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Organizing Learning and Practice to Enhance the Acquisition of Psychomotor Skills in Athletic Training

Ansley Y. Hendrick

ORGANIZING LEARNING AND PRACTICE TO ENHANCE THE ACQUISITION OF PSYCHOMOTOR SKILLS IN ATHLETIC TRAINING

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the College of Graduate Studies of

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In Partial Fulfillment

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In the Department of

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by

Ansley Y. Hendrick

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To the Graduate School:

This thesis, entitled "Organizing Learning and Practice to Enhance the Acquisition of Psychomotor Skills in Athletic Training Education," and written by Ansley Y. Hendrick, is presented to the College of Graduate Studies of Georgia Southern University. I recommend that it be accepted in partial fulfillment of the requirements for the Master of Science Degree in the Department of Health and Kinesiology.

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DEDICATION

In recognition of all her care, concern, and dedication to the education of undergraduate athletic training students, I hereby dedicate this thesis to the late Aimee Gunnoe.

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Introduction

Athletic training education has changed drastically in the last few years. One major development is the institution of a formal evaluation of students' clinical proficiencies.[1] In many athletic training education curricula, skill performance is acquired and demonstrated in laboratory class settings. Although the competency of all clinical proficiencies is a requirement of all accredited athletic training education programs (ATEP), currently there exists no literature to support superior teaching and learning methods for skill acquisition in athletic training education. One teaching approach has been to present the entire lesson through lecture and demonstration, and then to incorporate a blocked practice session (one skill practiced repeatedly) at the end of the instructional session to practice the skills that were taught. An alternative approach adopted from motor learning and pedagogy is to incorporate the organizational strategy of chunking[2] into a lesson, coupled with random and variable practice during the psychomotor skill practice sessions. By chunking (segmenting into parts)[2] a psychomotor skill lesson, randomizing the practice sessions, and varying the sequence within these sessions, the instructor can organize and present information to the learner in a way that may enhance meaningful memory storage and more effective recall of the information.

After an extensive literature review, no objective information was found comparing the effectiveness of these two strategies or of any other strategy for psychomotor skill teaching in athletic training education. From a motor learning perspective, the latter

teaching method of chunking and random/variable practice may be advantageous over the traditional method in learning and retention. To understand why, one must first be familiar with the theory of how a person acquires new information. Learning "involves a relatively permanent change in mental associations due to experience.[3]" It is believed that when an individual learns, he or she must receive the information presented, process it, and store it in long-term memory. This takes place in what is termed the dual-store model of memory.[3] The dual-store model has three components: sensory register, short-term or working memory, and long-term memory. According to theory, in order for information to be stored in memory, one must transfer it from the sensory register to working memory and eventually to long-term memory.

Working memory is where actual thinking and processing of cognitive information occurs and it determines what information will be processed further and eventually integrated into long-term memory[3]. Of important note is the theory that working memory has a very limited capacity for storing material.[3-7] Miller, from his work in 1956, proposed that, on average, an individual can only hold seven plus or minus two units of information at one time. These units can vary in size, being as small as a single digit to as large as an entire idea or concept. Miller termed these units "chunks[8]." He further proposed that "although the number of information units in working memory cannot be increased beyond seven plus or minus two, the amount of information in each unit can be increased.[3]" Hence, this increase in the amount of information can be accomplished by an organizational strategy of combining similar pieces of information, or chunking by the learner.

Due to the fact that the working memory has a limited capacity (five to twenty seconds), chunking (process of combining pieces of information)[3] by the learner can increase the amount of material that working memory can process. Chunking can also help the learner organize the material and store it appropriately so that it can be easily recalled later. With this concept in mind, Davies[2] proposes that an instructor can actually chunk a lesson body in order to decrease information overload. Davies[2] recommends that each chunk in a lesson plan last anywhere from three to eight minutes. Each discrete chunk should be separated into smaller segments that include learning, practicing, and reviewing. By chunking, or segmenting into parts, an actual lesson plan for learning particular skills, the teacher can actually help the learner in facilitating the organization of material into meaningful segments. It seems possible that by chunking a psychomotor skill lesson, an instructor can help to promote more effective retention and transfer of the newly learned material into long-term memory. At this time, there is no empirical evidence to support this idea, only theory that lesson body chunking may be beneficial. This idea may have an enormous impact on athletic training education and education in other allied health fields.

Long-term memory is where an individual maintains information he or she has learned for a long period of time. Information that is stored in long-term memory is thought to be organized and continually reorganized.[3] This type of internal organization[3] is how one spontaneously organizes new information. Chunking by the learner can help facilitate this continuous organization and hence may be why chunking a psychomotor skill lesson may be very beneficial to the learner. The basis of this research is to utilize

the chunking theory, taken from cognitive and psychomotor learning, and to adapt and apply it to psychomotor skill acquisition in athletic training education.

Another strategy that has been proposed to enhance the learning (a.k.a. retention and transfer) of psychomotor skills is to not only organize the lesson into chunks, but also to manipulate the organization of practice conditions between and within each chunk. One approach is to organize practice situations so that the conditions are random and variable.[4-7] During a random practice schedule, there is no specified order of occurrence for practicing several distinctly different skills.[4] Magill defines variable practice as a schedule that provides a variety of experiences while performing a skill.[4] Both of these practice schedules can be incorporated together during athletic training skill practice to help to imitate real world situations. The randomizing and varying of practice conditions has been shown to produce what is known as the contextual interference effect. Contextual interference (CI), which is very advantageous to the learner, has been defined by Magill as interference that results from the practicing of a task within the context of the practice situation.[4] To establish a high degree of contextual interference, instructors could randomize the order in which skills are practiced. [4-7] This includes practicing several distinctly different skills, so as to not confuse or blend the skills, during the same practice session. Usually, skills that are similar are grouped together, which can cause confusion to the learner. Randomizing the order of skills may help to prevent this confusion. For instance, in an athletic training classroom setting, the clinical instructor can mix the sequence of the different skills and concepts learned in one lesson continuously over the entire lesson. For example, instead of having one lesson devoted to

only special tests of the shoulder region, the instructor can randomize the lesson with skills of the ankle, knee, elbow, and various other body regions across the entire lesson. Another approach to attempt to establish a high degree of CI is to vary the practice conditions within a session.[4-7] For example, in athletic training, a skill may be practiced using human models of different body sizes and/or gender, practicing in different environments, or by varying the order in which the skill is practiced each time it is practiced. One application could be with the skill acquisition of testing cranial nerves. Typically, it has been observed that when this evaluative skill is learned, the student learns to test each cranial nerve in order from nerve one to nerve twelve. Randomizing the order of the skills while acquiring them is an excellent example of variable practice.

According to the literature, both random and varied practice situations tend to decrease initial performance of psychomotor skills, but to enhance retention and transfer (a.k.a. learning) of the same psychomotor skills.[4-7, 9-13] This has been termed the contextual interference effect.[9] Li and Wright attribute this finding to the idea that there was a higher attentional demand for individuals during their research trials in random practice groups than in blocked practice groups.[13] This effect is also attributed to the idea that when a skill is practiced repeatedly over a period of time, as in a blocked and serial practice situation, the learner focuses on that one particular task. With this method there is trial-to-trial repetition with no chance for the task to be forgotten by the learner. Therefore, there is very little interaction between the working memory and long-term memory. When skills are randomly practiced, the learner must process new information every time a new skill is presented. There is a continual interchange of information that resides within

working memory.[13] The learner must retrieve information from long-term memory and reconstruct this information. Therefore, new information is presented into working memory each time a new skill is presented for the entire duration of practice, hence making cognitive processing more difficult during random practice than during blocked practice.

The purpose of this study is to determine if the organizational strategy of chunking instructional episodes into small segments, coupled with variable and random practice is more effective in the retention and transfer of psychomotor skills in athletic training than a more typical, blocking of instructional episodes together with blocked/serial practice. This will be determined by comparing participant outcomes on the variables of performance, retention, and transfer. At this time no data for athletic training or any other allied health professions psychomotor skill instruction exists as to which is the most effective way to present skills to the learner. The data from this study will provide the beginning of a rationale to either support or refute the incorporation of the organizational strategy of the treatment approach into the instructional plans for a psychomotor skill based class. It is hypothesized that performance will show that the traditional instruction with low contextual interference is more effective immediately after instruction (performance), whereas retention rates and transfer scores will show that chunking with high contextual interference is more effective in the long-term (retention and transfer).

METHODS

Participants

Nine undergraduate students in their first year of a CAAHEP (Commission on Accreditation of Allied Health Education Programs) accredited athletic training education program (ATEP) participated in the study. All students were enrolled in the Clinical Skills in Sports Medicine II class for the semester. In this course, the students developed clinical psychomotor skills in the use of therapeutic modalities, therapeutic rehabilitation techniques, orthopedic evaluation skills, and reconditioning techniques. The course is offered every academic year to introduce first year athletic training students to the psychomotor competencies and clinical proficiencies set by the National Athletic Trainers' Association Education Council.[1] Each participant signed a university approved informed consent form prior to the commencement of the study (Appendix C).

Two clinical instructors were responsible for instructing each group of participants. Both clinical instructors were certified athletic trainers, approved clinical instructors (ACI's), and had some experience as undergraduate teachers. The two instructors were blind to the purpose of the study. To remove teacher bias, the clinical instructors' teaching approach crossed-over for the four class teaching sessions. The evaluators (n=3), who were responsible for evaluating the performance of each individual participant, were certified athletic trainers and approved clinical instructors (ACI's). In addition, they also had experience in teaching and in evaluating undergraduate students

on psychomotor skills. The evaluators were not informed which group each participant was in during the duration of the study.

Study Design

We used a quasi-experimental pre-test/post-test cross-over design to carry out this study. We pre-tested each participant during class time on manual muscle testing (MMT) skills of shoulder external rotation, ankle plantarflexion, and hip flexion, abduction, and external rotation prior to the commencement of instruction. We used each participant's score on the pre-test to randomly assign the participants into groups. Participants were paired based on their pre-test scores with the highest score being paired with the lowest score in one group and continued to be paired until all participants were grouped. One group received instruction incorporating chunking and random/variable practice, while the second group was instructed using a more typical, block/serial practice approach. To remove teacher bias, the two instructors crossed-over in instruction of the four class sessions. Also, each group alternated classrooms after each instructional session to eliminate participant familiarity with the classroom.

Immediately after the completion of the instructional sessions, each participant performed the specified MMT skills (shoulder external rotation, ankle plantarflexion, and hip flexion, external rotation, and abduction) during class time. These were the same MMT skills that they had been pre-tested on previously. We used the outcomes to determine a performance (post) score. Also at this time each participant performed two different but similar MMT skills (knee flexion and forearm pronation) at this time to assess for transfer. These two skills were similar to the previous skills they learned in

class; however, the participants were not specifically instructed on these particular skills. Two weeks following the performance and transfer tests, each participant performed the same MMT skills (shoulder external rotation, ankle plantarflexion, and hip flexion, external rotation, and abduction) to test for skill and learning retention (Figure 1).

