLQ and filled out a demographic questionnaire that asked them to report demographic information (age, and gender) and academic information (GPA and academic major/minor). The demographic questionnaire also asked participants about their prior experiences with teaching in a formal classroom setting, peer tutoring, and informal peer tutoring. All participants were thanked for their time and fully debriefed.
Results

Analysis of Trace Data and Content

Between-groups differences in study strategy use was analyzed in a 2 factor (expectancy condition) multivariate analysis of variance (MANOVA). Using Wilk’s statistic, there was a significant effect of teaching expectancy on the study behaviors of participants, $\lambda = .83$, $F(5, 71) = 3.04$, $p = .02$, $\eta^2 = 0.18$. Follow-up univariate analyses on study behaviors revealed a non-significant effect of teaching expectancy on the number of quotes used by participants, $F(1,75) = 2.58$, $p = .13$, $\eta^2 = 0.03$, and significant effects of teaching expectancy on the number of terms used by participants, $F(1,75) = 5.28$, $p = .02$, $\eta^2 = 0.07$, on the number of notes made, $F(1,75) = 10.65$, $p = .002$, $\eta^2 = 0.12$, and on the amount of organization within the note structures, $F(1,75) = 5.96$, $p = .02$, $\eta^2 = 0.07$ (Figure 1). This model also revealed a significant effect of teaching expectancy on the total amount of time participants spent studying $F(1,75) = 8.79$, $p = .003$, $\eta^2 = 0.11$ (Figure 2).

Analysis of Learning Assessments

A one-way ANOVA showed no significant effect of teaching expectancy on participants’ performance on the labeling test, $F(1,69) = 0.24$, $p = .63$, $\eta^2 = 0.003$. Additionally, self-reported familiarity with the anatomy of the ear did not correlate with performance on the labeling test, $r(73) = -.19$, $p = .11$.

When analyzing between-groups differences in performance on the learning assessment, Type I Sums of Squares were used to account for missing data in the control condition, which created unequal sample sizes for this test. A univariate ANOVA revealed a significant effect of teaching expectancy on participants’ performance on the multiple choice test, $F(1,59) = 5.94$, $p = .02$, $\eta^2 = 0.09$ (Figure 3). Participants in the teaching expectancy condition ($M = 72.52$)
performed significantly better on the multiple-choice test than participants in the control condition ($M = 56.94$). Performance on the multiple-choice assessment was not correlated with self-reported familiarity with the anatomy of the ear, $r(57) = -.13, p = .33$, nor with self-reported familiarity with pitch perception, $r(57) = -.09, p = .49$.

The researcher and an additional rater scored short answer responses on the learning assessment. A bivariate correlation showed high inter-rater reliability, $r(59) = .998$, $p < .001$. The rater’s scores were averaged together and used in a one-way ANOVA that revealed no significant effect of teaching expectancy on conceptual short answer response accuracy $F(1,59) = .31, p = .58$. Performance on this assessment was not correlated with self-reported familiarity with the anatomy of the ear, $r(57) = -.05, p = .68$, nor with self-reported familiarity with pitch perception, $r(57) = -.08, p = .54$.

**Assessment on Self-Reported Motivation and Learning Strategy Use**

Between-groups differences in self-reported motivational orientation were analyzed in a 2 factor (expectancy condition) MANOVA. Using Wilk’s statistic, there was not a significant effect of teaching expectancy on self-reported motivational orientation or emotional experiences of participants, $\lambda = .91, F(6, 68) = 0.38, p = .38, \eta^2 = 0.09$. Follow-up univariate analyses revealed no significant differences in self-reported emotions or motivations including intrinsic goal orientation, $F(1,73) = 0.40, p = 0.53, \eta^2 = 0.005$, extrinsic goal orientation, $F(1,73) = 0.26, p = .61, \eta^2 = 0.004$, task value, $F(1,73) = 1.20, p = .28, \eta^2 = 0.02$, control of learning beliefs $F(1,73) = 3.81, p = .06, \eta^2 = 0.05$, self-efficacy for learning, $F(1,73) = 0.24, p = .63, \eta^2 = 0.003$, nor test anxiety, $F(1,73) = 0.21, p = .65, \eta^2 = 0.003$.

Between-groups differences in self-reported learning strategy usage were analyzed in a second 2 factor (expectancy condition) MANOVA. Using Wilk’s statistic, there was not a
significant effect of teaching expectancy on the participants self-reported study strategy usage, λ
= .95, F(6, 68) = 0.61, p = .72, η² = 0.05. Follow-up univariate analyses revealed no significant
differences in self-reported learning strategy use including rehearsal, F(1,73) = 0.96, p = .33, η²
= 0.01, elaboration, F(1,73) = 0.01, p = .93, η² = 0.00, organization, F(1,73) = 0.70, p = .41, η²
= 0.009, critical thinking, F(1,73) = 0.38, p = .54, η² = 0.005, metacognitive self-regulation,
F(1,73) = 0.59, p = .47, η² = 0.007, nor effort regulation, F(1,73) = 0.35, p = .55, η² = 0.005.

**Calibration of Self-Reports to Observable Behavior**

There were significant positive correlations between test-expectant participants self-
reported organizational strategy use and number of terms created, r = .52, p = .001, number of
notes created, r = .41, p = .01, and number of linkages created, r = .39, p = .02.

