PART-TASK TRAINING VS. WHOLE-TASK TRAINING FOR SIMPLE VS. COMPLEX TASKS

By

Kerstie Hillman

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Arts in Industrial-Organizational Psychology

Middle Tennessee State University

May 2020

Thesis Committee:

Dr. Michael Hein, Chair

Dr. Alexander T. Jackson, Committee Member

Dr. Richard Moffett III, Critical Reader

ACKNOWLEDGMENTS

I would like to thank my thesis advisor, Dr. Hein, for his constant guidance and support throughout this entire process. If it were not for him, this study would not have been as successful. I would also like to thank Dr. Alex Jackson and Dr. Richard Moffett for their high-quality input regarding format, structure, and content to be included in this study.

Additionally, I would like to thank Sarah Graff, Samantha Koszalka, Zachary Swetz, and Jeb Wells for their assistance in data collection. Without these people, I would not have been able to stay sane and collect all of the information necessary to make sound conclusions.

Finally, I would like to thank my parents, Leslie Kersey and David Hillman, who have provided constant love and support throughout my entire time as a graduate student in MTSU's Industrial-Organizational Psychology Program. My future is brighter than ever because of you all.

ABSTRACT

There is a plethora of approaches to training people on complex tasks. One method that has commonly been used is the whole-task training approach. Another approach that has been used to train individuals on a complex task is through part-task training. Throughout literature there has been a debate regarding which method is more effective for training individuals to complete complex tasks. One measure that has been neglected throughout most research is retention. Most studies have either only measured immediate performance or measured retention a few days to a week after training. The purpose of this study was to examine whether part-task or whole-task training is superior for teaching complex versus simple tasks. The researchers also measured performance at two different times to distinguish between measures of immediate performance and measures of actual retention. The results, limitations, and suggestions for future research are discussed further.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

There is a plethora of approaches to training people on complex tasks (Naylor and Briggs, 1963; Cunningham, 1971; McDermott, Carolan, and Wickens, 2012; Wickens, Hutchins, and Carolan, 2013). One method that has commonly been used is the whole-task training approach. Whole-task training occurs when an individual or group of people are trained on a task in its entirety within one training session (Wightman & Lintern, 1985). Another approach that has been used to train individuals on a complex task is through part-task training. Part-task training involves breaking down a complex task into smaller elements and training individuals on each of these elements before having trainees perform the task as a whole (Hasher, 1971). Throughout the literature there has been a debate regarding which method is more effective for training individuals to complete simple and complex tasks (Naylor and Briggs, 1963; McDermott, Carolan, and Wickens, 2012; Wickens, Hutchins, and Carolan, 2013).

There are many part-training methods (Wightman and Lintern, 1985), and because of this, some researchers suggest that the characteristics of the task as well as the conditions under which the task is trained help to determine whether certain types of part-task training will be more or less effective for training tasks (Schmidt and Risberg, 2008). For example, Wightman & Lintern (1985) suggest that the components of a task that a trainer chooses to emphasize determines whether part-task training will show more favorable results than whole-task training. In addition, they also suggest that the effectiveness of part-task training in part depends on the schedule in which the parts are practiced. Three schedules in which part-task procedures can be trained include pure-part training, repetitive-part training, and progressive-part training (Wightman & Lintern, 1985). These schedules will be explained further in the next few pages.

Other researchers suggest that the qualities of the task, not the training method, determine which method will be superior (Naylor & Briggs, 1963; Anderson, 1968; So, Proctor, Dunston, & Wang, 2013). For instance, Naylor & Briggs (1963) concluded that training effectiveness was dependent on the organization of the task as well as the complexity of the task. Organization refers to the interrelationships between each part of the task, and complexity refers to the demands placed on an individual related to the processing of information (Naylor & Briggs, 1963). Wightman & Lintern (1985) suggest that part-task training may not be useful for simple tasks, and they also suggest this type of training may even be counterproductive for simpler tasks.

The purpose of the following study is to address more specific types of training and compare a couple different types through an in-person, two-part experiment. The researchers argue that there is a knowledge gap in the literature concerning different types of training and their effectiveness in improving task performance. Therefore, this study will help to close the knowledge gap by helping to determine which types of training are ideal under certain circumstances. More specifically, the researchers will compare the effectiveness of training simple versus complex tasks using both whole-task and part-task training methods. In addition, the researchers also want to compare task performance immediately after training as well as up to three weeks after training in order to see whether training has a lasting impact.

Part-Task Training

Part-task training is different than whole-task training because it involves training people on individual components of a task before attempting to perform a task in its entirety (Anderson, 1968). There are a variety of methods for training complex tasks using the part-task training technique (Wightman and Lintern, 1985; Wickens et al., 2013). Some methods differ in the focus that is placed on individual components of a task. Focus refers to the time spent on individual components of a task. Segmentation is one approach that focuses on training individuals on the most critical components of the task (Wightman & Lintern, 1985); therefore, one would spend the least amount of time training the least important or simpler components (Wightman & Lintern, 1985). For example, Wightman and Lintern (1985) described a study in their meta-analysis in which participants were trained to use a desktop flight simulator. The researchers found that the final approach, flare, and touchdown were the most difficult parts of this task. Therefore, following the segmentation approach, one would train participants on these parts more extensively. In 1987, Wightman and Sistrunk conducted a study in which researchers trained participants on a carrier landing task using a segmented approach. Participants would practice segments of the task starting at 2,000 feet from the ground and increasing another 2,000 feet for each segment (Wightman & Sistrunk, 1987). These researchers found that participants who were trained using the segmented approach performed better than the whole task condition in the transfer to the whole-task training (Wightman & Sistrunk, 1987). One form of segmentation is referred to as backward-chaining (Ash & Holding, 1990). Backward chaining is more specific than segmentation because the order in which components are trained matters (Wightman & Sistrunk, 1987). Backward-chaining involves training an individual on the last component of a task first and then providing reinforcement (Ash & Holding, 1990). Then the second to last part is added in and so on until the entire task is trained (Ash & Holding, 1990). For example, if the task was learning to drive a car, one could start training by learning to shift gears and park, and learning to start the engine could be the last part that is learned (Salden, Paas, and Merriënboer, 2006). Wightman and Lintern (1985) presented four studies using the segmented approach – three studies compared backward chaining to whole-task training, and one study compared forward chaining to whole-task training. Part-task training was superior to whole-task training for three of the four studies, and all three of those studies incorporated the backward-chaining technique (Bailey, Hughes, & Jones, 1980; Westra, 1982; Wightman, 1983; Sheppard, 1984). Forward-chaining is the other form of segmentation, which is very similar to backward-chaining except the parts are trained in chronological order in which they would normally be performed (Weiss, 1978). For example, if the task was still learning to drive a car, one would first learn to start the engine, and then he or she would learn the rest of the parts in chronological order, ending with parking the car (Salden et al., 2006). Weiss (1978) found forward chaining to be superior to backward chaining in a study where participants were trained to learn four six-link response chains using both training methods.

In addition to segmentation, another part-task training method is referred to as fractionation, which involves training an individual on two or more subtasks in isolation, and these subtasks would normally be performed simultaneously as a whole (Wightman & Lintern, 1985). For example, instead of practicing how to steer a car at the same time as practicing to use the gas pedal and shifting gears, one would practice each of these tasks in isolation (Salden et al., 2006). Studies conducted by Briggs and Brogden (1951), Briggs and Waters (1958), Briggs and Naylor (1962), and Stammers (1980) all compared fractionation to whole-task training and found whole-task training to be superior (Wightman & Lintern, 1985). Therefore, this method does not appear to be as effective for training tasks as the segmented method (Wightman & Lintern, 1985). Finally, a third method of part-task training is referred to as simplification, which is a technique that involves training an individual on a complex task by adjusting the components to decrease the difficulty of the task to be performed (Wightman & Lintern, 1985). For example, Wightman and Sistrunk (1987) simplified a carrier landing task by decreasing the overall weight of the aircraft in order to make it easier for participants to move the aircraft. They found that overall, simplification was not superior to whole-task training (Wightman & Sistrunk, 1987).