Instrumentation

We used four instruments in this study. The first was a brief questionnaire that the participants completed prior to the study that asked each participant's prior educational and clinical experiences in athletic training, as well as demographic information (Appendix D). The second instrument was another brief questionnaire that the participants completed at the conclusion of the study that asked the participant to qualitatively comment and reflect on their experiences and learning during the instructional sessions (Appendix D).

The third instrument used in the study was a clinical skills evaluation form (Appendix D). We designed this form to test the basic competencies on a specific skill that an athletic training student must acquire prior to becoming an entry-level athletic trainer. This form included the essential components of a particular skill listed in step-by-step format with a numerical value assigned to it. The steps were referenced out of Daniels and Worthingham's *Muscle Testing,* 6th ed. The participant received credit for each step of the skill completed correctly and no credit for each step of the skill not completed or not performed correctly. After the participant completed the particular skills, we calculated the points earned as a percentage with respect to a perfect score. This calculation reflected a grand total of the three MMT tests combined. We used a fourth

instrument in this study, which was a questionnaire that was given to all participants immediately after they were evaluated for performance and retention. We used this form to assess the participants' confidence, anxiety, preparedness, and thinking strategies used while performing and being evaluated on the previously mentioned skills (Appendix D).

Pilot Study

Prior to the study, we conducted a three-stage pilot test to determine the inter-tester reliability of the evaluation forms that will be used to evaluate the participants in the study. We compared the scores between evaluators to determine the inter-tester reliability of the evaluation forms. Three evaluators simultaneously evaluated nine certified and student athletic trainers on three separate skills during the first stage of the pilot testing. We did not perform any statistical analysis on this data, but rather we used the information gathered to revise the evaluation form. In the second stage of pilot testing, fifteen certified and student athletic trainers were evaluated simultaneously on three separate skills by three separate evaluators. We analyzed each item on the evaluation form for percent agreement between the three evaluators and revised items that did not score at least eighty percent or above on percent agreement (Appendix E). In the third stage of pilot testing, we evaluated eleven certified and student athletic trainers on the two skills that revisions were made on (hip flexion, abduction, and external rotation, and ankle plantarflexion). Three evaluators again simultaneously evaluated each participant on the skills included on the skills form. We analyzed each item for percent agreement between the three evaluators (Appendix E). We found that numbers were low for two of the skill steps. We concluded that these numbers were low because what each evaluator

accepted as correct for calf raises was in a range, not an exact number. For example, the correct range of calf raises for a grade four is ten to nineteen. If a participant stated an exact number, not the range, the evaluators were unsure of how to score the participant. This was cleared up after the initial phase of testing. We analyzed the total for each participant during final pilot testing for differences between evaluators. This was completed for all three skills(Appendix E).

From the final pilot results we determined the relative reliability of the evaluators (n=3) using an intraclass correlation coefficient. Results are listed in Appendix D. We also determined absolute reliability of the evaluators using standard error of measurement (SEM). Results are listed in Appendix E. Both analyses revealed a high level of reliability between the evaluators for the evaluation forms used.

Procedures

Prior to the study, we developed lesson plans for the four days of instruction (Appendix D) according to the instruction organizational strategy used (either chunking with random/variable practice (experimental) or typical with blocked/serial practice (control)). The skills being taught consisted of manual muscle testing (MMT) of the lower leg, foot and ankle, hip, knee, elbow, cervical region, trunk region, and shoulder. Because there was a sufficient amount of material to be covered during the four days of instruction, we chose manual muscle testing as the topic of instruction. In addition, the clinical instructors could instruct the skills with reference to the text *Muscle Testing* by Daniels and Worthingham (6^{th} ed.). We advised each instructor on procedures for following the lesson plans during the instruction days.

Prior to the first day of instruction, we provided information to the participants concerning their participation in the research study, as well as obtained informed consent from each individual who decided to participate. In the event that a student decided not to participate, we assigned them to the chunking group since this is the way the skills would have been taught normally in class. We pre-tested all participants on the three skills that were previously pilot tested (shoulder external rotation, hip flexion, abduction, and external rotation, and ankle plantarflexion). Also, each participant received a handout prior to the first day of instruction that listed the basic principles of manual muscle testing. The participants were responsible for reviewing this handout prior to the first day of instruction.

The four instructional sessions consisted of an hour and fifty minutes of instruction. One instructional session was included per day. The two blind instructors were responsible for instructing each group of participants on the four assigned class days. One instructor began by following the chunked, random/variable practice lesson plan, while the other followed the traditional, blocked/serial practice lesson plan. After each instructional session, the clinical instructors crossed-over and instructed the other group using a different method than they had previously used. In other words, if instructor A taught the traditional with blocked/serial practice group on day one, then he or she would instruct the chunking with random/variable practice group on day two. Both groups alternated classrooms after each day of instruction to eliminate participant familiarity with the classroom. Both instructors followed the lesson plan as written to the best of his or her ability.

The next class day following the end of the fourth class session, we tested the students on the skills that they were previously pre-tested on in class. This was conducted in the same manner as previously described for the pre-testing, producing a performance score. Additionally, at the conclusion on the instructional sessions, we tested the participants on two novel MMT skills focusing on the knee and the forearm. These were MMT skills that had not been introduced, and therefore assessed the transfer and application of the previously learned skills to related areas of the body. Two weeks following the end of the instructional sessions, we again tested each participant on the skills that were previously pre-tested and performance tested during the four-day instructional period. This evaluation took place during the regular class time, but within finals week, and assessed retention of the skills learned. Finally, participants completed the questionnaire designed to gather qualitative data concerning the sessions of instruction and each skill performance.

Data Analysis

We planned to use a two-way analysis of variance with repeated measures (group by time) to determine if significant differences between the experimental (chunking with random/variable practice) and control (no chunking and blocked/serial practice) groups with respect to performance and retention existed. For the within subjects factor of time, there were three levels (pre, post, retention). We performed an independent t-test to determine if there was a significant difference between the experimental and control groups on the transfer task. We tabulated data from the exit questionnaire and the post-

evaluation questionnaire and presented this data qualitatively. We set the alpha level for all statistics at .05

Results

All students (n=10) enrolled in Clinical Skills in Sports Medicine II consented to participate in the study. The original two-way ANOVA and independent t-tests were not performed due to the low number of subjects who participated in the study. It was determined that with only ten participants, a significant difference could not be found using these statistical methods. Results are reported by individual participant.

Participant number one was in the experimental group receiving chunking of a lesson plan with a random and variable practice session of the skills. This participant scored a 4.3 percent (with respect to a perfect score of 100) on the pre-test, a 72.5 percent on the post-test, and a 72.5 percent on the retention test. Participant one scored a 44.7 percent on the transfer test. This participant listed two strengths of the instructional sessions, which included small practice groups and varied practice. This participant listed two weaknesses of the instructional sessions, which included many skills in a short time and the practice of grades in a random/varied order. This candidate felt that more effort by the participants could have been put forth during the practice sessions.

When asked how prepared he or she felt when being evaluated during the post-test, the participant reported a 4/5 (prepared). The participant reported a 4/5 (confident) when asked the level of confidence felt, indicating confident. The participant reported a 2/5 (slightly anxious) when asked how anxious he or she felt. When asked how prepared, confident, and anxious he or she felt when being evaluated during the retention test, this

candidate reported a 5/5 (very prepared) for preparedness, a 5/5 (very confident) for confidence, and a 2/5 for anxiousness.

Participant number two was also in the experimental group. This participant scored a 4.3 percent on the pre-test, improved to a 92.8 percent on the post-test, and improved to a 95.7 percent on the retention test. Participant two scored a 46 percent on the transfer test. This participant reported one strength, which was the switching of instructors. This participant reported one weakness, which was that the material was presented too fast, and listed no ideas for improvement.

When asked how prepared he or she felt when being evaluated during the post-test, the participant reported a 4/5 (prepared). The participant reported a 4/5 (confident) when asked the level of confidence felt, indicating confident. The participant reported a 2/5 (slightly anxious) when asked how anxious he or she felt. When asked how prepared, confident, and anxious he or she felt when being evaluated during the retention test, the candidate reported a 5/5 (very prepared) for preparedness, a 4/5 (confident) for confidence, and a 4/5 (anxious) for anxiousness.

Participant three was in the experimental group as well. This participant scored a 0 percent on the pre-test, worse to a 85.5 percent on the post-test, and decreased to a 49.7 on the retention test. This participant scored a 36.7 percent on the transfer test. Participant three reported two strengths, which included presented well and organized. He or she reported one weakness, which was a lot of material in a short time. This participant also reported one idea for improvement, which was less material.

When asked how prepared he or she felt when being evaluated during the post-test, the participant reported a 4/5 (prepared). The participant reported a 3/5 (no response) when asked the level of confidence felt, indicating confident. The participant reported a 4/5 (anxious) when asked how anxious he or she felt. When asked how prepared, confident, and anxious he or she felt when being evaluated during the retention test, the candidate reported a 4/5 (prepared) for preparedness, a 4/5 (confident) for confidence, and a 4/5 (anxious) for anxiousness.

Participant four was in the control group, which received no chunking of a lesson plan with blocked/serial practice. This participant scored a 4.3 percent on the pre-test, improved to a 76.8 percent on the post-test, and also improved to an 81.2 percent on the retention test. He or she reported no strengths of the control group, one weakness, which included learning all skills at once and then practicing in a blocked fashion. This candidate reported one idea for improvement, which was being able to practice outside of class.

When asked how prepared he or she felt when being evaluated during the post-test, the participant reported a 4/5 (prepared). The participant reported a 3/5 (no response) when asked the level of confidence felt, indicating confident. The participant reported a 5/5 (very anxious) when asked how anxious he or she felt. When asked how prepared, confident, and anxious he or she felt when being evaluated during the retention test, the participant reported a 5/5 (very prepared) for preparedness, a 5/5 (very confident) for confidence, and a 2/5 (slightly anxious) for anxiousness.

Participant five was also in the control group. This participant scored a 0 on the pre-test, a 42 percent on the post-test, and a 24.6 percent on the retention test. This participant also scored a 9.3 percent on the transfer test. Participant five reported one strength of the control group, which was the detail of the material presented. This participant listed one weakness, which was that he or she felt overwhelmed. Participant five reported one idea for improvement, which included practicing immediately after each skill was presented.

When asked how prepared he or she felt when being evaluated during the post-test, the participant reported a 4/5 (prepared). The participant reported a 3/5 (no response) when asked the level of confidence felt, indicating confident. The participant reported a 4/5 (anxious) when asked how anxious he or she felt. When asked how prepared, confident, and anxious he or she felt when being evaluated during the retention test, he or she reported a 4/5 (prepared) for preparedness, a 4/5 (confident) for confidence, and a 5/5 (very anxious) for anxiousness.

Participant six was in the experimental group. This participant scored a 0 percent on the pre-test, improved to a 76.6 percent on the post-test, and decreased to a 31.9 on the retention-test. He or she scored a 39.3 percent on the transfer test. This participant reported five strengths of the group he or she was in, which included small groups, the presentation of the material, the time allotments, the review sessions, and the randomizing of the order of the grades for each skill during practice. This candidate listed no weaknesses and one idea for improvement, which included more time for review.