A linear regression model including number of quotes, terms, notes, and linkages made
by control condition participants explained a significant proportion of variance in their self-
reported organizational learning strategy use, R² = .31, F(4,32) = 3.51, p = .02. The total number
of terms created significantly predicted control condition participants’ self-reported
organizational learning strategy use, b = .42, t(33) = 2.44, p = .02 (Table 2). When replicated
using data from the teaching expectancy group, this model failed to predict any variance in self-
reported organizational strategy use (Table 3).

**Discussion**

This research examined study behaviors, self-reported motivational and emotional
factors, calibration of self-reported behaviors, and learning outcomes for teaching-expectant and
test-expectant learners. The foundational supposition of this investigation, that task condition
would affect ease of learning judgments and subsequently affect behavior on a studying task,
was supported by the results of this research.
The findings of this research supported the hypothesis that teaching-expectant participants would employ a wider variety of cognitive tools and metacognitive monitoring strategies. There was a significant difference in study behaviors of the teaching expectancy and the control groups, such that teaching-expectant participants selected and enacted a wider variety of study behaviors significantly more frequently than control group participants. This research supports Benware and Deci’s (1984) finding that teaching tasks lead to higher participant engagement during preparation than testing tasks. The results of this research also support previous research by Chase et al., (2009) finding that participants preparing to teach spent more time engaging in different study methods and developing more in depth conceptual structure maps of material than participants preparing for a test.

Teaching-expectant participants not only spent more time studying the given materials, but also engaged in higher rates of cognitive strategy usage, which confirms Bargh and Schul’s (1980) tentative supposition that teaching-expectant participants displayed more content-specific learning gains because of their development of more organized mental models of learned information. As seen in the analysis of study behaviors, teaching-expectant participants notes contained significantly more linkages than test-expectant participants notes. “Linkages” within nStudy were coded representations of hierarchical organizations within notes. Teaching-expectant participants created more notes that were more detailed and were more highly organized. See Figure 4 for an in-context example of participant usage of “linkages” in notes.

Significant differences in study behaviors can also have meaningful impacts on participants’ engagement of self-regulated learning. An interaction between cognitive and metacognitive strategy adoption may help explain the observed differing behavioral responses to task conditions. Interpreted in terms of SRL theory, it may be that as participants took notes
about terms and concepts in the learning unit, they were presented with opportunities to make judgments of learning by monitoring their reading comprehension and technical understanding of the presented material, feeling of knowing judgments about their ability to retain the information during future tasks, and confidence judgments about the correctness of the information that they have encoded while studying. Because teaching expectancy participants engaged in observable study behaviors significantly more than control participants, it is likely that they had more opportunity to benefit from these metacognitive judgments. As proposed in Winne and Hadwin’s (1998) model of SRL, engagement in active metacognitive monitoring can be seen as self-propelling leading to longer study periods and increased usage of effective cognitive study strategies.

The results of this research support the hypothesis that teaching expectancy participants would be more likely to identify and adjust study pacing, allowing more time and effort for their current task. Participants assigned the unfamiliar teaching expectancy task used a significantly greater number of combinations of cognitive tactics at significantly higher rates and studied for a significantly longer duration than participants in the familiar control condition. This is likely the result of teaching-expectant participants decreased reliance on heuristic study strategies and engagement of higher amounts of task-relevant monitoring.

Contrary to the hypothesis of this research, increased metacognitive monitoring did not lead to increases in calibration of reported study behaviors. While analyses of study traces in nStudy showed significant differences in observable study behaviors for test-expectant and teaching-expectant participants, there were no significant differences between the groups’ self-reported study strategy use. Further, a linear regression showed that a significant amount of variance in testing expectant participants organizational strategy self-reports could be predicted.
using a model of observed study behaviors. For teaching-expectant participants, this model did not predict organizational strategy self-reports. The finding that teaching-expectant participants self-reports were less calibrated than test-expectant participants suggests that even though teaching-expectant participants engaged in more metacognitive monitoring, and displayed more characteristic behaviors of self regulated learning, they were unaware of their changes in behavior. Howard Rose and Winne (1993) suggested that calibration of study strategy might be poor in some participants because of the amount of information included in complicated learning strategies. In the case of teaching-expectant participants, the complexity and relatively unfamiliarity of study tactics combined with the novelty of the task could explain their inaccurate self-reports: perhaps the cognitive load was simply to great to consciously attend to strategy usage.

The Metacognitive Strategies for Learning Questionnaire (MSLQ; Pintrich, 1991) assessed motivational orientations aligning with Deci’s (1975) and Ryan’s (1995) definitions of intrinsic and extrinsic motivational orientations. The results of this research did not support the hypothesis that intrinsic motivation would interact with cognitive and metacognitive learning process to enhance or degrade learners study behaviors, persistence at studying, and learning outcome. The results showed that there was no significant difference between groups on ratings of any motivational or emotional factors, including intrinsic goal orientation and extrinsic goal orientation. Specifically, in terms of motivational orientation, participants reported similarly low intrinsic goal orientation (control group, $M = 4.99$; teaching group, $M = 4.86$) and extrinsic goal orientation (control group, $M = 5.10$; teaching group, $M = 5.23$). This finding clearly contradicts SDT researchers’ findings that teaching tasks are innately intrinsically rewarding (Deci & Ryan, 1985, Ryan, 195, Ryan & Deci, 2000, Garbarino, 1975). This lends support to the idea that one
main shortcoming in SDT research attempting to determine the source of the positive effects of teaching may lie in the operational definitions of intrinsic and extrinsic motivation.