Schedules. Apart from the different component focuses of part-task training, there are also different schedules in which one can administer part-task training. Schedule refers to the order in which one chooses to integrate training different components of a task (Wightman & Lintern, 1985). Pure-part training involves training each individual part in isolation, and then the participant practices all of the individual parts together (Wightman & Lintern, 1985). Mané (1984) conducted a study comparing pure-part training with whole-task training for a space fortress video game where participants in the pure-part condition received training on three critical subtasks prior to receiving training on the task as a whole. The researchers found that participants in the pure-part condition performed up to the predetermined criterion in a shorter amount of time, and they also performed better than participants in the whole-task condition throughout the training of the whole task (Mané, 1984). With repetitive-part training, the participant is trained on one part of the task, and then the researcher gradually adds more parts until the individual is trained on the task as a whole (Wightman & Lintern, 1985). For example, a person could be trained on part 1 first, part 1 and 2 together, parts 1 through 3 together, and so on until the individual learns the entire task (Cunningham, 1971). Repetitive-part training has shown promising results for tasks that require serial recall of word lists (Postman and Goggin, 1966). Progressive-part training is another schedule that involves the participant learning one part of a task in isolation, then moving on to learn the next part in isolation, and progressively adding a new part after the previous part has been mastered (Wightman & Lintern, 1985). For example, Nettelbeck and Kirby (1976) compared three training methods used to teach young women, who were mildly mentally retarded, how to thread a sewing machine. The task was broken down into four parts: A, B, C, and D. Participants in the progressive-part condition would learn A in isolation, B in isolation, A and B together, C in isolation, A, B, and C together, D in isolation and finally all four parts together (Nettelbeck and Kirby, 1976). These researchers found that both pure-part practice and progressive-part practice were superior than whole-task practice; they also found that progressive-part practice was superior to pure-part practice (Nettelbeck and Kirby, 1976). Additionally, Naylor and Briggs (1963) found that part-task training using the progressive part schedule was superior to whole-task training specifically for tasks with highly difficult subparts with low interaction between subparts.

Effectiveness. One perspective that some researchers have taken views part-task training as the preferred method to train complex tasks. Earlier research has shown part-task training to be just as effective, if not more effective, than whole-task training for complex and simple tasks. For example, Naylor and Briggs (1963) concluded that part-task training was superior to whole-task training when the task was high in complexity (i.e., mental demands) but low in organization (i.e., interrelatedness of subtasks). According to Naylor and Briggs (1963), both levels of task complexity and task organization define task difficulty. Although they concluded that part-task training was more effective for tasks that are highly complex and low in organization, they were ultimately concluding that part-task training is more effective for tasks that are not difficult. Similarly, Anderson (1968) compared part-task training to whole-task training and found the part-task procedures to be more effective during both training and tests of retention. The difference in this study is that the task was learning problem-solving skills, and the participants were first grade elementary students (Anderson, 1968).

In 1970, Fingeret and Brogden compared two part-training procedures—successive practice and alternate practice—and a whole-part training procedure for acquisition of serial lists. Successive practice is otherwise referred to as pure part practice, which has been described previously. Participants in the successive group had to learn one list and reach a predetermined criterion performance level. They then had to learn a second list (Fingeret & Brogden, 1970). Participants in the alternate practice group were trained to learn one list, and then they were given an alternate list to learn (Fingeret & Brogden, 1970). However, participants did not have to perform one list to the desired performance criterion before alternating to the next list (Fingeret & Brogden, 1970). Fingeret and Brogden (1970) concluded that both part methods were found to be superior to whole-task training. A similar study by Hasher (1971) compared whole-task training to part-task training using free recall as the task. Hasher found that participants in the part-training condition took the same amount of time to memorize a list of words. These participants also recalled more words and maintained the superior retention a week later (Hasher, 1971). Although the researchers concluded that part-task training was more effective than whole-task training for their study, they also acknowledged that the task used for the study was relatively short and not difficult to learn (Hasher, 1971). This helps lend support for the notion of part-task training being used to train simple tasks.

By 1980, more complex computerized tasks were used to demonstrate the effectiveness of one training method over the other. Bailey, Hughes, and Jones (1980) studied the effectiveness of backward-chaining techniques compared to whole-task procedures. Backward-chaining, as discussed earlier, involves training participants on the last part of the task first (Bailey, Hughes, and Jones, 1980). Once the last part is trained, the researcher introduces some form of reinforcement and then continues to teach the second-to-last task and so forth (Bailey, Hughes, and Jones, 1980). In the study conducted by Bailey et al. (1980), the participants were air force instructor pilots, and they were trained on a 30-degree dive bomb task using a computer simulator. The participants in the backward-chaining group learned four separate components of the task (Bailey et al., 1980). These participants would learn the last segment of the task first, and they would move on to the next segment once they had completed two correct runs in consecutive order (Bailey et al., 1980). The participants in the whole task simply practiced the task as a whole for thirty trials (Bailey et al., 1980). The results of this study concluded that participants trained using the backward-chaining technique took less time to train the task, *and* their accuracy was superior to the participants trained using the whole-task approach (Bailey, Hughes, and Jones, 1980). However, all participants, regardless of assignment, practiced the task as a whole five times before training. This initial practice could have had an influence on the results. Similarly, Wightman and Sistrunk (1987) performed an experiment using a similar part-training method, segmentation. The participants were trained to learn the Air Combat Maneuvering task. The researchers found that participants who were trained using the segmented part-task training technique performed better on the test of transfer to the whole task than did participants trained using the whole-task approach (Wightman & Sistrunk, 1987).

More recent research continues to show advantages of part-task training over whole-task training (So, Proctor, Dunston, and Wang, 2013). Smith (1999) compared forward chaining with backward chaining and whole-task training. The results of the study concluded that both part-task training procedures were superior to the whole-task training approach (Smith, 1999). Another study conducted in 2015 found that age can influence the effectiveness of training techniques (Chan, Luo, Yan, Cai, and Peng, 2015). For example, the researchers found that when teaching children a motor learning task, first and third graders performed better than fifth graders using the part-task training approach (Chan et al., 2015).

Whole-Task Training

Other literature has found whole-task training to be more effective than part-task training for complex tasks. For example, Briggs and Brogden (1954) found whole-task training to be superior to several types of part-task training for certain coordination-related tasks. However, the researchers considered this particular task to be low in complexity (Briggs & Brogden, 1954). Therefore, the researchers suggest that whole-task methods may not be superior to part-task methods as task complexity increases (Briggs & Brogden, 1954). However, Naylor and Briggs (1963) found whole-task training to be more effective for tasks that are highly complex. Additionally, Wightman and Lintern (1985) found whole-task training to be an overall more effective method for training complex tasks. These studies help explain the narrower debate on whether task complexity is the variable that influences training method effectiveness.

Whole-task training has been utilized in educational settings. For example, in 1969, Blake and Williams compared part-task training to whole-task training using groups with three different learning abilities. The researchers found no real differences between the reactions to the training methods that each group received. However, all three groups performed best when they were trained using the whole method (Blake & Williams, 1969). Additionally, Lim, Reiser, and Olina (2008) compared part-task training to whole-task training to train participants to create a grade book in Microsoft Excel. These researchers found that participants who were trained in the whole-task condition performed better than the participants in the part-task condition (Lim, Reiser, and Olina, 2008).

Even if whole-task training is not shown to be more effective, it is still preferred to part-task training methods often because the costs for administering whole-task training are relatively cheaper (Teague, Gittelman, & Park, 1994). For simulators, however, it has shown to be cheaper to administer part-task training on the most important parts of a task in order to avoid the costs and complexities of building an entire simulation (Adams & Hufford, 1962).

The Missing Gap: Retention

Although the majority of literature shows evidence of part-task training as a more effective method for training complex tasks than whole-task training, there is some research that indicates *whole-task* training is more effective. One aspect of these experimental designs that most researchers have failed to measure is retention. Most studies have only measured performance immediately after training has ended (e.g., Naylor and Briggs, 1963; Fingeret and Brogden, 1970; Wightman and Lintern, 1985; Salden, Paas, and Merriënboer, 2006).

One study that did measure retention two weeks after training ended was conducted by So, Proctor, Dunston, and Wang in 2013. The researchers trained university students on a simulated hydraulic excavator task, in which there were three phases of measurement: the training phase, the immediate testing phase, and the retention phase (So, Proctor, Dunston, & Wang, 2013). The students were randomly assigned to either the part-task training group or the whole-task training group. The results of this study concluded that part-task training was more effective than whole-task training in terms of immediate performance as well as retention (So et al., 2013).