When asked how prepared he or she felt when being evaluated during the post-test, the participant reported a 4/5 (prepared). The participant reported a 4/5 (confident) when asked the level of confidence felt, indicating confident. The participant reported a 3/5 (no response) when asked how anxious he or she felt. When asked how prepared, confident, and anxious he or she felt when being evaluated during the retention test, the candidate reported a 3/5 (no response) for preparedness, a 3/5 (no response) for confidence, and a 2/5 (slightly anxious) for anxiousness.

Participant seven was in the control group. This participant scored a 0 percent on the pre-test, a 50 percent on the post-test, and improved to a 97.7 percent on the retention test. He or she scored a 32 percent on the transfer test. Participant seven reported one strength of the control group, which was practice on same day as material was presented. This participant reported two weaknesses, which included feeling rushed and not being able to use textbook. He or she reported two ideas for improvement, which included more practice time and a slower pace.

When asked how prepared he or she felt when being evaluated during the post-test, the participant reported a 1/5 (not at all). The participant reported a 1/5 (not at all) when asked the level of confidence felt, indicating confident. The participant reported a 2/5 (slightly anxious) when asked how anxious he or she felt. When asked how prepared, confident, and anxious he or she felt when being evaluated during the retention test, he or she reported a 3/5 (no response) for preparedness, a 4/5 (confident) for confidence, and a 1/5 (not at all) for anxiousness.

Participant eight was in the experimental group. This participant scored a 48 percent on the pre-test, a 100 percent on the post-test, and a 100 percent on the retention test. He or she scored a 68 percent on the transfer test. This participant reported two strengths of the experimental group, which included small class size and the use of different models. This candidate reported no weakness and no ideas for improvement.

When asked how prepared he or she felt when being evaluated during the post-test, the participant reported a 5/5 (very prepared). The participant reported a 5/5 (very confident) when asked the level of confidence felt, indicating confident. The participant reported a 2/5 (slightly anxious) when asked how anxious he or she felt. When asked how prepared, confident, and anxious he or she felt when being evaluated during the retention test, he or she reported a 5/5 (very prepared) for preparedness, a 5/5 (very confident) for confidence, and a 2/5 (slightly anxious) for anxiousness.

Participant nine was in the control group. This participant scored a 4.8 percent on the pre-test, a 46.1 percent on the post-test, and an 87.2 percent on the retention test. He or she scored a 62 percent on the transfer test. This participant reported two strengths of the control group, which included repetition and review. This participant reported two weaknesses, which included many skills and a short practice time, and reported one idea for improvement, which was to have smaller sessions.

When asked how prepared he or she felt when being evaluated during the post-test, the participant reported a 4/5 (prepared). The participant reported a 3/5 (no response) when asked the level of confidence felt, indicating confident. The participant reported a 2/5 (slightly anxious) when asked how anxious he or she felt. When asked how prepared,

confident, and anxious he or she felt when being evaluated during the retention test, he or she reported a 4/5 (prepared) for preparedness, a 3/5 (no response) for confidence, and a 4/5 (anxious) for anxiousness.

Participant ten was in the control group. This participant scored a 4.3 percent on the pre-test, a 50.7 percent on the post-test, and a 50 percent on the transfer test. This participant did not participate in the retention testing. This participant reported three strengths of the control group, which included thorough, review time, and ample practice time. He or she reported one weakness, which was the order the grades were taught. He or she also reported one idea for improvement, which was to include AV materials.

When asked how prepared he or she felt when being evaluated during the post-test, the participant reported a 4/5 (prepared). The participant reported a 2/5 (slightly confident) when asked the level of confidence felt, indicating confident. The participant reported a 4/5 (anxious) when asked how anxious he or she felt.

Strategies reported that were used by the participants in the experimental group when performing each skill evaluation are included in Tables 4 and 5. Both groups seemed to use a variety of thinking strategies to help them in their performance of the skills. No difference was noted between the two groups.

DISCUSSION

The purpose of this study was to determine if the organizational strategy of chunking instructional episodes into small segments, coupled with variable and random practice is more effective in the retention and transfer of psychomotor skills in athletic training than a more typical, blocking of instructional episodes together with blocked/serial practice. Literature in the area of motor learning reveals that performance as measured is typically inferior in a random practice group when compared to a blocked practice group during the initial learning of a skill.[4-7, 9-13] Li and Wright[13] attribute this finding to the idea that there is a higher attention demand for individuals during research trials in random practice groups than in blocked practice groups. This higher attentive demand forces the learner to increase interaction between working and long-term memory. The increased difficulty for the learner may demonstrate why performance scores for random practice groups are usually inferior to blocked practice groups.

As expected, all participants (n=10) increased their scores from the pretest to the posttest. Only one participant from the control group decreased in performance from the post-test to the retention test (retention), while three actually improved their scores. For the retention variable, two participants from the experimental group stayed the same from post-test to retention test, one participant increased, and one participant actually decreased in performance from posttest to the retention test, not appearing to support the findings of the previously mentioned authors. This may be attributed to several reasons. One confounding factor was that the organizational strategy of chunking a psychomotor

skill lesson plan had previously been used throughout the athletic training curriculum at the institution where the research took place. The participants had previously been exposed to this strategy and were familiar with it. This may be one reason why the participants seemed to feel more comfortable with the experimental group setting, as evidenced by their comments (Table 2). One participant in the control group actually reported that he or she preferred practicing each skill immediately after instruction (the treatment that the experimental group received). This may be attributed to a previous exposure and familiarity with the chunking method in class.

Another confounding factor was that the performance variable included testing of the specific skills in the last day of instruction, not when each skill that was being tested was initially learned. Previous research trials tested individuals after they had initially learned a specific skill(s). Due to our study design, we tested individuals for performance on the last day of instruction. This flaw in the study design may explain why the experimental group performed better on the performance variable than the control group. We may also be able attribute the results to the testing effect in which subjects in the control group expected to have the same tests on which they had been previously tested on and were prepared to perform those skills.

Another explanation for the results is that several of the participants in the experimental group reported that they were not prepared for testing on the retention-testing day. Although the participants were not allowed to actually study the material taught, these two students reported that they were not prepared to come to the testing site during their scheduled testing time due to various reasons. Two participants reported this

to the principal investigator (PI) on the day of retention testing, stating that they had forgotten about the testing and were reminded just prior to testing by other classmates of the PI. This may have resulted in a decrease in scores of the experimental group from post-test to retention test and the lower than average score by the control group from post-test to retention test. We had assumed that all students would prepare and do their best job during the research study. However, this was not the case of all subjects during the retention testing period.

Literature, not just in the area of motor learning, but also in the area of nursing education is of importance when speaking of transfer of psychomotor skills. Lauder et al[14] states that knowledge poorly structured, or organized in memory, is difficult to transfer to new or novel situations. With this in mind, the group that received chunking with random/variable practice was presented material in a more organized fashion than the non-chunking group. Although not a truly large difference, participants in the experimental group did score higher on the transfer test than participants in the control group. Several participants did report that one of the strengths of the experimental group's instructional session was that the practice was varied. This variable practice included using different models and a different order of the skills while practicing. Variable practice has been shown in motor learning literature to facilitate a better transfer of skills to a new situation.[4-7, 9-13] In this study, there was a difference in the two groups on transfer scores supporting the notion that variable practice enhanced the transfer of manual muscle testing for the participants in the experimental group. This is very important in the area of athletic training education and all allied health professions, since

being able to transfer skills learned from the classroom to real world situations is the ultimate goal.

One major limitation of the study was the low number of participants. The original number of participants when the study was proposed and approved was fourteen. Since four of the original fourteen participants decided to not take the clinical skills class the second semester of school due to grades, change of major, etc., the total number of participants was ten. During the study one participant could not participate in the retention testing due to a death in the family. It was believed that since there was a low number of participants, no significant difference would be found using the original data analysis proposed. Thus, the original data analysis procedures were not completed because there was a low number of participants that participated in the study (n=9). As a result of this, data was reported in means, standard deviations, and ranges, as well as qualitative data presented as originally planned.

A second uncontrollable limitation was the death of one of the clinical instructors responsible for instructing during the four class sessions. The two clinical instructors that were chosen and agreed to participate in the instruction of the instructional session had three weeks in advance to prepare for the days of instruction. They were given the lesson plans for the instructional sessions in advance, along with the text that the material was referenced from (*Muscle Testing* by Daniels and Worthingham, 6^{th} ed.). The clinical instructors also met with the principal investigator and cleared up any questions that they had concerning their roles and responsibilities, as well as the way the material was to be taught.

With the sudden death of one clinical instructor on the first day the study was to begin, not only were the instructional days postponed, but also a new clinical instructor who had not been prepared to teach took over the responsibility of instructing one group of participants. The unpreparedness of the new clinical instructor may have effected the study outcome. The switch had to be done due to circumstances beyond the principal investigator's control. The unpreparedness of the new instructor may have had an effect on the instruction of the participants, one reason being that the original two clinical instructors were presented with the lesson plans for the four instructional days three weeks in advance to there teaching. They had the opportunity to meet with the principal investigator on several occasions to clear up any questions on how they should instruct. Also, they had ample time to review all of the material to be presented and to be comfortable with its content. The sudden addition of a new clinical instructor did not allow for this time and preparation, and therefore, he or she was not prepared to instruct in the way that was assigned by the PI. Also of importance was the fact that many of the participants were disturbed by the terrible news and in turn some of them missed class days. One participant missed class because the instructional sessions had to be rescheduled from what had previously been proposed due the death of the clinical instructor. Again, this was out of the principal investigator's control.

There were also some limitations due to the study design. The time period for the material to be instructed lasted only two weeks. Due to time constraints with scheduling, and the amount of clinical skills available on the topic of manual muscle testing, the instructional period was set at two weeks. This short duration may not have been enough

time for the variables to have an effect on learning. Also of note with the study design is that the retention testing was scheduled. In an ideal situation, subjects would be randomly tested for retention. This would ensure that students would not be able to expect being evaluated. This flaw may have effected the retention testing during this research. Also, the skills that were chosen for this study may not have been the most effective.

What is most important in this study is the qualitative that was obtained from the research. No literature on data of this type exists at the present time. Although not interviewed during the study, the students did have the opportunity to answer three open-ended questions on what they felt were the strengths and weaknesses of the organizational method they were exposed to, as well as any ideas for improvement that they felt were pertinent. In the present study, the experimental group reported a higher number of "strengths" than the control group. Also, the experimental group reported fewer "weaknesses" than the control group and less ideas on what could have been done better than the control group for the instructional method they were exposed to. This reveals that the experimental group felt the instructional method they were exposed to was more enjoyable for them. The comments may be attributed to the notion that the participants felt more comfortable with the way the material was presented. Some participants stated that they did not feel rushed or that their interest was kept better due to the random practice and the variable practice, specifically the changing of practice partners and practice situations. In a class that is in a laboratory setting and lasts approximately two hours long, keeping the student's attention and keeping them motivated is very important so that they are focused on the material presented and do not

lose interest. Participants in the experimental group, by being exposed to random skills and variable practice, seemed to be more pleased with their class than the control group.