One finding in particular supports the notion that other conceptualizations of motivational perspectives may be more fitting for studying the effects of motivation and emotion on studying behaviors and task performance. Of the six motivational and emotional factors assessed by the MSLQ, only one approached significance; test-expectant participants reported marginally higher amounts of control of learning beliefs. The control of learning beliefs scale in the MSLQ assesses learners’ belief that learning outcomes are contingent on their efforts, in contrast to external factors. High reported control of learning beliefs indicates that learners feel that if they study in appropriate ways, they will be able to master given materials. This finding aligns with the hypothesis of this research. Csikszentmihalyi and Rathunde (1993) conceptualized intrinsic motivation as a result of one’s experience of flow. In light of this definition this teaching task should not be experienced as intrinsically rewarding flow experience for participants, as they are unlikely to have had adequate experience to develop high control of learning and self-efficacy beliefs for teaching tasks to balance out the challenging nature of the task.

The findings of this research may also suggest that the categorization of intrinsic versus extrinsic motivation, and the idea that these motivational drives are easily manipulated, may be inherently flawed. Other research conceptualizing goal orientation as motivational factors have found results similar to those presented in the current research when investigating participant study behaviors. Nesbit et al. (2006), used gStudy, a software program similar to nStudy, to assess study tactic usage in a group of participants studying for test and conceptualized motivational drives as goal orientations that were deeply rooted, and should be measured rather than manipulated. Their findings showed that participants with stronger mastery goals were less
concerned about poor performance, were more likely to avoid surface level processing strategies, and were more likely to choose relatively deep processing tactics.

Despite use of more effective cognitive tools and increasing study duration, analysis of the Labeling Test and Learning Assessment showed that teaching-expectant participants higher rates of study behaviors only significantly affected performance on the multiple-choice portion of the Learning Assessment (Figure 2). No significant between-groups differences were found in performance on the Labeling Test or Short Answer Tests.

This research is a first step in unlocking the power of teaching tasks for improving learning outcomes. The findings showed that learners studied for more time and used more effective cognitive tools when preparing for a teaching task than when preparing to take a test. While this is an important result on its own, other factors in this research suggest that there may still be additional ways to enhance the benefits of teaching expectancy during learning tasks. First, this research showed that learners were unaware of the changes they made in study strategy usage. Training learners to use effective cognitive tools and metacognitive monitoring strategies, bringing metacognitive monitoring strategies and cognitive tools into the awareness of the learner, could further increase the benefits of teaching tasks. Additionally, the findings showed that teaching-expectant learners reported similar motivational orientation and marginally weaker self-efficacy for learning and performance beliefs than test-expectant learners. Future research may find that improving learner’s self-efficacy beliefs for a task will raise their intrinsic motivation for the task, making the task more enjoyable, and leading to even greater metacognitive monitoring and cognitive strategy use.
In total, the results of this research suggest that educators may be able to increase students’ perception of assigned task value and increase the amount of time students spend studying by including targeted teaching activities as a part of coursework.

Limitations and Future Research

There were some limitations in the current study. The data were collected from a small, midwestern liberal arts college, making it less representative than would be attained at a larger university or from a sample taken from a non-academic setting. Additionally, as the participants in this research were part of the human-subjects pool of Introduction to Psychology students, the majority of the participants were first-time freshman. It is possible that some variability in study strategy is not represented by these novice college students. Future research would benefit from having a more representative sample of demographic variables including socioeconomic status, age, and class standing. Additionally, future research may benefit from extending samples beyond the traditional subject pool. It may be interesting to specifically look at subpopulations (ex. expert teachers vs. novice teachers) to see if various experiences affect calibration of behavioral self-reports.

A limitation of this study was that data were collected from a single study session. Technical issues with the transparency of the web design (study space) and the nStudy interface caused some data loss and should be resolved in future research projects. In this research, participants had never used nStudy. The results clearly showed that participants were able to use the software after the combination of watching a tutorial video and having a printed reference guide for technical functions in nStudy; however participants were still relatively unfamiliar with the software program. It is possible that this may have inhibited some participant’s software usage.
Other researchers have used similar software programs in long-term research. Nesbit et al. (2006) used gStudy as a part of a semester long introductory educational psychology course before using the program as part of a research project. While this greatly increased participants’ familiarity with the software, they also speculated that participants’ behavior was affected by their awareness that they were being observed. The benefits of participant familiarity with nStudy may be achieved by spreading the research over several sessions. Additional research questions involving calibration of self-reports and the influence of motivational orientation may be addressed in the future using a multi-session design. Multi-session research may be useful in investigating whether learning benefits and behavioral influences of teaching task conditions can be further enhanced through task experience, as it may lead to a motivational orientation similar to Csikszentmihalyi’s concept of emergent motivation (Csikszentmihalyi & Rathunde, 1993).