The purpose of the present study was to determine whether part-task training or whole-task training is more effective for learning simple and complex tasks. In addition, the researchers incorporated the retention measure from the So et al. (2013) study into a new assessment of training effectiveness using a different task. The present study trained some participants on a complex task (Wii Archery) and some participants on a simple task (Wii Swordplay). These tasks were chosen because research shows that motion-controlled video-games can positively influence video-game performance as well performance on real-world tasks (Downs & Oliver, 2016). The researchers measured performance immediately after training, and they measure retention approximately ten to twenty days after training has ended.

Although previous literature shows mixed results concerning which training method is superior, it appears the majority of literature favors the part-task method for complex tasks. The researchers side with this position and therefore propose the following:

Hypothesis: Part-task training will be superior to whole-task training for learning complex tasks.

Additionally, there is not adequate research describing which training method is superior for training simple tasks. Therefore, the researchers pose the following research question:

RQ: Will part-task training or whole-task training be superior for teaching simple tasks?

METHODS

Measures and Procedures

Pilot. Before the study began, the researchers held a pilot test to determine the specific tasks to be assigned. Graduate students played a variety of Wii games in one sitting. The games consisted of archery, bowling, tennis, and sword fighting. After sampling each game, the students filled out a scale adapted from Maynard and Hakel in 1997. This scale included items that assessed the subjective complexity and difficulty of each game as well as measuring the motivation of each student playing the game. The Likert scale consisted ratings ranging from 1 (*Totally Disagree*) to 7 (*Totally Agree*). Subjective task complexity consisted of five items, and motivation consisted of four items. Each variable was scored by taking the averages of the items coinciding with each variable. The researchers chose sword fighting as the simple task to be compared because it had the lowest subjective task complexity rating of 2.12 out of 7. Respondents also reported having the least motivation with this game, with an average motivation rating of 5.5 out of 7. The researchers chose archery as the complex task because it had the highest average subjective task complexity rating of 5.72 out of 7. Respondents also reported an average higher motivation rating of 6.4 out of 7. Although sword fighting had the lowest average motivation rating, the researchers chose to use this game as the simple task because both archery and sword fighting consist of multiple levels. In this regard, it is easier to rule out pre-existing differences in the tasks. The Task Complexity Scale can be found in Appendix A.

Materials. The Nintendo Wii was used to observe task performance. All participants filled out a State Trait Expression Inventory adapted from Spielberger, Krasner, and Solomon (1988). This was later adapted further by Jackson, Howes, Kausel, Young, and Loftis in 2018. This was administered during the first session before and after playing, and it can be found in Appendix B. This scale was not administered during the second session. The researchers introduced this scale to see if differences in emotional states influenced performance or vice versa. The inventory consisted of 8 items in which a participant had to rate each item from 1 ("Not at all like me") to 5 ("Very much like me"). Each item represented a different personality state, and these states were considered to be either a happy state or an angry state. A high score on items including pleased, calm, joyful and happy indicates that the participant was happy during and after playing. A high score on items including angry, furious, mad, or frustrated indicates that an individual was upset during and after playing. Scores were calculated by computing the mean and comparing means across the two administrations. The internal consistency reliability for the pre-training administration of the happy items was $\alpha = 0.76$. The internal consistency reliability for the pre-training administration of the angry items was $\alpha = 0.72$. The internal consistency reliability for the post-training administration of the happy items was $\alpha = 0.84$. The internal consistency reliability for the post-training administration of the angry items was $\alpha = 0.58$. Participants were also given a set of assigned instructions based on the condition assigned. These can be found in Appendices E, F, G, and H. Additionally, participants who came back for the second session filled out a post-study survey. The purpose of this survey was to gather information regarding the individual differences that exist within participants.

Participants. For this study, approximately 84 students from Middle Tennessee State University (29 males and 55 females) were randomly assigned to either the part-task group or whole-task group. A number of participants did not come back for the second half of the study, resulting in 69 total participants who participated in the entire study. Ages for participants ranged from 18 to 45, with an average age of 20.32, SD = 4.34. The researchers used a SONA research pool to recruit participants, and these students received research credit for their participation. When signing up for the study, students were made aware they were encouraged to come back to finish the second half of the study. Students received one credit for showing up for the first session, but they did not receive a second credit until they showed up for the second session. Additional students were recruited from two intact psychology classes, and they were given class credit for their participation. Additionally, they were made aware that they could not receive credit for the second session unless they attend the first session. For students who were enrolled in both classes, they were given the opportunity to receive one credit for one class and another credit for the other class. However, they could not receive two credits for both classes. After the second session students were given a demographic questionnaire.

Apparatus. All training sessions and tests were performed using the Nintendo Wii. The researchers used Wii Archery as the complex task and Wii Swordplay game as the simple task. Wii Archery was chosen as the complex task due to the fact that it has three different difficulty levels (i.e. Beginner, Intermediate, Expert). These different levels allowed the researchers to break down the entire game into smaller parts that could be trained. It also had the highest average subjective task complexity score. Wii Swordplay was chosen as the simple task because it had the lowest subjective task complexity score. In addition, this game only requires use of the main controller, whereas, Archery requires use of the main controller *and* the nunchuk. Wii Swordplay also has multiple levels, so three levels were chosen for this game in order to keep both game conditions parallel.

Experimental Task and Design. The participants were not randomly sampled. In the part-task condition of the archery task, participants practiced three different levels of difficulty: Beginner, Intermediate, and Expert. Each level had four targets to hit, and the participant had three opportunities to hit each target. The whole-task condition consisted of only the Expert level. The objective of the game is to aim as closely to the bullseye as possible. The closer one gets to the bullseye, the more points an individual receives.

In the part-task condition of the Swordplay task, participants practiced also practiced three different levels of difficulty: Level 1, Level 2, and Level 3. Each level required the participant to fight all opponents, while maintaining a high combo score and keeping as many lives (hearts) as possible. The whole-task condition solely consisted of training on Level 3.

The researchers determined training method effectiveness by measuring individual performance on the highest level of the game. Performance was measured by total points scored by each individual participant. More points indicate higher performance, which in turn shows which training method is more effective.

All participants were measured at two different points in time: immediately after training and approximately 10 to 20 days after training. The initial test measured immediate performance, and the second test measured retention, which in turn measured skill acquisition.

Procedure. Participants were randomly assigned to either the part-task condition for the Archery task, the whole-task condition for the Archery task, the part-task condition for the Swordplay task, and the whole-task condition for the Swordplay task. For the first session, the students were informed of the study's procedures as well as the purpose of the game, which is to aim as closely to the bullseye as possible to get as many points as possible for Wii Archery and to defeat as many people without getting hit for Wii Swordplay. Before receiving instructions, participants filled out the State Trait

Anger Expression Inventory crafted by Spielberger, Krasner, and Solomon in 1988. Before playing commenced, participants in the archery condition were given a list of instructions for operating the Wii controller and nunchuck device that are used during the archery task. Participants in the swordplay condition were only given a list of instructions for operating the controller because the nunchuck is not an accessory essential for carrying out this particular task. Each condition had a slightly different set of instructions due to the different methods of training, resulting in four different sets of instructions: archery whole-task, archery part-task, swordplay whole-task, and swordplay part-task. These are included in Appendices E, F, G, and H.

Participants in the both the archery part-task training condition and swordplay part-task training condition were asked to practice skills for three different difficulty levels on the Wii. Each level is considered a different trial, and each trial lasted approximately 8 minutes. Once the 8 minutes lapsed, participants took a one-minute break before moving on to the next level. Participants in the whole-task condition only practiced the highest level of difficulty (the third trial for the part-task condition) for approximately 24 minutes. Every 8 minutes, however, the participants took a one-minute break just as the part-task participants did. After the 24 minutes of practice was over, participants in all conditions filled out the State Trait Anger Expression Inventory again and then were allowed to leave.

Students came back for the second session between 10-20 days after their first session. The students were advised not to play the assigned game at all in-between sessions. The purpose of these instructions was to measure retention, which shows if participants retained any skills they learned from the first test or if performance decreased. This retention test helps to control for individual differences between each of the participants. For the second session, students played the same game they were previously assigned to for the first session. However, for this session the students only played for 8 minutes on the third level ("Beach" for Swordplay and "Expert" for Archery). After the 8 minutes lapsed, students filled out a post-study survey. The survey covered demographic information (age, class, gender, dominant hand) as well prior Wii experience (before the first session and/or in between sessions).