The biggest impact from the research was the data obtained on preparedness, confidence, and anxiety while being evaluated. Again, no literature of this type was found. During the post-test, data showed that the experimental group felt more prepared, more confident, and less anxious than the control group while being evaluated during the posttest and retention test. This may support the hypothesis that the instructional strategy of chunking with random/variable practice was more effective in preparing the students for evaluation. A student that feels comfortable in a learning environment is going to respond better to the material and in turn will feel more confident and prepared when being evaluated on the material learned.

Feedback from the two clinical instructors used during the study also supported the idea that participants were more comfortable in the chunking with random/variable practice class setting. One instructor reported that they preferred instructing the experimental class because there was a constant interaction with the participants when compared to the control class. They also reported that they felt like there was a larger instructor-student interaction in the experimental setting. With this method the participants are constantly doing and the attention is kept at an optimal level. As stated earlier, Li and Wright[12] revealed that there is a higher cognitive demand for individuals during random practice when compared to blocked practice groups. This is again explained that when an individual learns by rehearsal, that information is kept in working memory. Random and/or variable practice forces the individual to process new

information each time it is presented. The instructor also pointed out, as stated previously, that there is a cognitive and psychomotor component to teaching athletic training clinical skills. This particular instructor felt the chunking with random/variable practice class was a superior environment for the mix of these two educational domains.

The other clinical instructor who participated in the study had similar comments. This CI stated that they felt comfortable teaching both the experimental and control groups, but they could tell that the students preferred the experimental group's instruction better. This particular instructor also stated that they would prefer teaching the chunking with random/variable practice class over the blocked/serial practice class in the future.

Another clinically relevant finding was the data obtained from the clinical skills evaluation forms from the pilot study. After conducting three sessions of pilot testing, a finalized form was developed that was assumed to be reliable. We took many steps to improve the reliability of the form including adding more detail, writing steps in a more clear, concise fashion, eliminating ambiguous statements, and specifying what exactly is acceptable and not acceptable for credit. The form was used to assess the participants at four separate occasions (pre-test, post-test, retention test, and transfer test) during the study. What is of important note is that during all four testing occasions of the participants, the scores between the three outside evaluators only varied a minute degree. The small variance of scores supports the pilot work on the inter-tester reliability of the forms. With many accredited undergraduate athletic training education programs moving to a similar type of evaluation form, this pilot data can be very useful in future development of skill assessment forms for athletic training students.

If I had to carry out this study again, there are many aspects that I would change. If available, I would have a large number of participants. The high number of subjects would control for participants not completing the study or not being able to be evaluated at any one point of the study. I would also suggest that the participants not be athletic training students, but instead possibly exercise science or physical education majors. Although this research is in the area of athletic training, there could be more control over outside variables with other subjects. One difficult aspect of this study design was that it was hard to control for educational background and outside athletic training clinical experiences of each participant. For instance, although the same year in the ATEP program, each individual has had various clinical rotations and previous job experiences that may have given them an advantage or a disadvantage with the material that was instructed during the study. By using subjects of a related, but separate major, the participants would have the same background in anatomy and physiology and biomechanics, but would not have been exposed to any athletic training skills previously. I believe that the outside experience of the students in the current study was a major factor in their performance scores.

Another aspect that I would change would be to incorporate this study during the first semester of the participant's first year. The change of semesters would also help to control prior experience of the participants. I believe that by attempting this study during the second semester that the participants in the study were very familiar with the clinical skills class itself, the various instructors, the material presented, and the method of being evaluated. This made controlling for outside variables very difficult.

What prevails as the single most important discovery made during the conduction of this research was the reality that in a real-world setting it is very difficult and sometimes impossible to control all potential pedagogical variables. When research is focused on education in the classroom, it becomes much more complicated. What can be said is that maybe there is no right or wrong method when it comes to instructing psychomotor skills in athletic training. However, maybe there is an organizational strategy that the instructor is more comfortable with, the students are more comfortable with, that the students grow and learn in, and most of all, that is enjoyable for all involved.

Conclusion

There has been major reform and a lot of advancement in the area of athletic training education recently. Of much debate is the topic of the clinical proficiencies in undergraduate education. One topic that arises is what method(s) are more effective by which the psychomotor proficiencies should be taught. From this research it can be concluded that chunking a psychomotor skill lesson and incorporating random and variable practice is an alternative method to the more traditional, blocked/serial practice method. Although not demonstrated at this time to be superior in the area of retention, there was a difference in transfer between the two groups with the chunking with random/variable practice being superior. Of importance is the feedback gathered from this research. At this time there is no research on this particular topic that is specific to the area of athletic training education, nor is there any data of this sort in the literature. From the results it can be concluded that qualitative data seemed to support the organizational strategy of chunking a psychomotor skill lesson coupled with random and variable practice. The feedback from the participants as well as the clinical instructors and evaluators who were a part of this research is an excellent beginning to what future research in this area holds.

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Table 1. Number of Subjects for Each Test

	Pre	Post	Retention	Transfer
Experimental	**5**	**5**	**5**	**5**
Control	**5**	**5**	**4**	**5**

Table 2. Student's Perceptions of Instructional Method
***Number in ( ) equals duplicate responses**

	Strengths	Weaknesses	What could Have Been Done Better
Experimental	**Organized (2)** **Small Class Size(3)** **Using Different Models (2)** **Time Allotments** **Varied Practice** **Review**	**A Lot of Material in a Short Time (3)**	**Less Material**
Control	**Practice Same Day** **Review (2)** **Ample Practice Time (2)** **Repetition**	**Rushed** **No Text** **Order Taught (grades) Same** **A Lot of Material in a Short Time** **Learn All Skills-then Practice** **Overwhelmed**	**More Practice** **Slower** **Less Skills** **Outside Practice**

Table 3. Strategies Used (by group) When Being Evaluated on Skills for Performance

	Strategies
Experimental	**Paid Attention in Class** **Visualize (2)** **Reviewed Notes After Each Class** **Review/Practice**
Control	**Read Over Notes** **Know Motions/Muscles** **Start with a Grade Three and Go From There** **Visualize**

Table 4. Strategies Used (by group) When Being Evaluated on Skills for Retention

	Strategies
Experimental	**Paid Attention in Class** **Visualize** **Know Definition of Grades (2)** **Review/Practice** **Know Muscle Origins and Insertions**
Control	**Read Over Notes** **Know Motions** **Start with a Grade Three and Go From There** **Visualize (2)** **Acronyms**