The results of this research also suggested that there may be a floor effect of increasing metacognitive monitoring while engaging in a novel task, wherein the increased cognitive load may lead to inaccurate calibration of self-reported strategy use. By looking at changes in study behaviors and calibration of self-reports over the course of several targeted activities, researchers may be able to better determine the precise role that experience and self-efficacy beliefs play in self-regulated learning.

Additionally, other methods of self-reporting behavioral strategies should be investigated. This research suggested that teaching-expectant participants had poor retroactive memory for metacognitive strategy usage, however it may be possible to cue participants’ retrieval of implicitly encoded procedural memory for study strategies used by participant with their own study outline. Given cues, participants may be able to more accurately describe their
metacognitive monitoring processes while creating the outline, giving researchers a more thorough perspective on the role of metacognitive monitoring in studying tasks.
References


Winne, P. H., & Hadwin, A. F. (2009). nStudy: A web application for researching and promoting self-regulated learning (version 0.8) [computer program]. Simon Fraser University, Burnaby, BC, Canada.


List of Tables

Table 1. Participant Demographic Characteristics.................................53

Table 2. Regression Analysis Summary for Control Participants' Study Behaviors Predicting Reported Organizational Strategy Use.................................54

Table 3. Regression Analysis Summary for Teaching Participants’ Study Behaviors Predicting Reported Organizational Strategy Use.................................55
Table 1

*Participant Demographic Characteristics*

<table>
<thead>
<tr>
<th></th>
<th>Teaching Expectancy</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n = 38$</td>
<td>$n = 37$</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>Female</td>
<td>21</td>
<td>16</td>
</tr>
<tr>
<td>Age (years)</td>
<td>18.74 (0.95)</td>
<td>18.84 (1.01)</td>
</tr>
<tr>
<td>Class Standing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freshman</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Sophomore</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Junior</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Senior</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Grade Point Average</td>
<td>3.04 (0.51)</td>
<td>3.06 (0.78)</td>
</tr>
<tr>
<td>Had Formal Teaching Experience</td>
<td>27.03%</td>
<td>42.11%</td>
</tr>
<tr>
<td>Had Formal Tutoring Experience *</td>
<td>10.81%</td>
<td>31.58%</td>
</tr>
<tr>
<td>Had Informal Tutoring Experience</td>
<td>59.46%</td>
<td>76.32%</td>
</tr>
</tbody>
</table>

*Note.* Means and frequencies. Standard deviations in parenthesis. *$p < .05$.*
Table 2
Regression Analysis Summary for Control Participants' Study Behaviors Predicting Reported Organizational Strategy Use

<table>
<thead>
<tr>
<th>Variable</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of quotes created</td>
<td>.04</td>
<td>0.27</td>
<td>.79</td>
</tr>
<tr>
<td>Number of terms created</td>
<td>.42</td>
<td>2.44</td>
<td>.02</td>
</tr>
<tr>
<td>Number of notes created</td>
<td>.13</td>
<td>0.50</td>
<td>.62</td>
</tr>
<tr>
<td>Number of linkages created</td>
<td>.11</td>
<td>0.44</td>
<td>.66</td>
</tr>
</tbody>
</table>

*Note. $R^2 = 0.31 \ (N = 36, \ p = .02)$.  

Table 3

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of quotes created</td>
<td>-.18</td>
<td>-1.04</td>
<td>.31</td>
</tr>
<tr>
<td>Number of terms created</td>
<td>-.07</td>
<td>-0.40</td>
<td>.69</td>
</tr>
<tr>
<td>Number of notes created</td>
<td>.38</td>
<td>1.34</td>
<td>.19</td>
</tr>
<tr>
<td>Number of linkages created</td>
<td>-.14</td>
<td>-0.14</td>
<td>.65</td>
</tr>
</tbody>
</table>

*Note. $R^2 = 0.12$ ($N = 37$, $p = .36$).*
List of Figures

Figure 1. Between groups differences in elected study tactics........................................56
Figure 2. Between groups differences in time spent studying materials................................57
Figure 3. Between groups differences in multiple-choice test score........................................58
Figure 4. Demonstration of “linkages” in nStudy note function........................................59
Figure 5. Modified COPES model of metacognitive monitoring and control........................60
Figure 1.
Figure 2.

Between groups differences in time spent studying materials
Figure 3.

Between groups differences in multiple-choice test score

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage Correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Condition</td>
<td>50</td>
</tr>
<tr>
<td>Teaching Expectancy Condition</td>
<td>70</td>
</tr>
</tbody>
</table>
Demonstration of “linkages” in nStudy note function

Figure 4. Screenshot of linkages made within notes taken on “Structures of the Ear” page. Notes’ structure includes 3 linkages.
Figure 5. Modified from Winne & Hadwin’s (1998) COPES 4-phase model of metacognitive monitoring and control in 4 stages of studying. See Appendix 1 for narrative explanation of processes in this model.
A.1 APPLIED EXAMPLE OF WINNE & HADWIN’S (1998) COPES (4-PHASE) MODEL OF METACOGNITIVE MONITORING AND CONTROL

Bobby, a college freshman, is generally good student, but he is also involved in several extracurricular activities that take up much of his time. Bobby finds the social aspect of college classes highly enjoyable. Bobby is taking a communication course to fulfill a general education requirement. On the first day of Bobby’s communication class, the professor hands out the first class assignment: “The following paragraph is an excerpt from a recent presidential address. Memorize the paragraph completely. During next class session, you will be asked to recite the paragraph in front of the class.” Bobby had never watched a presidential address before and had no idea of how this kind of a recitation should go, but he was comforted by the fact that he was good at memorizing speeches – public speaking had never been difficult for him. If Bobby was worried about anything it was about making a good impression on his new professor.