Data Analysis

A two-way Analysis of Variance (ANOVA)was conducted to test the effects of training method (part task, whole task) and task type (simple, complex) on skill acquisition (session 1, session 2), resulting in one ANOVA per condition. After the retention test, the researchers administered a post-experimental questionnaire to the students in each condition. This questionnaire asked if any student had ever played the assigned game on the Wii prior to this study. The students were also asked if they had played the game in between the time the immediate test of performance was taken the retention test. If students answered yes, then they were asked how often they played and for how long.

An additional variable that was not included in the analysis but was still measured was state affect before and after training. The researchers wanted to observe whether there was a correlation between state affect and performance.

To restate, the independent variables included training method (part-task, whole-task) and task type (Swordplay=simple, Archery=complex). The dependent variable is immediate performance, which is collected at Time 1 through the average performance of each participant along with the best performance for each participant. Another dependent variable is retention, which is collected at Time 2 through the average performance of each participant along with the best performance for each participant.

RESULTS

Table 1
Descriptive Statistics

	N	Mean	Standard Deviation
Age	71	20.32	4.34
Class	70	1.89	1.08
# times played prior	67	16.15	97.86
# played in between sessions	70	0.03	0.24
T1: Swordplay Combo Avg.	43	12.85	3.45
T1: Swordplay Combo Best	43	22.67	6.98
T1: Archery Average	41	57.73	15.45
T1: Archery Best	41	76.44	18.75
T2: Swordplay Combo Avg.	35	12.24	3.64
T2: Swordplay Combo Best	35	16.77	5.45
T2: Archery Average	35	53.68	12.35
T2: Archery Best	35	60.89	14.40

*Class: 1=Freshman, 2=Sophomore, 3=Junior, 4=Senior

Descriptive statistics are provided in the table above. "# of times played prior" refers to the number of times the participant had played his or her assigned game prior to participating in the experiment. "# played in between sessions" refers to the number of times the participant played his or her assigned game in between Session 1 and Session 2. T1 refers to scores collected at Time 1, and T2 refers to the scores collected at Time 2. Combo is one of the data points collected for performance measures for the Swordplay task. The Combo captured performance for those participants who played Swordplay. Scores for Archery were straightforward and simply referred to as a composite score. In order to compare means, Z-scores were calculated. However, raw scores were used in the actual analysis because results were the same using either method.

Swordplay Combo Average is considered the average total score one received during Swordplay. Combo Best refers to the best score one received during each session playing Swordplay. Archery Average refers to the average total score one received while playing Archery. Archery Best refers to the best score one received of all the trials in each session for Archery. None of these demographic variables were used as controls because there were no meaningful differences found for these variables. The researchers did not control for when Session 2 occurred. The days in between were calculated but not included in further analyses because the time in between sessions only ranged from 10 to 20 days. The researchers still measured everyone at least ten days apart, which is more than what other research has considered. The researchers determined that additional days after the 10-day mark might have a significant impact on skill acquisition. However, this was not the focus of this study, and the researchers chose to analyze this separately, and this was not included in this document. This will contribute to further studies regarding retention.

Table 2

Estimated Marginal Means for Swordplay Combo Average Scores

Condition	Session	Mean	Standard Error	N
Part-task	Time 1	15.40	.688	16
	Time 2	12.22	.924	19
Whole-task	Time 1	10.77	.632	16
	Time 2	12.26	.848	19

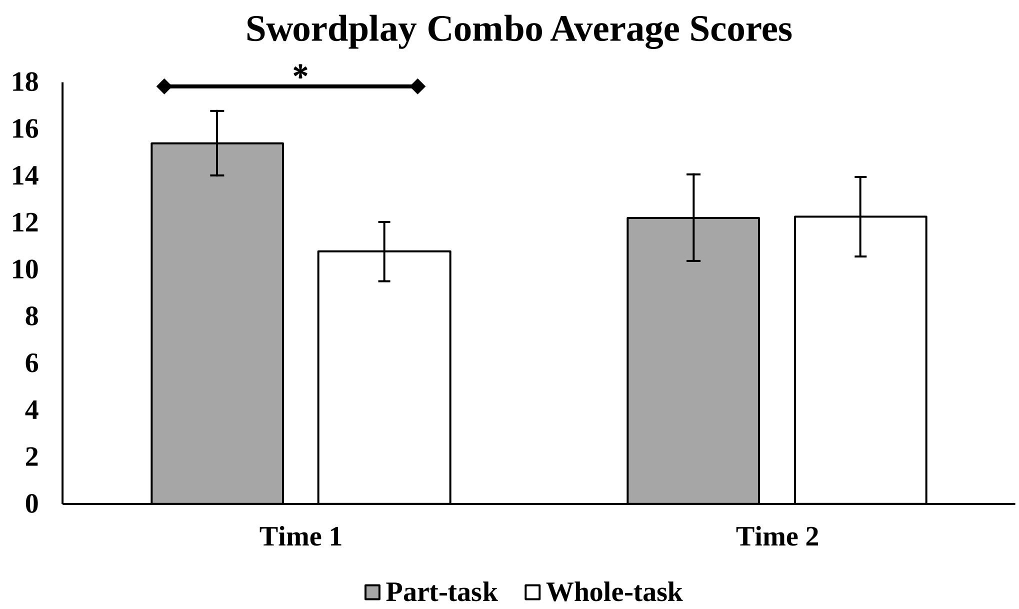


Figure 1. *Swordplay Combo Average Scores. * Indicates a significant difference at the .05 level. Error bars represent SEM*2 to represent a 95% confidence interval.*

Estimated marginal means and standard errors for Swordplay Combo average by session and condition are shown in Table 2. A two-way Repeated Measures (RM) ANOVA with session (Time 1, Time 2) as a within-subjects factor and condition (part-task, whole-task) as a between-subjects factor was used to examine differences in Swordplay Combo average performance. A familywise alpha of .05 was used. There was a significant main effect for condition, F (1, 33) = 5.63, p = .024. There was not a significant main effect for session time, F (1, 33) = 2.44, p = .128. These effects were qualified by a significant interaction between session time and condition, F (1, 33) = 18.74, p < .01. The part-task condition performed better for the first session, but there were no meaningful differences in performance found between the two conditions for the second session.

Table 3

Estimated Marginal Means for Swordplay Best Combo Scores

Condition	Session	Mean	Standard Error	N
Part-task	Time 1	27.06	1.47	16
	Time 2	16.69	1.38	19
Whole-task	Time 1	18.90	1.35	16
	Time 2	16.84	1.27	19

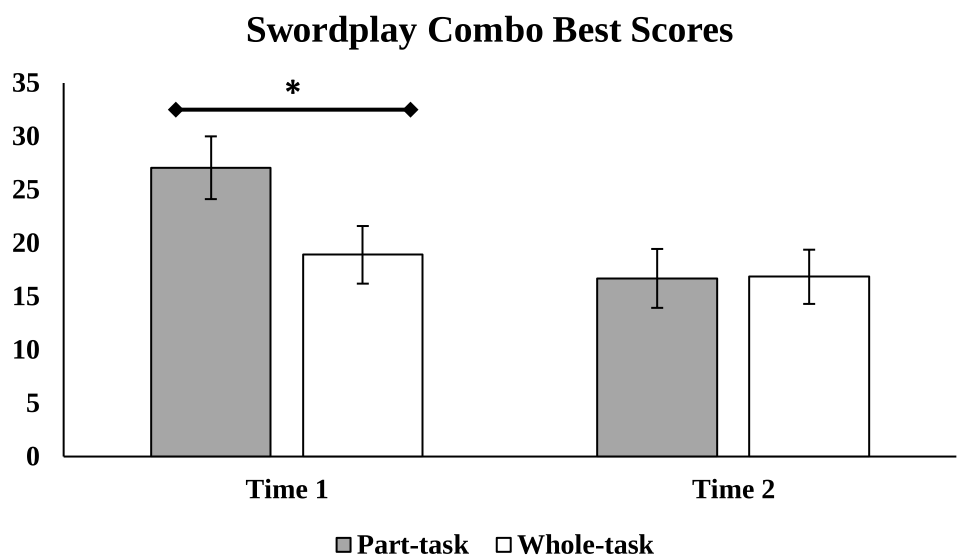


*Figure 2. Swordplay Combo Best Scores. * Indicates a significant difference at the .05 level. Error bars represent SEM*2 to represent a 95% confidence interval.*

Estimated marginal means and standard errors for Swordplay best Combo by session and condition are shown in Table 3. A two-way RM ANOVA with session (Time 1, Time 1) as a within-subjects factor and condition (part-task, whole-task) as a between-subjects factor was used to examine differences in Swordplay best Combo performance. There was a significant interaction between session time and condition, F (1, 33) = 15.10, p < .01. There was a significant main effect for session time, F (1, 33) = 33.67, p < .01. There was also a significant main effect for condition, F (1, 33) = 6.19, p = .018. The part-task condition performed better for the first session, but there were no meaningful differences in performance found between the two conditions for the second session.