Figure 1. Study Design

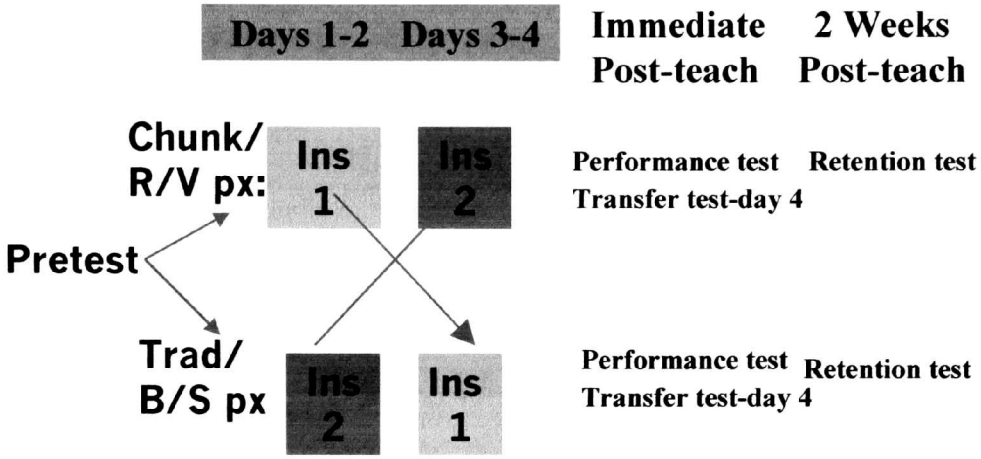


Figure 2. Results of Skills Testing for Participant #1

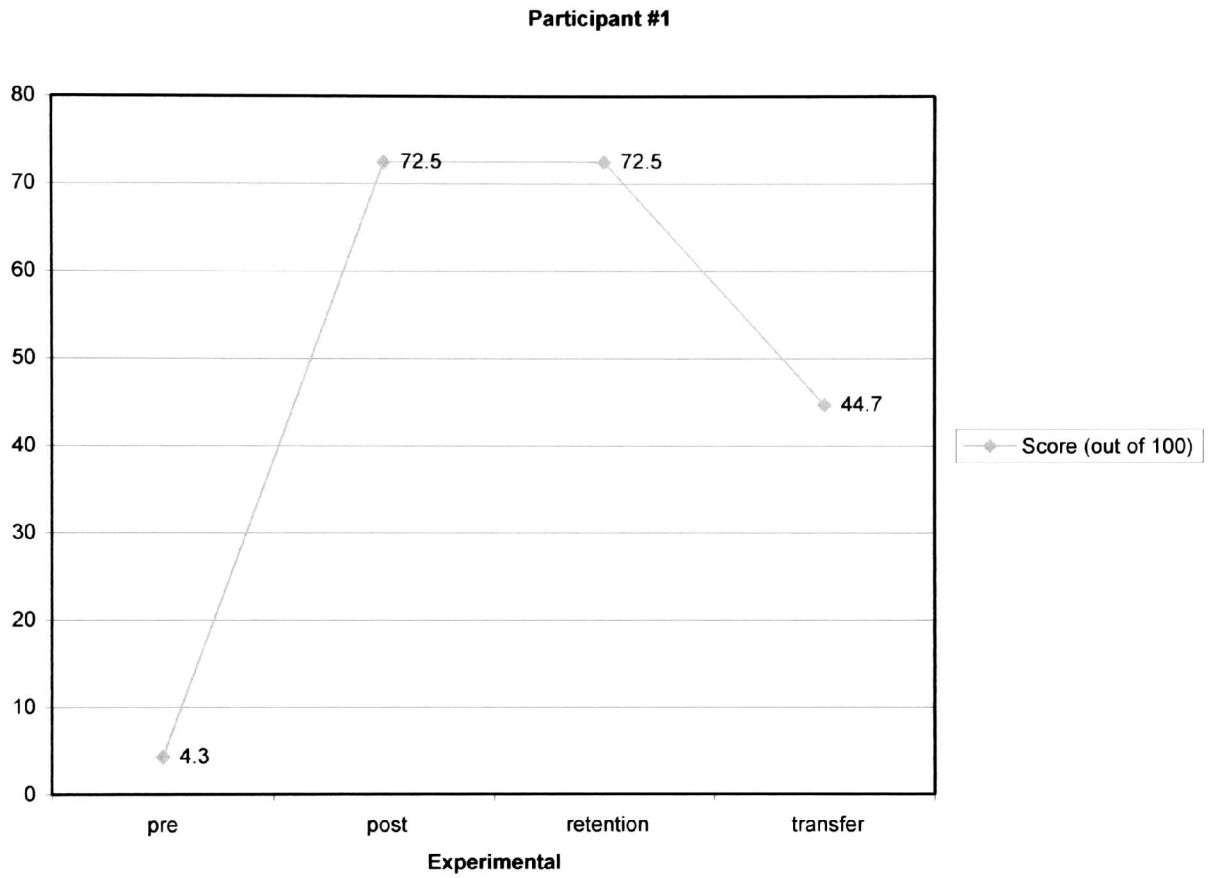


Figure 3. Results of Skills Testing for Participant #2

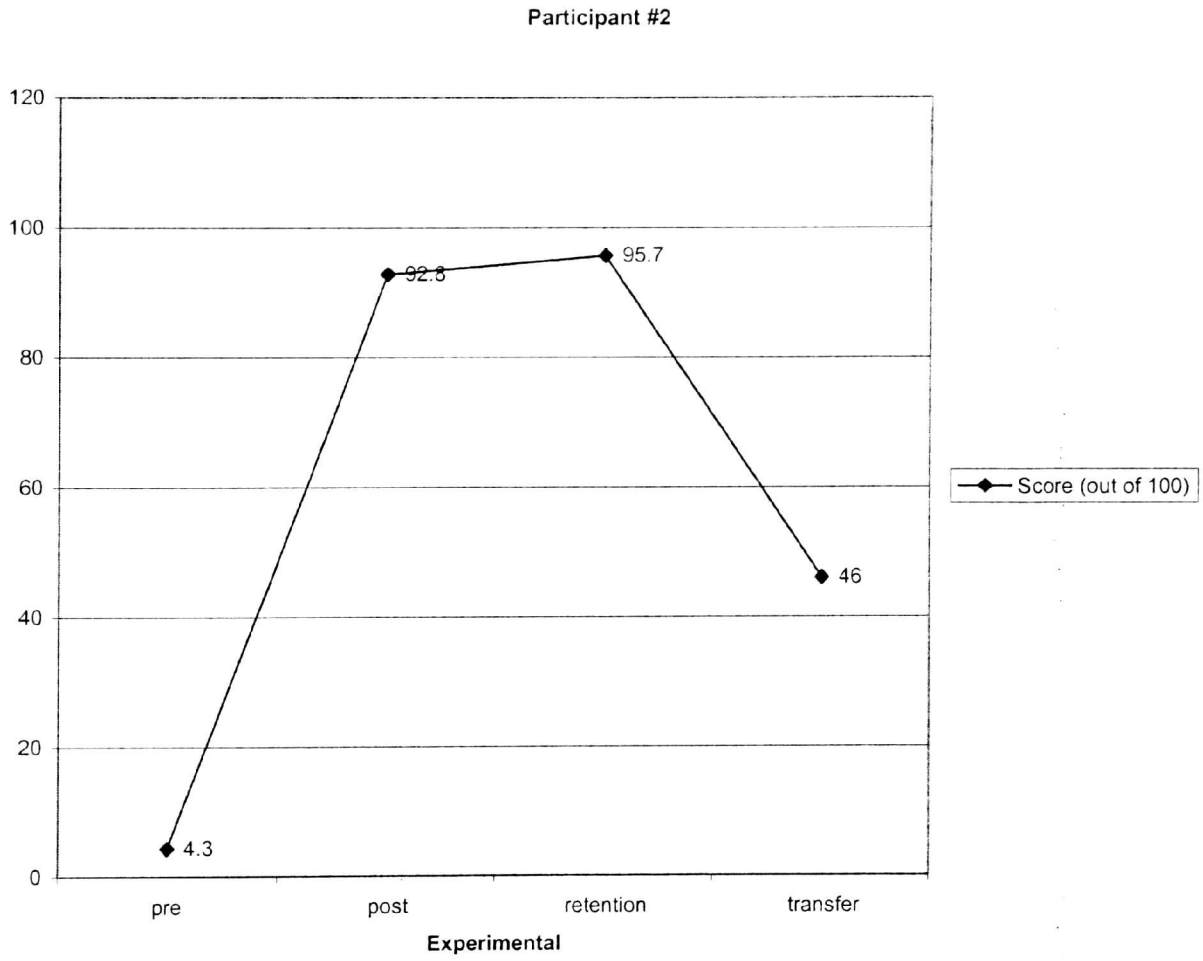


Figure 4. Results of Skills Testing for Participant #3

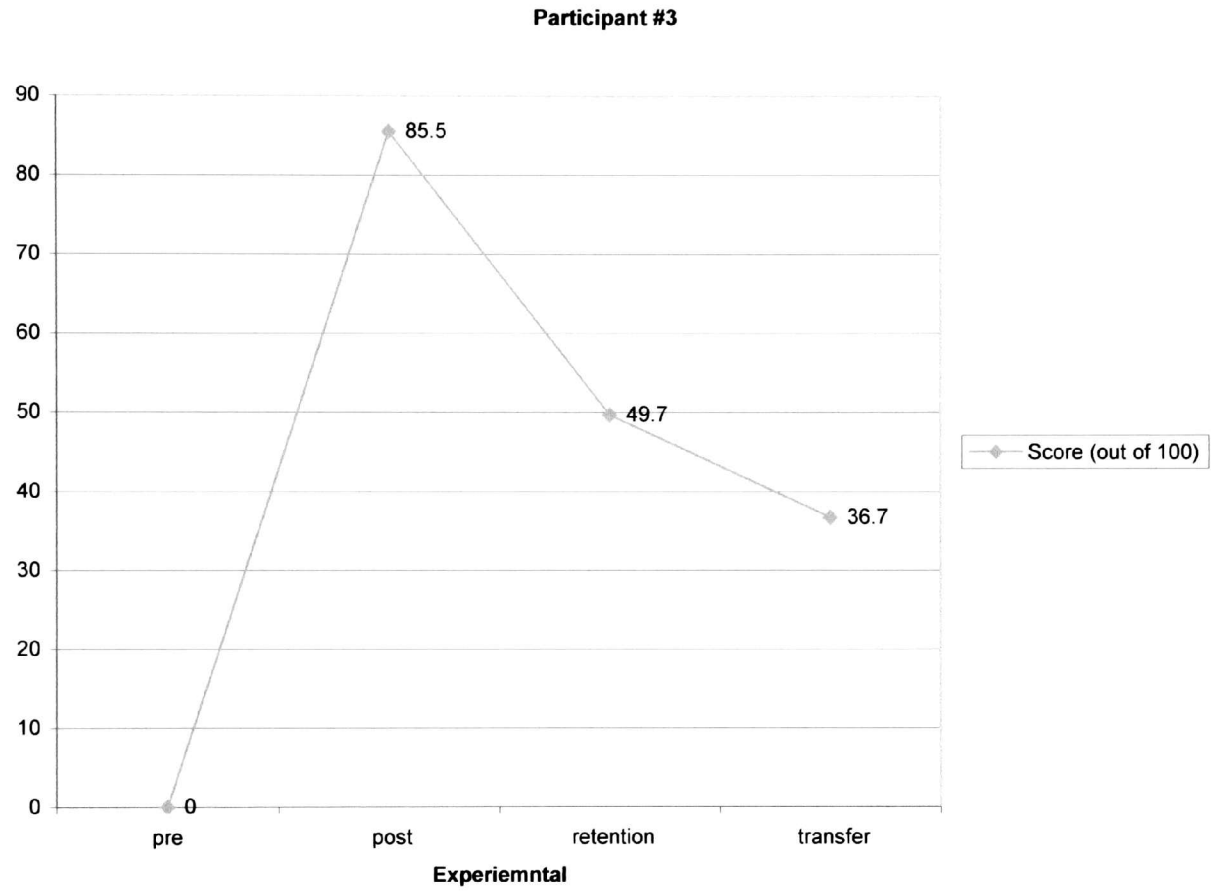


Figure 5. Results of Skills Testing for Participant #4

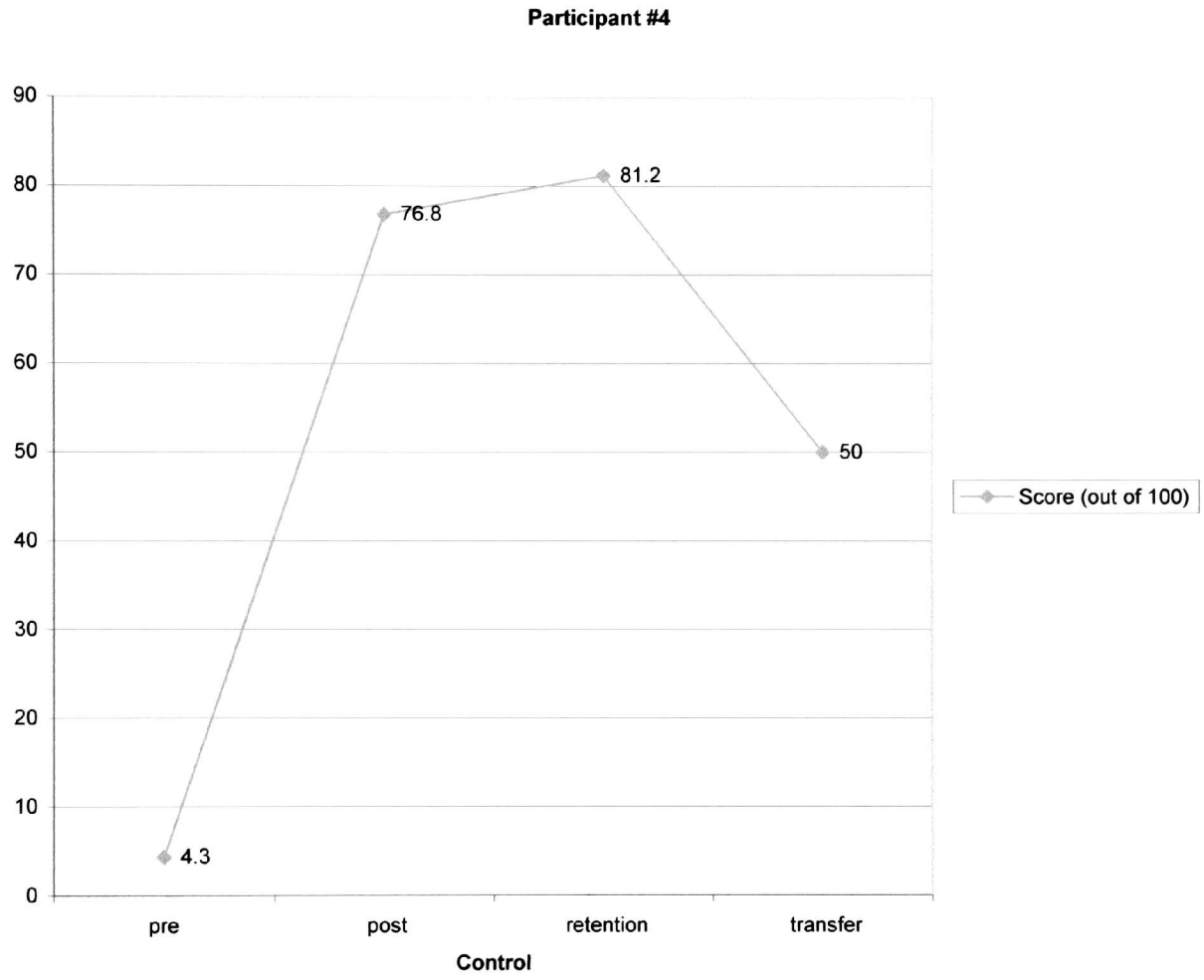


Figure 6. Results from Skills Testing for Participant #5

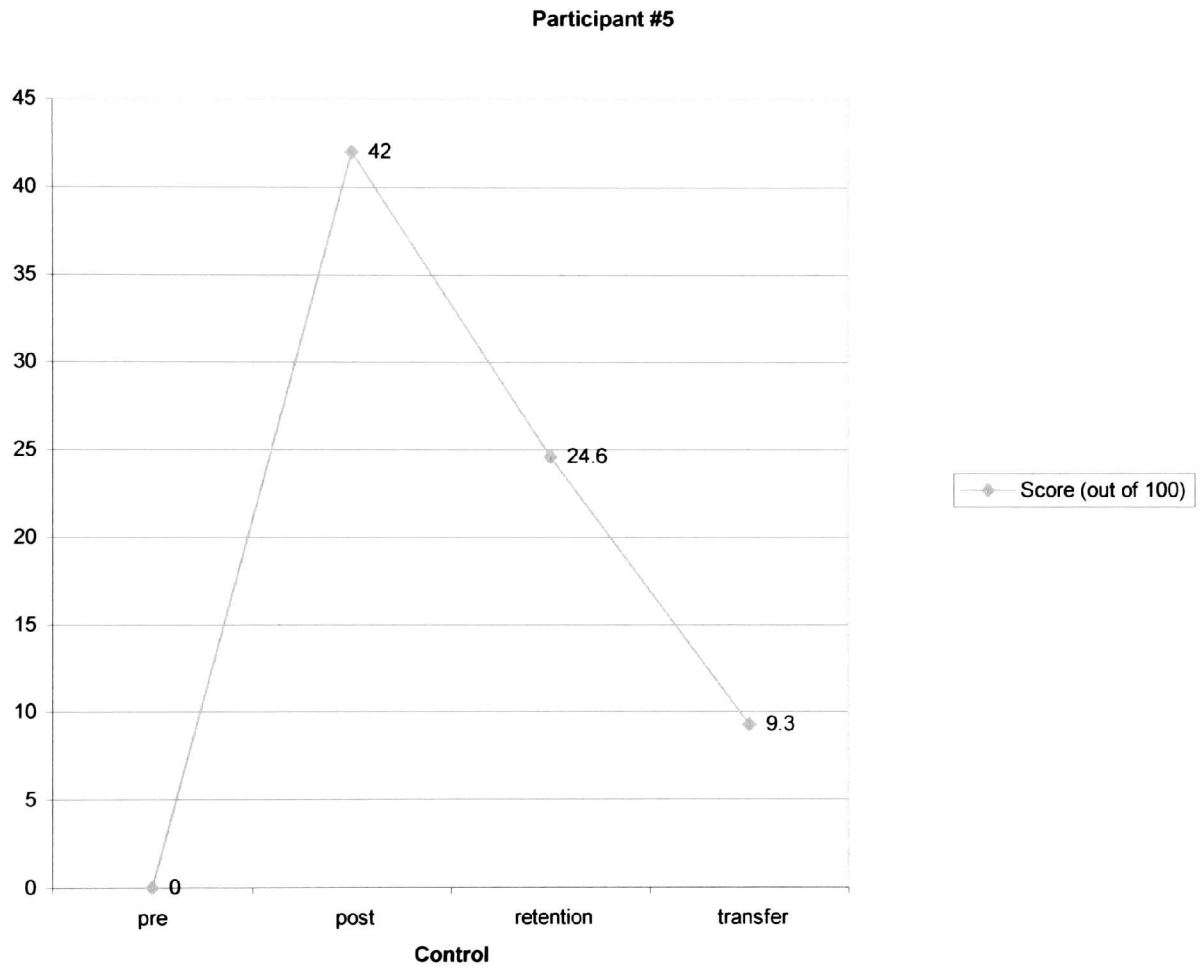


Figure 7. Results of Skills Testing for Participant #6

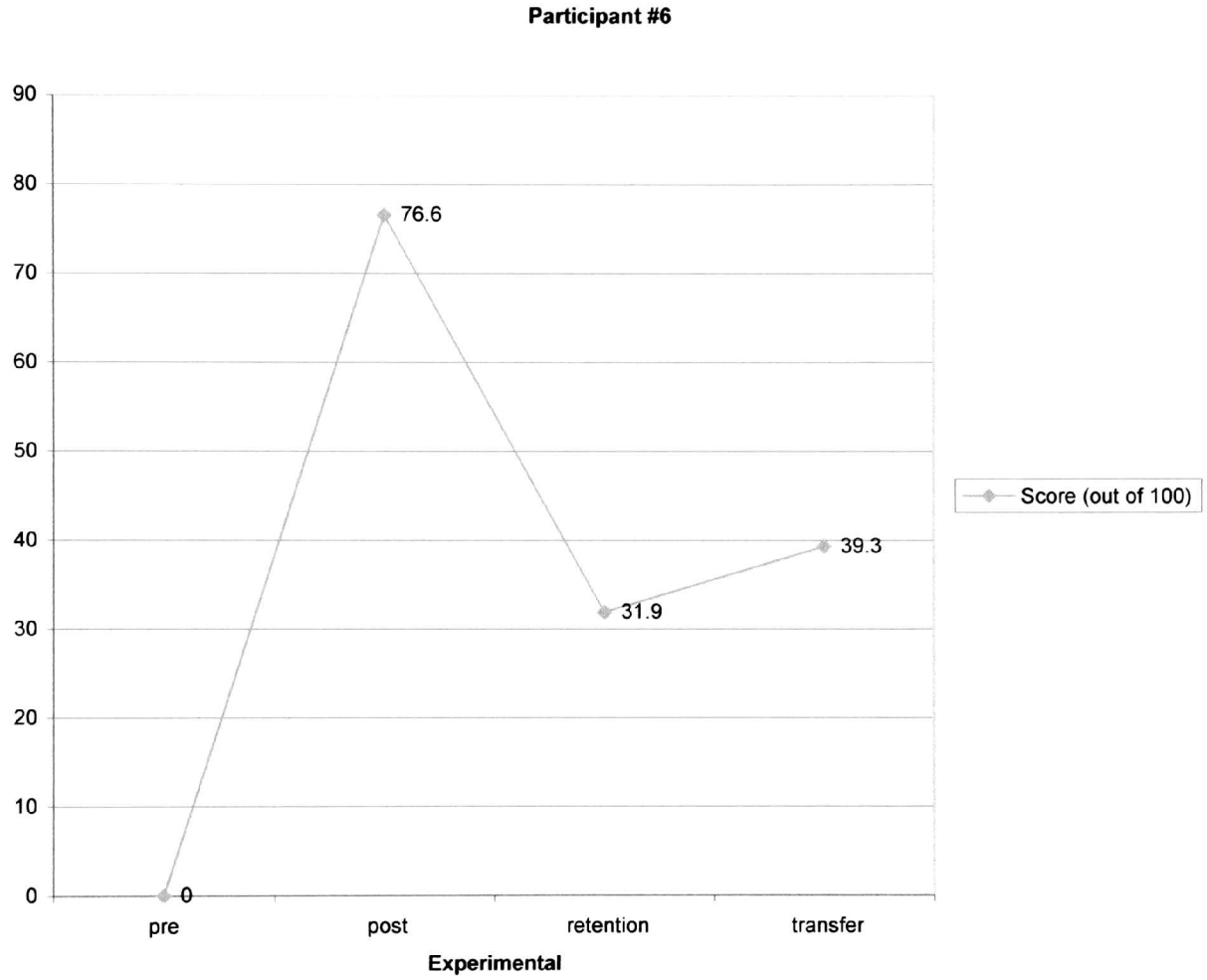


Figure 8. Results of Skills Testing for Participant #7

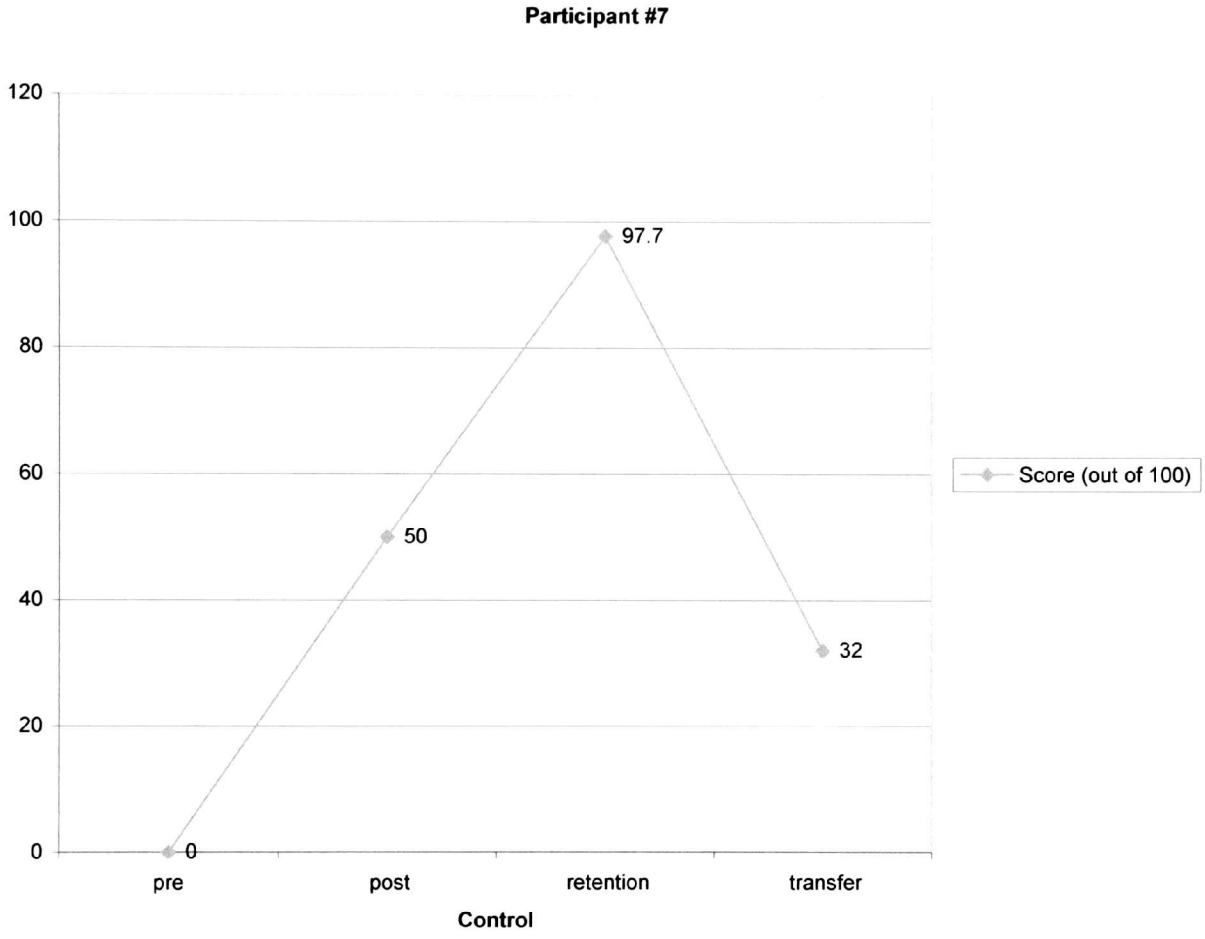