In this scenario, Bobby includes assignment instructions, due date, and defined expectations as task conditions and his relative comfort with public speaking and confidence for memorization tasks as a cognitive condition (phase one). Bobby’s anxiety about making a good impression on a new professor and unfamiliarity with presidential addresses may also affect Bobby’s task definition.

During phase two, Bobby selects goals for his current task. While Bobby is highly motivated to make a good impression, he is busy with extracurricular activities and adopts a secondary goal to learn the material in the shortest amount of time possible. Because Bobby is unsure of exactly what this task entails, how a presidential address should be given, or if this might change the way he needs to approach memorization, he decides to look up examples (uncertainty in task definition, return to phase 1). After reviewing examples, Bobby decides that he will be sure to check that he can confidently flow from sentence to sentence in the same manner he observed in the videos (after re-entry into phase 2, addition of tactic to strategy).

During phase three, Bobby begins using the strategies he selected to study the paragraph his professor assigned for memorization. Bobby works through the text sentence-by-sentence,
reading each sentence then repeating each sentence back to himself until he feels confident of his memorization (strategy use informed by cognitive conditions; ongoing JOLs and confidence judgments). Bobby would normally also practice stringing sentences together, but given his time constraints he decides to skip that step (phase 4 adjustment, deletion of tactic from strategies to fit goal hierarchy). Bobby spends a half hour reciting the passage, abandoning the task when he feels confident that he can remember the first half of the paragraph (EOL, JOL, and FOK). The next day, when Bobby attempts to recall the sentences he worked on memorizing, he finds that he cannot remember them; his learning strategy has failed him (JOL and confidence judgment in phase 4). Bobby resolves to budget more time for the memorization assignment (restructuring goals for task). Bobby realizes that altering his usual strategy for memorization was a bad idea (re-adding a tactic into a strategy). See Figure 5 for a diagram of the above textual material applied to a modified version of Winne & Hadwin’s (1998) COPES model of metacognitive monitoring and control in studying behavior.
A.2 HUMAN EAR TEXT

**Physics and Psychology of Sound**

Our auditory systems are well adapted for detecting and interpreting many kinds of information. Sound waves are periodic compressions of air, water, or other media. Sound waves vary in amplitude and frequency. The amplitude of a sound wave is its intensity. Loudness is a sensation related to amplitude, but not identical to it. For example, a rapidly talking person sounds louder than slow music of the same physical amplitude.

The frequency of a sound is the number of compressions per second, measured in Hz. Pitch is an aspect of sound perception that is related to sound wave frequency. Higher frequency sounds are higher in pitch. Most adult humans hear sounds ranging from about 15 Hz to somewhat less than 20,000 Hz. Children hear higher frequencies than adults, because the ability to perceive high frequencies decreases with age and exposure to loud noises (Schneider, Trehub, Morrongiello, & Thorpe, 1986).

**Structures of the Ear**

Anatomists distinguish the outer ear, middle ear, and the inner ear. The outer ear includes the pinna, the familiar structure of flesh and cartilage attached to each side of the head. By altering the reflections of sound waves, the pinna helps us locate the source of a sound.

After sound waves pass through the auditory canal, they strike the tympanic membrane, or eardrum, in the middle ear. The tympanic membrane vibrates at the same frequency as the sound waves that strike it. The tympanic membrane connects to three tiny bones that transmit the vibrations to the round window, a membrane of the inner ear. These bones are sometimes known by their English names: hammer, anvil, and stirrup. The footplate of the stirrup connects to the round window. The vibrations of the tympanic membrane transform into more forceful vibrations of the smaller stirrup. The net effect converts the sound waves into waves of greater
pressure on the small round window. This transformation is important because more force is required to move the viscous fluid behind the round window than to move the eardrum, which has air on both sides.

The inner ear contains a snail-shaped structure called the cochlea. The stirrup makes the round window vibrate at the entrance to the cochlea, thereby setting in motion the fluid in the cochlea. Auditory receptors, known as hair cells, line the basilar membrane within the cochlea. Vibrations in the fluid of the cochlea displace the hair cells. A hair cell responds within microseconds to displacement by opening ion channels in its membrane and communicating an auditory message to nerve fibers of the auditory nerve.

**Pitch Perception**

The two main ways of coding auditory sensory information are (1) which cells are active and (2) how frequently they fire. The size and stiffness of the basilar membrane determines which part of the basilar membrane will respond to various frequencies of sound. Low-pitched tones cause maximal displacement closer to the apex where the membrane is larger and floppier and high-pitched tones cause maximal displacement near the stiff base of the basilar membrane.

In response to low-frequency sounds (15Hz – 100Hz; more than an octave below middle C in music), the basilar membrane vibrates in synchrony with the sound waves and auditory nerve neurons fire with each vibration. Soft sounds activate fewer neurons, and stronger sounds activate more. At low frequencies, the frequency of impulses identifies the pitch, and the number of firing cells identifies loudness.