Table 4
Estimated Marginal Means for Archery Average Score

Condition	Session	Mean	Standard Error	N
Part-task	Time 1	68.10	2.97	18
	Time 2	52.81	2.95	17
Whole-task	Time 1	46.25	3.06	18
	Time 2	54.60	3.03	17

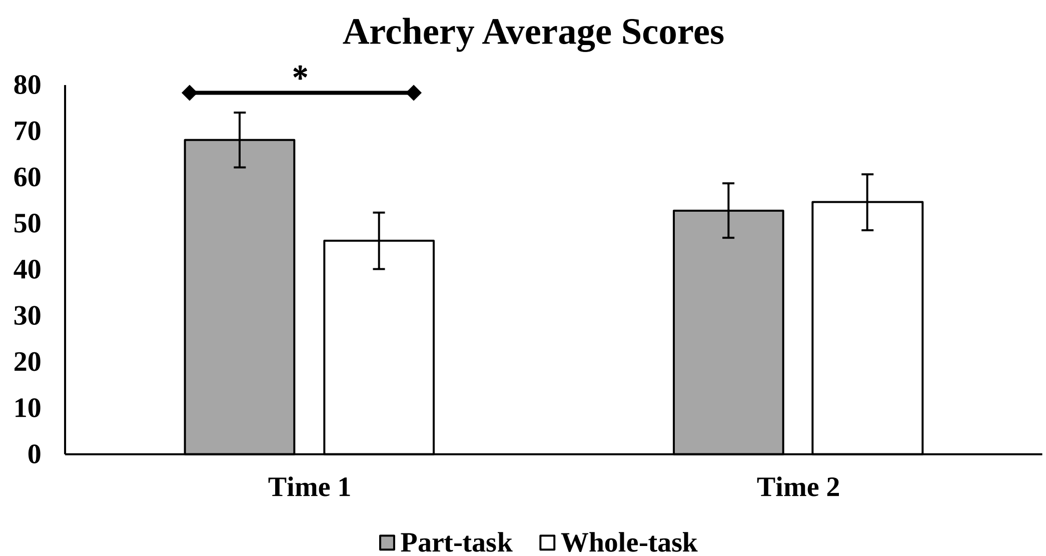


*Figure 3. Archery Average Scores. * Indicates a significant difference at the .05 level. Error bars represent SEM*2 to represent a 95% confidence interval.*

Estimated marginal means and standard errors for Archery average score by session and condition are shown in Table 4. A two-way RM ANOVA with session (Time 1, Time 2) as a within-subjects factor and condition (part-task, whole-task) as a between-subjects factor was used to examine differences in Archery average performance. There was a significant interaction between session time and condition, *F* (1, 33) = 69.95, $p <$ .01. There was a significant main effect for session time, *F* (1, 33) = 6.03, $p = .020$. There was also a significant main effect for condition, *F* (1, 33) = 6.28, $p = .017$. The part-task condition performed better for the first session, but there were no meaningful differences in performance found between the two conditions for the second session.

Table 5

Estimated Marginal Means for Archery Best Score

Condition	Session	Mean	Standard Error	N
Part-task	Time 1	90.39	3.21	18
	Time 2	59.50	3.43	17
Whole-task	Time 1	61.88	3.31	18
	Time 2	62.35	3.53	17

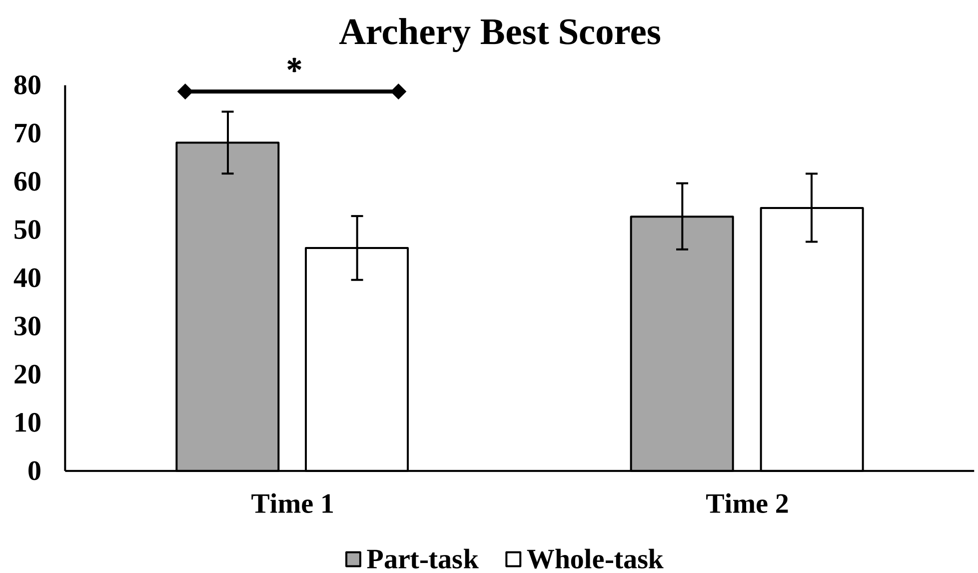


*Figure 4. Archery Best Scores. * Indicates a significant difference at the .05 level. Error bars represent SEM*2 to represent a 95% confidence interval.*

Estimated marginal means and standard errors for Archery best score by session and condition are shown in Table 5. A two-way RM ANOVA with session (Time 1, Time 2) as a within-subjects factor and condition (part-task, whole-task) as a between-subjects factor was used to examine differences in Archery best performance. There was a significant interaction between session time and condition, F (1, 33) = 69.00, $p < .01$. There was a significant main effect for session time, F (1, 33) = 64.92, $p < .01$. There was also a significant main effect for condition, F (1, 33) = 8.59, $p = .006$. The part-task condition performed better for the first session, but there were no meaningful differences in performance found between the two conditions for the second session.

DISCUSSION

There are many ways for training a variety of tasks. Two methods that have been studied in the past are whole-task training and part-task training. The majority of research has found part-task training to be superior to whole-task training for teaching complex tasks. However, some studies have shown contradictory results. The purpose of this study was to compare both types of training in order to determine which method was superior for training certain types of tasks. The researchers hypothesized that part-task training would be superior to whole-task training for complex tasks. A research question was also posed as to which training method would be superior for teaching simple tasks.

For participants who played Swordplay, the part-task condition on average performed better for the first session, but there were no significant differences in performance found between the two conditions for the second session. For participants who played Archery, the part-task condition on average performed better for the first session, but there were no meaningful differences in performance found between the two conditions for the second session. Therefore, the type of task did not appear to have a meaningful influence on performance, regardless of how participants were trained (part-task or whole-task). For both games, the part-task condition outperformed the whole-task condition for the first session. This shows that training method had an initial influence on task performance. However, for the second session, all conditions performed relatively the same. Therefore, training method did not have an influence on overall retention.

The hypothesis was partially supported due to the fact that participants in the part-task condition did perform better on the complex task during the first session. However, these results did not hold true for the second session. Therefore, there is only partial support for the hypothesis. As for the research question, the researchers asked what type of training would be the most effective for teaching simple tasks. The results were similar to those for the complex task. Part-task training appeared to be more effective at the outset; however, neither training method had a meaningful influence on actual retention. So et al. (2014) also found part-task training to be more effective for tests of immediate performance. However, they also found that part-task training was more effective for measures of retention. Therefore, the findings from this study partially support previous research.