Figure 9. Results of Skills Testing for Participant #8

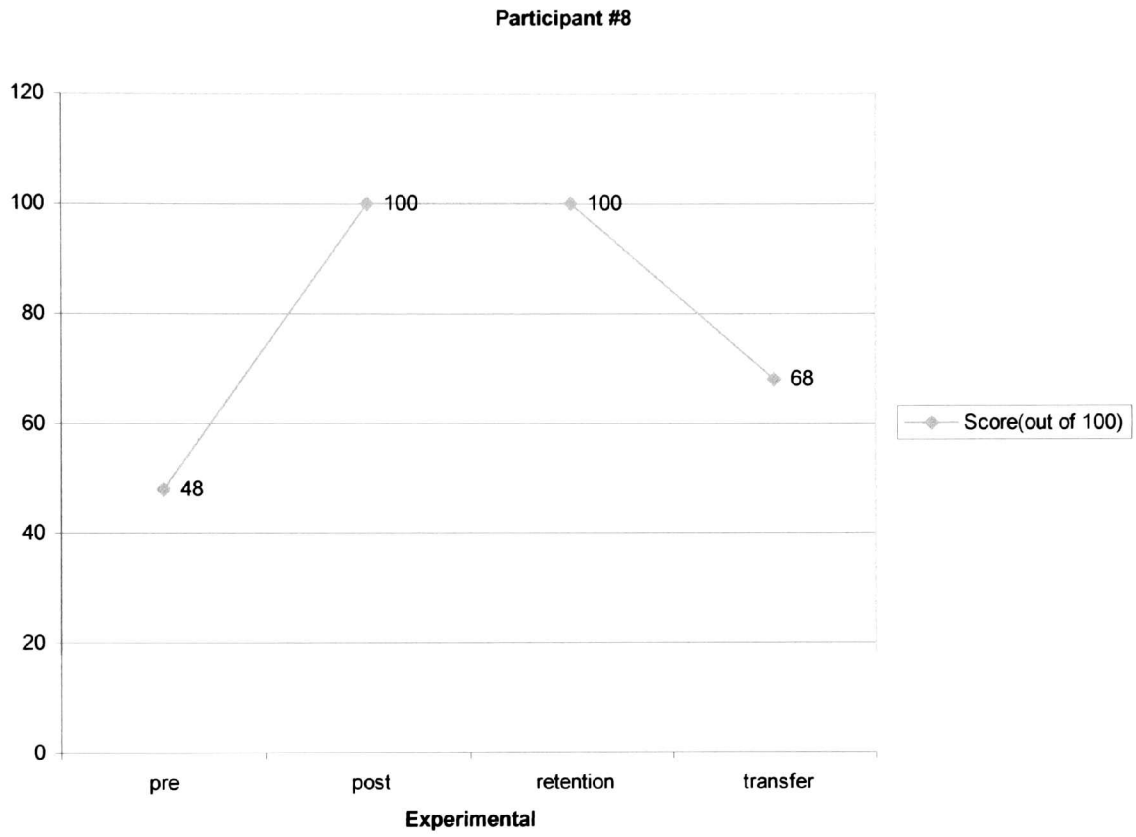


Figure 10. Results of Skills Testing for Participant #9

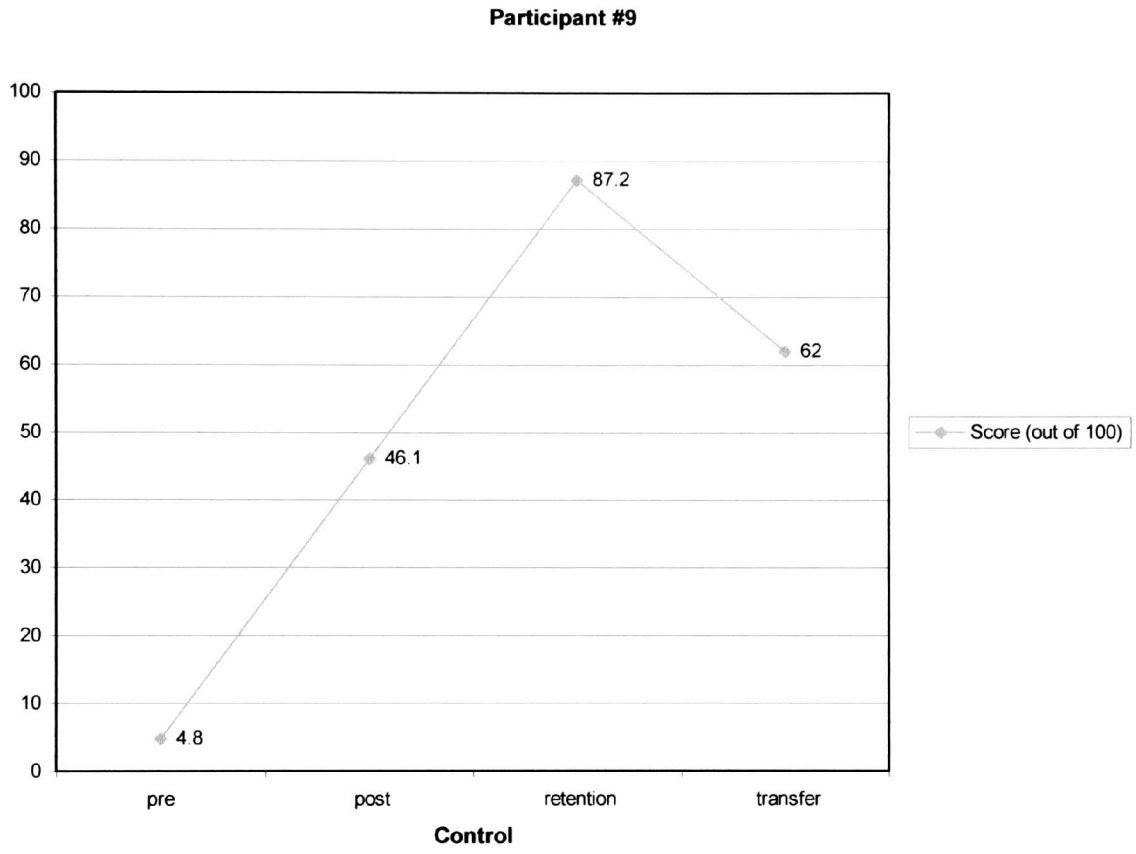
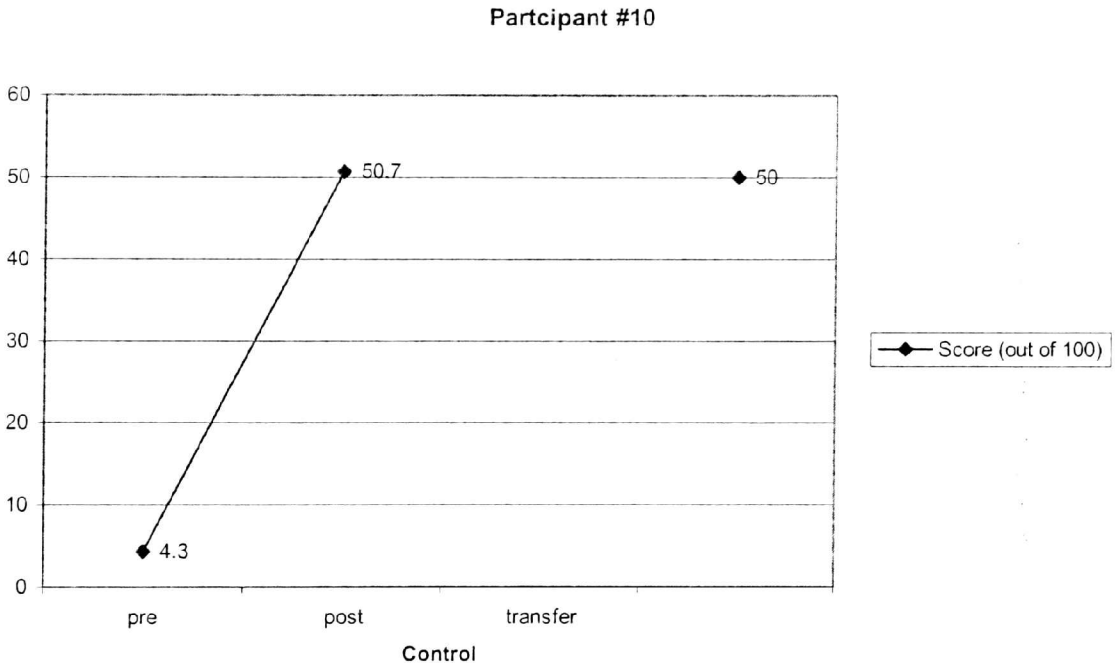


Figure 11. Results of Skills Testing for Participant #10



Appendic

Appendix A

Extended Introduction

Research Hypotheses

1-Performance will demonstrate that the typical instruction with blocked/serial practice is more effective immediately after instruction, whereas retention rates will demonstrate that chunking with random/variable practice is more effective long-term.

2- Transfer scores will demonstrate that chunking with random/variable practice is more effective long-term.

Limitations

1-Not a random sample.

2-Not a large sample (10 participants).

3-Cannot control for instructor bias.

4-Cannot control for outside instruction and/or practice by participants.

Delimitations

1-First year undergraduate athletic training students enrolled in KINS 2322 only.

2-Only at one educational institution.

Assumptions

1-All students will put forth their best effort when being evaluated on the specific skills.

2-All students will not practice or get outside instruction on the material learned in class during the study sessions.

3-All students will not discuss any details about their instruction session with other classmates until the conclusion of the study.

4-All students will answer truthfully on the qualitative questionnaire given at the end of the study.

5-The instrumentation used is reliable and valid.