As sounds exceed 100Hz, it becomes harder for a neuron to continue firing in synchrony with the sound waves. At medium frequencies, neurons split into volleys, one volley firing with one vibration and another with the next. These volleys of responses are detected across many
auditory nerve receptors. In response to high-frequency tones, the neurons in the auditory nerve may fire on every second, third, fourth or later wave.

**Individual Differences**

*Pitch Perception*

People vary in their sensitivity to pitch. An estimated 4% of people have amusia, impaired detection of frequency changes (Hyde & Peretz, 2004). Amusia is commonly called “tone deafness.” They have trouble detecting a change in sound frequency less than about 10%, whereas other people can detect a change of less than 1% (Loui, Alsop, & Schlaug, 2009). They have trouble recognizing tunes. They can’t tell whether someone is singing off-key, and do not detect a “wrong” note in a melody. Many relatives of a person with amusia have the same condition, so it probably has a genetic basis.

Absolute pitch (or perfect pitch) is the ability to hear a note and identify the pitch by name – for example, “That’s a C sharp.” Genetic predisposition may contribute but the main determinant is early and extensive music training. Not everyone with musical training develops absolute pitch, but almost everyone with absolute pitch had extensive musical training.

*Hearing Impairment*

Individuals may experience one of two categories of hearing impairments. Diseases, infections, tumorous bone growth, or even excess ear wax can prevent the middle ear from transmitting sound waves properly to the cochlea resulting in conductive deafness. It is sometimes temporary. If it persists, it can be corrected either by surgery or by hearing aids that amplify the stimulus.

The second category of hearing impairment, nerve deafness, results from damage to the cochlea, the hair cells, or the auditory nerve. It can occur in any degree and may be confined to
one part on the cochlea, in which case someone hears certain frequencies and not others. Nerve deafness can be inherited (Wang et al., 1998), or it can develop from a variety of disorders (Cremers & van Rijn, 1991; Robillard & Gerdsdorff, 1986), including: certain diseases, inadequate oxygen to the brain during birth, or exposure to loud noises. Researchers have found that exposure to loud sounds produces long-term damage to the synapses and neurons of the auditory system that doesn’t always show up on hearing tests. It might eventually lead to ringing in the ears, extreme sensitivity to noise, or other problems (Kujawa & Liberman, 2009).
A.3 HUMAN EAR DIAGRAM
A.4 IDENTIFICATION TEST

Labeling Test: Diagram 1

Complete the following form to the best of your ability. Be sure to enter an answer all items. You may have to scroll down to view all items. When finished, click “Submit” on the form to submit your answers before continuing on to the next form.

Label the numbered parts of the diagram.

* Required

Please enter your student id number *

#1 *

#2 *

#3 *

#4 *

#5 *

#6 *

#7 *

#8 *

#9 *

#10 *
A.5 LEARNING ASSESSMENT

Learning Assessment
Complete the following form. Be sure to answer all items. You may have to scroll down to view all items. When finished, click "Submit" on the form to submit your answers before continuing on to the next form.

* Required

1. Please enter your student id number *

..............................................................................................................................

2. The structure that is commonly referred to as the ear (on the outside of the head) is formally known as the *

..............................................................................................................................

3. What is it's function? *
   Mark only one oval.
   - It vibrates in synchrony with high-frequency tones.
   - It protects the eardrum from overstimulation
   - It filters out distracting sounds.
   - It helps us locate the source of sounds.

4. What is the common range of human hearing? *
   Mark only one oval.
   - 15Hz - 20,000Hz
   - 0Hz - 150,000Hz
   - 45Hz - 20,000Hz
   - Option 415Hz- 45,000Hz

5. In the auditory system, hair cells are specialized receptors that respond to: *
   Mark only one oval.
   - Chemicals
   - Electromagnetic Energy
   - Mechanical Displacement
   - Vestibular Input
6. A person who is “tone deaf”, has problems detecting change in what element of sound? *
   Mark only one oval.
   
   - Frequency
   - Amplitude
   - Frequency & Amplitude

7. The changes in the amplitude of a sound wave effect what aspect of sound perception? *
   Mark only one oval.
   
   - Pitch
   - Loudness
   - Pitch & Loudness

8. How does the size and stiffness of the basilar membrane affect pitch perception? *

9. Suppose the highest pitch you can hear is about 20,000 Hz. Under what circumstances will that limit change? *

10. Which type of hearing loss would be more common among members of rock bands and why? *

11. Carrie Sue is a professional violist. During her time at conservatory, a hearing specialist at her institution discovered that she had perfect pitch. Carrie Sue is now expecting a child- can she reasonably expect that her baby will inherit her perfect pitch ability? Is there anything that Carrie Sue can do to increase her child’s chances of developing perfect pitch? Explain. *

Powered by Google Drive
A.6 REVISED MSLQ

Part A. Motivation

The following questions ask you about your motivation for and attitudes about the learning unit included in this experiment. **Remember there are no right or wrong answers, just answer as accurately as possible.** Use the scale below to answer the questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, find the number between 1 and 7 that best describes you.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>not at all true of me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>very true of me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. I prefer reading materials that really challenge me so I can learn new things.  
   1  2  3  4  5  6  7