All participants who attended both sessions returned for the second session between 10 and 20 days after appearing for the first session. This may partially explain why other studies with a shorter time period in between sessions (1 week or less) found part-task training to be superior for immediate performance as well as for retention. Another interesting observation from the findings is that although performance was superior for the part-task condition during the first session, performance decreased for the second session. Additionally, in three of the four scores calculated for performance, the whole-task condition's performance actually increased from Time 1 to Time 2.

Due to today's growing world of technology, the results from this study can help identify certain types of online or on-the-job training that may be beneficial for employees in the workplace. For example, Eichenbaum, Bavelier, and Green (2014) found that video games helped to promote job-related skills. Additionally, Boot, Blakely, and Simons (2011) claimed that, "Game training holds great promise as one of the few training techniques to show transfer beyond the trained task". Finally, Badurdeen, Abdul-Samad, Story, Wilson, Down, and Harris (2010) conducted a study using the Nintendo Wii. They found that exposure to this gamed helped improve performance on a basic surgical task (Badurdeen et al., 2010).

LIMITATIONS AND FUTURE RESEARCH

One potential limitation of this study was the use of Wii games to train participants. There may not have been enough differentiation between Swordplay and Archery in order to distinguish one game as a simple task and the other one as a complex task. Therefore, future research should look at other types of tasks to see if the results hold true for different types of tasks. Both of the tasks in this study were psychomotor tasks, so future research should explore other, more cognitive tasks.

Additionally, some participants did not return for the second session. Therefore, the results from this study are limited to the participants who came back, and they may not be conclusive. There may not have even been a large enough sample at the outset of the experiment. This could have led the researchers to consider meaningful differences, when they may have not been meaningful if a larger sample was used.

Another potential limitation may be the generalizability of the results of the study to other individuals. The sample collected came from an accredited university, and most of the students had prior knowledge of Wii games. This could have influenced performance, and therefore, may not generalize to other, maybe older populations who are not as often exposed to the Nintendo Wii.

The researchers encourage future research to explore other types of tasks as well as other methods for training in order to identify what conditions work best for training certain kinds of tasks.

CONCLUSION

To conclude, the research regarding the effectiveness of part-task training versus whole-task training for certain types of tasks is mixed, although more literature leans toward part-task training as the more effective method for complex tasks. What most studies have failed to consider is whether actual learning has resulted from different types of training. Most studies have only tested performance immediately after training but not again after this. Therefore, the purpose of this study was to determine what methods were more effective for certain types of tasks on immediate performance as well as retention (10-20 days after First Session). Participants were assigned to one of four conditions: Swordplay Part-task, Swordplay Whole-task, Archery Part-task, and Archery Whole-task. Participants were trained according to their assigned condition for Session 1, and participants performed a final round (without training) during the Session 2.

The researchers found that part-task training for both tasks was significantly better than whole-task training on the test of immediate performance during Session 1. However, there were no significant differences found between the two conditions on the learning test during Session 2. Hypothesis 1 was partially supported because the part-task condition did perform better than the whole-task condition for the complex task. However, both conditions performed similarly for Session 2. The researchers encourage future research to delve further into capturing measures of retention.

REFERENCES

Adams, J. A., & Hufford, L. E. (1962). Contributions of a part-task trainer to the learning and relearning of a time-shared flight maneuver. *Human Factor,* 159-170.

Anderson, R. C. (1968). Part-task versus whole-task procedures for teaching a problem-solving skill to first graders. *Journal of Educational Psychology, 59(3)*, 207-214.

Ash, D. W. & Holding, D. H. (1990). Backward versus forward chaining in the acquisition of a keyboard skill. *Human Factors, 32(2),* 139-146.

Badurdeen, S., Abdul-Samad, O., Story, G., Wilson, C., Down, S., and Harris, A. (2010). Nintendo Wii video-gaming predicting laparoscopic skill. *Surgical Endoscopy, 24,* 1824-1828.

Bailey, J., Hughes, R. G., & Jones, W. E. (1980). *Application to backward chaining to air-to-surface weapons delivery training.* Flying Training Division, Air Force Human Resources Laboratory.

Blake, K. A., and Williams, C. L. (1969). Retarded, normal, and superior subjects: Learning of paired associates by whole and parts methods. *Psychological Reports, 25,* 319-324.

Boot, W. R., Blakely, D. P., and Simons, D. J. (2011). Do action video games improve perception and cognition? *Frontiers in Psychology, 2(226),* 1-6.

Briggs, G. E., and Brogden, W. J. (1954). The effect of component practice on performance of a lever-positioning skill. *Journal of Experimental Psychology, 48(5),* 375-380.

Briggs, G. E., and Naylor, J. C. (1962). The relative efficiency of several training methods as a function of transfer task complexity. *Journal of Experimental Psychology, 64,* 505-512.

Briggs, G. E., and Waters, L. K. (1958). Training and transfer as a function of component interaction. *Journal of Experimental Psychology, 56,* 492-500.

Chan, J. S. Y., Luo, Y., Yan, J. H., Cai, L., and Peng, K. (2015). Children's age modulates the effect of part and whole practice in motor learning. *Human Movement Science, 42,* 262-272.

Cunningham, D. J. (1971). Task analysis and part versus whole learning methods. *AV Communication Review, 19(4),* 365-398.

Downs, E. & Oliver, M. B. (2016). How can Wii learn from video games? Examining relationships between technological affordances and socio-cognitive determinates on affective and behavioral outcomes. *International Journal of Gaming and Computer-Mediated Solutions, 8(1),* 28-43.

Eichenbaum, A., Bavelier, D., and Green, S. C. (2014). Video games: Play that can do serious good. *American Journal of Play, 7(1),* 50-72.

Fingeret, A. L. & Brogden, W. J. (1970). Part versus whole practice in the acquisition of serial lists as a function of class and organization of material. *Journal of Experimental Psychology, 83(3),* 406-414.

Hasher, L. (1971). Retention of free recall learning: The whole-part problem. *Journal of Experimental Psychology, 90(1),* 8-17.

Jackson, A. T., Howes, S. S., Kausel, E. E., Young, M. E., and Loftis, M. E. (2018). The reciprocal relationships between escalation, anger, and confidence in investment decisions over time. *Frontiers in Psychology, 9(1136),* 1-13.

Lim, J., Reiser, R. A., & Olina, Z. (2008). The effects of part-task and whole-task instructional approaches on acquisition and transfer of a complex cognitive skill. *Educational Technology Research and Development, 57,* 61-77.

Mané, A. M. (1984). Acquisition of perceptual-motor skill: adaptive and part-whole training. *Proceedings of the Human Factors Society*.

Maynard, D. C., Hakel, M. D. (1997). Effects of objective and subjective task complexity on performance. *Human Performance, 10(4),* 303-330.

McDermott, P. L., Carolan, T., and Wickens, C. D. (2012). Part task training methods in simulated and realistic tasks. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 56(1),* 2502-2506.

Naylor, J. C., Briggs, G. E. (1963). Effects of task complexity and task organization on the relative efficiency of part and whole training methods. *Journal of Experimental Psychology, 65(3),* 217-224.

Nettelbeck, T., and Kirby, N. H. (1976). A comparison of part and whole training methods with mildly mentally retarded workers. *Journal of Occupational Psychology, 49(2),* 115-120.

Postman, L., and Goggin, J. (1966). Whole versus part learning of paired-associate lists. *Journal of Experimental Psychology, 71(6),* 867-877.

Salden, R. J. C. M., Paas, F., and Merriënboer, J. J. G. (2006). A comparison of approaches to learning task selection in the training of complex cognitive skills. *Computers in Human Behavior, 22(3),* 321-333.

Schmidt, R. A., and Wrisberg, C. A. (2008). *Motor learning and performance: A situation-based learning approach.* (4th ed.) Champaign, IL: Human Kinetics.

Sheppard, D. J. (1984). *Visual and part-task manipulations for teaching simulated carrier landings* (NAVTRAEQUIPCEN 81-C-0105-9). Orlando, FL: Naval Training Equipment Center.

Smith, G. J. (1999). Teaching a long sequence of behavior using whole task training, forward chaining, and backward chaining. *Perceptual and Motor Skills, 89(3),* 951-965.

So, J. C. Y., Proctor, R. W., Dunston, P. S., Wang, X. (2013). Better retention of skill operating a simulated hydraulic excavator after part-task than after whole-task training. *Human Factors, 55(2),* 449-460.