2. If I study in appropriate ways, then I will be able to learn the material in this unit.  
   1  2  3  4  5  6  7

3. When I taking the final test over the learning unit, I think about how poorly I am doing compared with other participants.  
   1  2  3  4  5  6  7

4. I think I will be able to use what I learned in this unit in other courses.  
   1  2  3  4  5  6  7

5. I believe I will receive an excellent grade on the final learning assessment of the unit.  
   1  2  3  4  5  6  7

6. I’m certain I can understand the most difficult material presented in the learning unit reading.  
   1  2  3  4  5  6  7

7. Getting a good grade is the most satisfying thing for me right now.  
   1  2  3  4  5  6  7

8. When I taking the final test over this unit, I think about items on other parts of the test I can’t answer.  
   1  2  3  4  5  6  7

9. It is my own fault if I don’t learn the material in this unit.  
   1  2  3  4  5  6  7

10. It is important for me to learn the material in this unit.  
    1  2  3  4  5  6  7
| 11. The most important thing for me right now is improving my overall performance as a student, so my main concern during this experiment is getting a good grade. | 1 2 3 4 5 6 7 |
| 12. I’m confident I can learn the basic concepts taught in this unit. | 1 2 3 4 5 6 7 |
| 13. If I can, I want to get better scores on the final test on this unit than most of the other participants. | 1 2 3 4 5 6 7 |
| 14. When I taking the final test on this learning unit, I think of the consequences of failing. | 1 2 3 4 5 6 7 |
| 15. I’m confident I can understand the most complex material presented in this learning unit. | 1 2 3 4 5 6 7 |
| 16. I prefer learning material that arouses my curiosity, even if it is difficult to learn. | 1 2 3 4 5 6 7 |
| 17. I am very interested in the content area of this learning unit. | 1 2 3 4 5 6 7 |
| 18. If I try hard enough, then I will understand the material in the learning unit. | 1 2 3 4 5 6 7 |
| 19. I have an uneasy, upset feeling when I taking the final test over this learning unit. | 1 2 3 4 5 6 7 |
| 20. I’m confident I can do an excellent job on the final test in this learning unit. | 1 2 3 4 5 6 7 |
| 21. I expect to do well on the assigned task. | 1 2 3 4 5 6 7 |
| 22. In this task, the most satisfying thing for is trying to understand the content as thoroughly as possible. | 1 2 3 4 5 6 7 |
| 23. I think the material in this unit is useful for me to learn. | 1 2 3 4 5 6 7 |
| 24. When I have the opportunity, I chose activities that I can learn from even if they don’t guarantee a good grade. | 1 2 3 4 5 6 7 |
| 25. If I don’t understand learning unit material, it is because I didn’t try hard enough. | 1 2 3 4 5 6 7 |
| 26. I like the subject matter of this learning unit. | 1 2 3 4 5 6 7 |
| 27. Understanding the subject matter of this learning unit is very important to me. | 1 2 3 4 5 6 7 |
**Part B. Learning Strategies**

The following questions ask you about your learning strategies and study skills for this learning unit. **Again, there are not right or wrong answers. Answer the questions about how you study in this class as accurately as possible.** Use the same scale to answer the remaining questions. If you think the statement is very true of you, circle 7; if a statement is not at all true of you, find the number between 1 and 7 that best describes you.