Spielberger, C. D., Krasner, S. S., and Solomon, E. P. (1988). The experience, expression and control of anger. *Individual Differences, Stress, and Health Psychology,* 89-109.

Stammers, R. B. (1980). Part and whole practice for a tracking task: Effects of task variables and amount of practice. *Perceptual and Motor Skills, 50,* 203-210.

Teague, R. C., Gittelman, S. S., Park, O. (1994). *A review of the literature on part-task and whole-task training and context dependency.* U.S. Army Research Institute for the Behavioral and Social Sciences.

Weiss, K. M. (1978). A comparison of forward and backward procedures for the acquisition of response chains in humans. *Journal of the Experimental Analysis of Behavior, 29(2*), 255-259.

Westra, D. P. (1982). *Investigation of simulator design features for carrier landing: 11. In-simulator transfer of training* (NAVTRAEQUIPCEN 81-C-0105-1). Orlando, FL: Naval Training Equipment Center.

Wickens, C. D., Hutchins, S., and Carolan, T. (2013). Effectiveness of part-task training and increasing-difficulty training strategies: A meta-analysis approach. *Human Factors, 55(2),* 461-470.

Wightman, D. C. (1983). Part-task training strategies in simulated carrier landing final approach training. (NAVRAEQUIPCEN 1H-347). Orlando, FL: Naval Training Equipment Center.

Wightman, D. C. & Lintern, G. (1985). Part-task training for tracking and manual control. *Human Factors, 27(3),* 267-283.

Wightman, D. C. & Sistrunk F. (1987). Part-task training strategies in simulated carrier landing final-approach training. *Human Factors, 29(3),* 245-254.

APPENDICES

Appendix A: Adapted Task Complexity Scale

	Totally Disagree	*Mostly Disagree*	*Somewhat Disagree*	*Neither Agree Nor Disagree*	*Somewhat Agree*	*Mostly Agree*	*Totally Agree*
1. I found this to be a complex task.	1	2	3	4	5	6	7
2. This task was mentally demanding.	1	2	3	4	5	6	7
3. This task was physically demanding.	1	2	3	4	5	6	7
4. I found this to be a challenging task.	1	2	3	4	5	6	7
5. I was motivated to perform well on this task.	1	2	3	4	5	6	7
6. This task was interesting to me.	1	2	3	4	5	6	7
7. I put a lot of effort into figuring out how to perform as well as possible.	1	2	3	4	5	6	7
8. This task required a lot of hand-eye coordination.	1	2	3	4	5	6	7
9. I kept trying my best up until the very end.	1	2	3	4	5	6	7

Reference: Maynard & Hakel, 1997.

Appendix B: State Affect Scale

Below you will find several adjectives about yourself. How are you feeling **right now**?

	Not at all like me				Very much like me
Angry	1	2	3	4	5
Pleased	1	2	3	4	5
Furious	1	2	3	4	5
Calm	1	2	3	4	5
Joyful	1	2	3	4	5
Mad	1	2	3	4	5
Happy	1	2	3	4	5
Frustrated	1	2	3	4	5

Reference: Spielberger, Krasner, and Solomon, 1988.

Appendix C: SONA Description

This study is looking at how practice influences performance on Wii games. There are two sessions included in this study. For the first session, participants will practice playing a Wii Sports game for approximately 30-40 minutes. They will then be encouraged to return for the second session approximately three weeks later to only perform the last ten minutes from the first session. If you choose to participate in the first session, you will receive 1 SONA credit. If you choose to attend the second session, you will receive an additional SONA credit. However, you will not receive the second credit until you have finished the second session. Additionally, you are not able to receive the second credit unless you previously attended the first session.

If you have any questions, please feel free to contact:

Primary Investigator
Kerstie Hillman
Department of Psychology
Middle Tennessee State University
Kmh2bg@mtmail.mtsu.edu

Faculty Advisor
Dr. Michael Hein
Department of Psychology
Middle Tennessee State University
Michael.Hein@mtsu.edu

Appendix D: Class Hand-Out

We are looking for volunteers!

This study is looking at how practice influences performance on Wii games. This study includes two different sessions. For the first session, participants will practice playing a Wii game for approximately 30 minutes, and then they will be asked to play an additional 10 minutes, so the researchers can observe their performance. The second session will take place approximately three weeks after the first session, and participants will only perform the last 10 minutes of the game from the previous session. If you choose to participate in the first session, then you will receive class credit for this class. If you choose to participate in the second session, then you will receive additional credit for this class. However, you will not receive the additional credit from the second session until after you have attended this second session. Additionally, you will not be able to receive credit for the second session unless you previously attended the first session.

***NOTE: If you are in Dr. Jackson's class and Dr. Moffett's class, then you can choose which class your credit goes towards. If you attend both sessions, you are able to allocate points from the first session for one class and points for the second session to the other class. However, you cannot receive double points for both classes.

If you have any questions about this study, please contact:

Primary Investigator
Kerstie Hillman
Department of Psychology
Middle Tennessee State University
Kmh2bg@mtmail.mtsu.edu

Faculty Advisor
Dr. Michael Hein
Department of Psychology
Middle Tennessee State University
Michael.Hein@mtsu.edu

Appendix E: Archery Whole-Task Instructions

You will be playing the Archery game on the Wii. You will play for approximately 24 minutes with 1-minute breaks for every 8 minutes of playing time. The goal of the game is to shoot your arrow and get it as close to the bullseye as possible.

Each round will consist of 4 targets you are supposed to hit. Each target will be further away from the previous target. There are 10 rings on each target. The outermost ring is worth 1 point, while the innermost ring (the bullseye) is worth 10 points. You will have 3 opportunities to shoot each target. This means, you have the ability to make a total of 30 points per target, which totals a possible 120 points per round. You want to collect as many points as possible.

Be aware that there may be obstacles in your path that make it more difficult to aim for the target. There also might be secret hidden targets that are out of the way. If you hit one of these targets, you will get 10 points. However, this will count as one of your three shots.

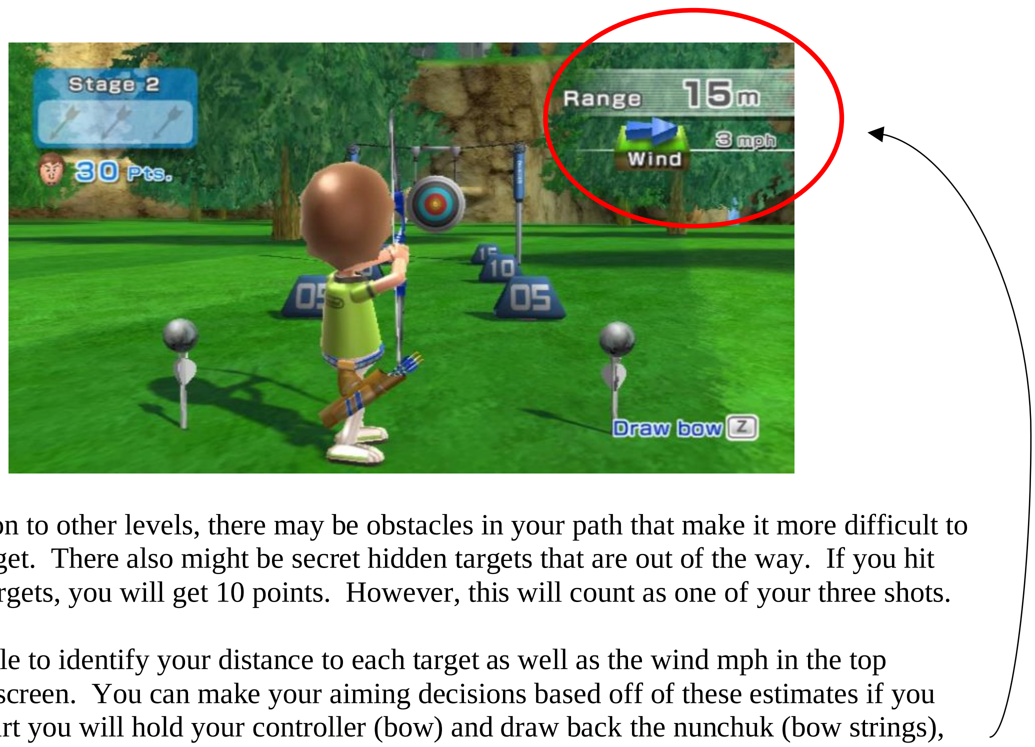
You will be able to identify your distance to each target as well as the wind mph in the top corners of the screen. You can make your aiming decisions based off of these estimates if you choose. To start you will hold your controller (bow) and draw back the nunchuk (bow strings), and the game will focus in on a target. The controller should be facing right side upwards (vertical). To aim, you will tilt the controller forward or backward to simulate up and down movements. You can also rotate the controller to the left or right in order to aim left or right. You can choose to release when you feel the focus is on whatever you are trying to hit. However, if you wait too long, the retinal will lose focus. When it loses focus, the controller will start blinking, and you will have to start over.