<table>
<thead>
<tr>
<th>Question</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>28. I feel my heart beating fast when I take the final test over the learning unit.</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>29. I’m certain I can master the material being taught in this learning unit.</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>30. I want to do well in this experiment because it is important to show my ability to family, friends, employers, or others.</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>31. Considering the difficulty of this material and my skills, I think I will do well on the final test over the learning unit.</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>32. When I study this learning unit, I outline the material to help me organize my thoughts.</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>33. When studying this learning unit I often miss important points because I’m thinking of other things.</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>34. When reading the material in this unit, I make up questions to help focus my reading.</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>35. I often feel lazy or bored while studying this learning unit, so I quit before I finish what I planned to do.</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>36. I often find myself questioning things I read in the learning unit to decide if I find them convincing.</td>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>37. When I study the material in this unit, I practice saying the material to myself over and over.</td>
<td>1</td>
</tr>
<tr>
<td>38. When I become confused about something I’m reading in this unit, I go back and try to figure it out.</td>
<td>1</td>
</tr>
<tr>
<td>39. When studying this learning unit, I go through the reading and my notes and try to find the most important ideas.</td>
<td>1</td>
</tr>
<tr>
<td>40. When information in the learning unit is difficult to understand, I change the way I read the material.</td>
<td>1</td>
</tr>
<tr>
<td>41. When studying this material, I read over my notes and the learning unit over and over again.</td>
<td>1</td>
</tr>
<tr>
<td>42. When a conclusion is presented in the learning unit, I try to decide if there is good supporting evidence.</td>
<td>1</td>
</tr>
<tr>
<td>43. I work hard to do well on my task, even if I don’t like what I am doing.</td>
<td>1</td>
</tr>
<tr>
<td>44. I make simple charts, diagrams, or tables to help me organize learning unit material.</td>
<td>1</td>
</tr>
<tr>
<td>45. I treat learning unit material as a starting point and try to develop my own ideas about it.</td>
<td>1</td>
</tr>
<tr>
<td>46. When studying the material in this learning unit, I pull together information from different sources, such as readings, diagrams, notes, and prior experience.</td>
<td>1</td>
</tr>
<tr>
<td>47. Before I study any learning unit material thoroughly, I skim it to see how it is organized.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>48. I ask myself questions to make sure I understand the learning unit material I have been studying.</td>
<td>1</td>
</tr>
<tr>
<td>49. I try to change the way I study the learning unit in order to fit the task requirements.</td>
<td>1</td>
</tr>
<tr>
<td>50. I often find that I have been reading the given learning material, but I don’t know what it was all about.</td>
<td>1</td>
</tr>
<tr>
<td>51. I memorize key words to remind me of important concepts from the learning unit.</td>
<td>1</td>
</tr>
<tr>
<td>52. When learning unit material is difficult, I either give up or only study the easy parts.</td>
<td>1</td>
</tr>
<tr>
<td>53. When studying the learning unit, I try to think through the topic and decide what I am supposed to learn from it rather than just reading it over.</td>
<td>1</td>
</tr>
<tr>
<td>54. I try to relate ideas in this learning unit to those in other courses I have taken whenever possible.</td>
<td>1</td>
</tr>
<tr>
<td>55. When studying learning unit material, I go over my notes and readings and make an outline of important concepts.</td>
<td>1</td>
</tr>
<tr>
<td>56. When reading this learning unit, I try to relate the material to what I already know.</td>
<td>1</td>
</tr>
<tr>
<td>57. I try to play around with ideas of my own related to what I am currently learning in this unit.</td>
<td>1</td>
</tr>
<tr>
<td>58. When studying the learning unit material, I write brief summaries of the main ideas from the reading and my notes.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>METACOGNITIVE BENEFITS</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>59.</td>
<td>I try to understand the material in this learning unit by making connections between the reading and concepts I should already know.</td>
</tr>
<tr>
<td>60.</td>
<td>Whenever I read an assertion or conclusion in this unit, I think about possible alternatives.</td>
</tr>
<tr>
<td>61.</td>
<td>I make lists of important items from the learning unit and memorize the lists.</td>
</tr>
<tr>
<td>62.</td>
<td>Even when the learning material in this unit is dull and uninteresting, I manage to keep working until I finish.</td>
</tr>
<tr>
<td>63.</td>
<td>When studying materials in this learning unit, I try to determine which concepts I don't understand well.</td>
</tr>
<tr>
<td>64.</td>
<td>When studying this learning unit, I set goals for myself in order to direct my activities for the study period.</td>
</tr>
<tr>
<td>65.</td>
<td>If I get confused when taking notes on the learning unit, I make sure that my confusion is sorted out before I’m finished studying.</td>
</tr>
<tr>
<td>66.</td>
<td>I try to apply things I have learned during a learning activity to other learning activities.</td>
</tr>
</tbody>
</table>
A.7 PARTICIPANT BACKGROUND QUESTIONNAIRE

Participant Background Questionnaire
Complete the following form. Be sure to answer all items. You may have to scroll down to view all items. When finished, click "Submit" on the form to submit your answers before continuing on to the next form.

Complete the following questionnaire as accurately and completely as possible.

* Required

1. Please enter your student id number *

2. Age *

3. Select all completed levels of education *
   Check all that apply.
   - Some High School
   - High School
   - Associates Degree
   - Technical Degree
   - Bachelors Degree
   - Masters Degree
   - Doctoral Degree or Higher

4. Major/Minor

5. Class Standing *
   Mark only one oval.
   - freshman
   - sophomore
   - junior
   - senior
   - Other: ...........................................................

6. Expected Completion Date *
   Mark only one oval.
   - 2018
   - 2017
   - 2016
   - 2015
   - 2014
   - 2013
   - Other: ...........................................................
7. To the best of your knowledge, what is your overall GPA?

8. Prior to this HIT, rate your familiarity with the anatomy of the ear *
   Mark only one oval.

   1 2 3 4 5
   very familiar ☐ ☐ ☐ ☐ ☐ unfamiliar

9. Prior to this HIT, rate your familiarity with the processes involved in pitch perception, including individual differences in pitch perception. *
   Mark only one oval.

   1 2 3 4 5
   very familiar ☐ ☐ ☐ ☐ ☐ unfamiliar

10. Have you ever taught in a classroom setting? (Examples: giving a classroom lecture or leading group discussion as part of a class assignment) *
    Mark only one oval.

    ☐ Yes
    ☐ No

11. If you selected yes for question 10, describe this experience.

    ........................................................................................................................................

12. Have you ever provided formal tutoring to another student? (Formal tutoring means that you have participated in an established tutoring program and/or were paid to tutor.)*
    Mark only one oval.

    ☐ Yes
    ☐ No

13. If you selected yes for question 12, describe this experience.

    ........................................................................................................................................

14. Have you ever provided informal tutoring to another student? (Informal tutoring refers to tutoring a friend or classmate outside of an established tutoring program and without any payment.)*
    Mark only one oval.

    ☐ Yes
    ☐ No

15. If you selected yes for question 14, describe this experience.

    ........................................................................................................................................