When you are getting ready to shoot, hold the A button down on the controller. Hold the Z button on the nunchuks to simulate you drawing the arrow back. Let go of the Z button to release your arrow.

Appendix F: Archery Part-Task Instructions

You will be playing the Archery game on the Wii. There are three difficulties: beginner, intermediate, and expert. You will spend about 8 minutes on each level with a 1-minute break in between levels. The goal of the game is to shoot your arrow and get it as close to the bullseye as possible.

Each level will consist of 4 targets you are supposed to hit. Each target will be further away from the previous target. There are 10 rings on each target. The outermost ring is worth 1 point, while the innermost ring (the bullseye) is worth 10 points. You will have 3 opportunities to shoot each target. This means, you have the ability to make a total of 30 points per target, which totals a possible 120 points per level. You want to collect as many points as possible.



As you move on to other levels, there may be obstacles in your path that make it more difficult to aim for the target. There also might be secret hidden targets that are out of the way. If you hit one of these targets, you will get 10 points. However, this will count as one of your three shots.

You will be able to identify your distance to each target as well as the wind mph in the top corners of the screen. You can make your aiming decisions based off of these estimates if you choose. To start you will hold your controller (bow) and draw back the nunchuk (bow strings), and the game will focus in on a target. The controller should be facing right side upwards (vertical). To aim, you will tilt the controller forward or backward to simulate up and down movements. You can also rotate the controller to the left or right in order to aim left or right. You can choose to release when you feel the focus is on whatever you are trying to hit. However, if you wait too long, the retinal will lose focus. When it loses focus, the controller will start blinking, and you will have to start over.

When you are getting ready to shoot, hold the A button down on the controller. Hold the Z button on the nunchuks to simulate you drawing the arrow back. Let go of the Z button to release your arrow.

Appendix G: Swordplay Whole-Task Instructions

You will play one assigned level of swordplay for approximately 24 minutes with 1-minute breaks for every 8 minutes of playing.

In Showdown, your Mii runs across a bridge fighting numerous opponents along the way. You get three hearts, which are displayed at the bottom left corner of the screen. One hit from an opponent takes away a heart. After losing all of your hearts, you are taken to the end game screen, where you can try again.

Your total completion during the level is tracked by percentage in the lower right corner of the screen. As you defeat opponents, you can accumulate combos by making chains of hits without mistakes. Being blocked or being hit will end your combo, although swinging and missing entirely will not. A trumpet sounds and your combo count is displayed at a five hit combo, a ten hit combo, and every ten hits from there on.

Your score is increased by using less hearts and having a higher combo (your longest combo is displayed at the end). Your goal is to get as high of a score as you possibly can without losing hearts.
**NOTE: You are starting with zero points, but the game does not reset. Try not to get hung up on the level number because it may not reflect your true score. You can keep track of your score by keeping track of the positive or negative points added after each level is completed.

Appendix H: Swordplay Part-Task Instructions

You will play three rounds of Swordplay, practicing each level for approximately 8 minutes.

In Showdown, your Mii runs through three different levels fighting numerous opponents along the way. You get three hearts, which are displayed at the bottom left corner of the screen. One hit from an opponent takes away a heart. After losing all of your hearts, you are taken to the end game screen, where you can try again or go back to another game.

There are different numbers of opponents on each level, and your total completion during the level is tracked by percentage in the lower right corner of the screen. As you defeat opponents, you can accumulate combos by making chains of hits without mistakes. Being blocked or being hit will end your combo, although swinging and missing entirely will not. A trumpet sounds and your combo count is displayed at a five-hit combo, a ten-hit combo, and every ten hits from there on.

Your score is increased by using less hearts and having a higher combo (your longest combo is displayed at the end). Your goal is to get as high of a score as you possibly can without losing hearts.
**NOTE: You are starting with zero points, but the game does not reset. Try not to get hung up on the level number because it may not reflect your true score. You can keep track of your score by keeping track of the positive or negative points added after each level is completed.

Appendix I: Post-Study Survey

We Encourage You to Answer These After You Have Completed Your Second Session

- How old are you?
- What class level are you?
- What is your gender?
- What side is your dominant hand?
- Did you have prior experience with a Wii before your first session?
- If you had prior experience, had you played this particular game before your first session?
- If you were familiar with this game prior to your first session, approximately how many times had you played?
- Did you play this game in between sessions? If so, how often/how many times?

Appendix J: IRB Approval Form

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

MIDDLE TENNESSEE STATE UNIVERSITY

IRBN001 - EXPEDITED PROTOCOL APPROVAL NOTICE

Wednesday, October 30, 2019

Principal Investigator	**Kerstie Hillman** (Student)
Faculty Advisor	Michael Hein
Co-Investigators	Zachary Swetz, Sarah Graff
Investigator Email(s)	*kmh2bg@mtmail.mtsu.edu; michael.hein@mtsu.edu; zts2v@mtmail.mtsu.edu; sag4p@mtmail.mtsu.edu*
Department	Psychology
Protocol Title	***Part-task training versus whole-task training for simple versus complex tasks***
Protocol ID	**20-2048**

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXPEDITED** mechanism under 45 CFR 46.110 and 21 CFR 56.110 within the category *(7) Research on individual or group characteristics or behavior.* A summary of the IRB action and other particulars in regard to this protocol application is tabulated below:

IRB Action	**APPROVED for ONE YEAR**		
Date of Expiration	8/31/2020	Date of Approval	10/28/19
Sample Size	300 (THREE HUNDRED)		
Participant Pool	Target Population 1: Primary Classification: **General Adults (18 or older)** Specific Classification: **Psychology SONA and other students** Target Population 2: Primary Classification: **NONE** Specific Classification: **NONE**		
Exceptions	Contact information allowed for coordinating research interactions and to award course credit to certain student participants.		
Restrictions	**1. Mandatory signed adult informed consent.** **2. Approved for direct interaction only; NOT approved for online data collection.** **3. Not approved for collecting certain identifiable data, such as, audio/video data, photographs, handwriting samples, and etc.** **4. Mandatory inal report (refer last page).**		
Approved Templates	Signature informed consent and Non-MTSU email recruitment script		
Comments	NONE		

Post-approval Actions

The investigator(s) indicated in this notification should read and abide by all of the post-approval conditions (https://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php) imposed with this approval. Any unanticipated harms to participants, adverse events or compliance breach must be reported to the Office of Compliance by calling 615-494-8918 within 48 hours of the incident. All amendments to this protocol, including adding/removing researchers, must be approved by the IRB before they can be implemented.

Continuing Review **(The PI has requested early termination)**

Although this protocol can be continued for up to THREE years, The PI has opted to end the study by 8/31/2020 The PI must close-out this protocol by submitting a final report before 8/31/2020 Failure to close-out may result in penalties including cancellation of the data collected using this protocol.

Post-approval Protocol Amendments:

Only two procedural amendment requests will be entertained per year. *In addition, the researchers can request amendments during continuing review. This amendment restriction does not apply to minor changes such as language usage and addition/removal of research personnel. .*

Date	Amendment(s)	IRB Comments
10/30/2019	Samantha Koszalka (swk2j - CITI6976213) is added to the study.	ADMIN

Other Post-approval Actions:

Date	IRB Action(s)	IRB Comments
10/30/2019	Spelling in this template was corrected.	ADMIN

Mandatory Data Storage Requirement: All research-related records (signed consent forms, investigator training and etc.) must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data must be stored for at least three (3) years after the study is closed. Subsequently, the data may be destroyed in a manner that maintains confidentiality and anonymity of the research subjects.

The MTSU IRB reserves the right to modify/update the approval criteria or change/cancel the terms listed in this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

Quick Links:

- Post-approval Responsibilities: http://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php

Expedited Procedures: http://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php