Definitions

1-Dual-Store Model of Memory-Model that suggests that memory has three components: a sensory register, short-term memory, and long-term memory. [1]

2-Chunking- process of combining pieces of information to increase the amount of information that the limited space of working memory can hold. [1]

3-Contextual Interference- interference that results from practicing a task within the context of the practice situation. [2]

4-Random Practice- A practice schedule in which there is no specified order of occurrence for practicing several different skills. [2]

5-Blocked Practice- A practice schedule in which one skill is practiced repeatedly before moving on to practice another skill. [2]

6-Variable Practice- Practice that provides a variety of experiences for performing a skill.[2]

7-Acquistion- Stage in which the concern is primarily with providing experiences that improve learning and not with demonstrating how well the player, student, or subject can perform. [3]

8-Serial Practice- A practice schedule in which several skills are practiced in a specified and repeating order during each practice period.[2]

9-Performance- A temporary behavioral act seen when a person performs a skill.

10-Retention Test- A test of a practiced skill that is given following an interval of time after practice has ceased.[2]

11-Transfer-The influence of having previously practiced or performed a skill or skills on the learning of a new skill.[2]

12-Chunking (of a psychomotor skill lesson)- grouping information into meaningful segments.[4]

Clinical Significance

The results from this study can be applied in athletic training education. The theories of chunking and contextual interference are being adapted and tested in an athletic training educational setting. Because there is a scarce amount of data that exists in the area of psychomotor skill acquisition in athletic training, this research will provide the rationale to either refute or support the use of the organizational strategy of chunking as well as the use of random and variable practice during practice sessions when teaching

psychomotor skills. This will allow clinical instructors to have another teaching strategy available if they decide to incorporate it into the classroom.

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Appendix B

LITERATURE REVIEW

Psychomotor Skill Acquisition (PSA)

Although limited research exists specific to athletic training education, there has been a plethora of research conducted in the area of motor learning, pedagogy, and nursing in the acquisition of psychomotor skills. These psychomotor skills fall into the category of the psychomotor domain. Singer defines the psychomotor domain as including behaviors that are primarily movement-oriented and emphasize overt physical responses.[1] In this domain there is less emphasis on cognitive and affective aspects and more emphasis on the psychomotor area. Motor learning, nursing, and athletic training are three major areas that are highly focused on learning and teaching in the psychomotor domain.

Fitts and Posner[2], in 1969, first proposed a three-stage model for perceptual motor learning which is applicable to psychomotor skill learning. The first stage, termed the cognitive stage, is where the learner tries to grasp and understand the skill presented. The instructor must call attention to what is important and provide feedback to the learner. As the learner attempts the skill, they must watch the instructor perform the actual skill and process the steps. The second stage, termed the associative stage, is where the actual mechanics of the skill are learned and errors are gradually eliminated.[2] The final stage is termed the autonomous stage. It is during this stage that the skill becomes automatic to

the learner. Every learner strives for this stage in skill acquisition but very few ever attain it.

The three stages for perceptual motor learning are very important to designing clinical education. Anderson stated that "focusing on coordination forces the nursing student to concentrate on the psychomotor skill itself rather than the total gestalt, particularly during the early stages of learning". [3] This is applicable in athletic training education as well. When teaching to novice learners, an instructor must teach psychomotor skills according to these three stages. It is the instructor's responsibility to develop a lesson plan that will promote effective skill acquisition, and hence follow the three-stage model.

Learning versus Performance

When one thinks of the concept of learning a skill, they may automatically think about how one performs. However, immediate performance and actual learning are different entities. Ormrod defines learning as "a relatively permanent change in behavior [and mental associations] due to experience.[5] Magill describes performance as a behavior that is observable, and learning as an internal phenomenon that one infers from the observable behavior. With this in mind, he also points out that there are three ways to assess learning: practice observations, retention tests, and transfer tests.[6] By observing a behavior repeatedly over a period of time, an individual can assess if learning has actually occurred.

Shea and Wright state that performance happens during the acquisition stage, and retention and transfer are more accurate learning measures.[8] The authors also make a clear distinction between learning and performance. They point out that temporary

factors may affect performance that may not necessarily affect learning. For instance, practicing a skill repeatedly over a period of time may result in superior performance due to the fact that the movements or motions are memorized. However, without meaningful, organized learning, an individual may not be able to retain or transfer the material.

Also, when learning is assessed, it would not be fair to only assess immediate performance scores, but rather to assess learning by retention test.[8] Singer does makes an excellent distinction between learning and performance. He suggests that performance should be "thought of as a temporary occurrence, fluctuating from time to time because of many potentially operating variables whereas learning is relatively more permanent.[9]"

Information Processing and the Dual-store Model of Memory

In order to learn a specific skill, one must process the steps presented and commit it into long-term memory. According to Proctor and Dutta, there are three stages in information processing: perceptual processes, decision making and response selection, and execution.[10] This coincides with a memory system that was first proposed in 1968 by Atkinson and Shiffrin as being a dual-store model.[5] This is also known as multiple memory theory. As stated earlier, learning involves a relatively permanent change in mental associations and behavior due to experience.[5] When an individual learns, he or she must take the information presented and store it in long-term memory. Storage is the process of committing new information to memory.[5] The individual must then encode, or modify the information, as well as be able to retrieve, or locate the information in memory. All of these steps take place in what many believe is the dual-store model of

memory[5]. The dual-store model has three components: sensory register, short-term or working memory, and long-term memory.

According to Ormrod, the sensory register holds new information that is presented for only a brief time (1-4 seconds) to allow preliminary cognitive processing.[5] In order for information to be stored in memory, one must transfer it from the sensory register to working memory. For this to take place the person must be attentive.[5] This is why the instructor must plan accordingly and incorporate different strategies such as retrieval cues and emphasizing important points in a lesson. By planning and organizing the lesson, the instructor can help to promote a more effective learning situation. Chunking is an effective way to organize a lesson so that the learner's attention is kept. By limiting the amount of information an individual must attend to, information can be encoded and stored in a more organized fashion.

Cognitive processing takes place in what is described as the working memory[5]. Working memory determines what information will be processed further into long-term memory. The working memory holds information anywhere from five to twenty seconds. This is a relatively short time to decide what information will be transferred into long-term memory. Of important note is the fact that working memory has a very limited capacity for storing material.[2,5-8,11-12] Miller, in 1956, proposed an individual can hold "five to nine units of information in working memory at one time, with the average number of memorable units being about seven.[5]" He termed these units "chunks" and the process of combining these units "chunking", which will be discussed further in a later section.[5]

Long-term memory is where an individual maintains information he or she has learned for a long period of time. The capacity of the long-term memory is unlimited, with the duration being relatively permanent. The more an individual understands and is able to organize material, the more effectively they may be able to store it in long-term memory. Many authors have proposed that chunking may help to facilitate this organization. From long-term memory is where one can retrieve information that has been learned when needed.

Chunking

Chunking is defined as a way to "organize, group, and/or classify information into meaningful segments.[13] Miller proposed that an individual can only hold seven plus or minus two units of information at one time in short-term memory and he termed these units chunks.[14] He further postulated that "although the number of information units in working memory cannot be increased beyond seven plus or minus two, the amount of information in each unit can be increased".[5] This can be accomplished by an organizational strategy of combining similar pieces of information, otherwise known as chunking. By using this mechanism of chunking, one can increase the amount of information that can be stored in working memory.[5] From his findings, Miller concluded that information can be described in bits and bits can be grouped into chunks.

Although Miller is probably the most recognized name in experimental psychology when the topic of chunking is mentioned, the idea has also been well established in motor learning research. Fitts and Posner[2] refer to Miller's work when they discuss performance capacities in motor learning by stating that the amount of material

that is presented to the learner can affect the capacity for short-term memory.[2] Rose makes a clear distinction between novice and expert performers in that "expert performers have learned to organize, or chunk, large amounts of information into larger memory units that can then be retrieved with greater speed and ease of recall".[11]

Magill discusses the topic of subjective organization. This is a strategy used by learners to group or organize information into a meaningful segment. He points out that the learner will organize information in a way that is meaningful to the learner.[6] An example of this is when a novice is learning a new and complex skill. When the learner first approaches learning the skill, he or she will look at it as comprising many parts or chunks. As the learner becomes more proficient in the skill, he or she will then develop larger chunks or parts of the skill. It is suggested that this strategy makes the information learned easier to incorporate into working memory.[6] These findings can also be applied to the planning of instruction of a skill to the learner. Magill points out that many skills have a specific organizational structure. This lends the idea that there are numerous ways to break up that structure in the instruction and practice of psychomotor skills.[6]

Gobet et al examined the effect of different chunking mechanisms on human learning.[15] The research focused more on the cognitive domain rather than the psychomotor domain of learning. The authors discuss how chunking is helpful with recall and memory and summarize findings from research on chess players by Chase and Simon (1973) which showed that perceptual chunking was more advantageous for master chess players in memory of chess positions than novices. This seems to be due to the fact that experts can encode more information in a limited time and recall that information in

meaningful chunks. They also point out that that the chunking theory can be applied to more general areas of education.[15] Hence the application to psychomotor skill acquisition. Gobet and Simon discuss further how the chunking theory is applicable in memory of chess positions. The principle claims of the chunking theory are two-fold: 1) expert chess players are more proficient in memory recall than novices because they are able to evoke from memory previously learned chunks and 2) the chunks guide what is called forward search which is used to choose the next chess move.[16]

Smith (1992) studied the effectiveness of chunking on immediate recall. This research examined the relationship between information content and number of items, when the exposure duration is fixed. Smith used six subjects to test conditions where he varied the exposure time and information content. Through a linear regression equation he found that immediate recall of visual information did depend on time of presentation and the content of the information.[17] This equation may be successful in predicting the amount of information a subject can recall from the number of items and content of the items. The author points out that when the duration is fixed, individuals recode or chunk familiar information so that the amount of information they can recall is greater.[17]

Contextual Interference (CI)

An additional approach to enhance learning of a psychomotor skill is to organize practice in a way that may create a high degree of contextual interference. A well established notion in motor learning[2,6-9,11,18-25], contextual interference is defined as interference that results from practicing a task within the context of the practice situation.[6] Although it has been shown that interference may contribute to forgetting,

several studies reveal that while the low contextual interference practice situation leads to superior practice performance, it results in much poorer retention performance than the high contextual interference situation. Two methods that can be incorporated to provide a high contextual interference during practice sessions include random practice and variable practice. Both random and variable practice (high CI) has been shown to decrease initial performance of psychomotor skills but enhance retention and transfer of psychomotor skills.[6-8,11,18-21] This has been shown in lab and real world settings. The implication of the contextual interference effect is that immediate performance gains will be sacrificed for long-term learning and retention.

As early as 1979, Shea and Morgan studied contextual interference effects, specifically blocked practice, on the acquisition, retention, and transfer of a motor skill. The authors compared a blocked and a random practice group for the task. They found that retention, as well as transfer scores, were greater for the random practice group than for the blocked practice group.[21] They provided a tentative explanation for their findings in stating that performance was more difficult in the high CI group. This was due to the fact that the random practice group "was forced to use multiple processing strategies to optimize its performance during acquisition[21]" They further reveal that this greater elaboration may have led to superior retention and transfer of the material presented to the random practice group. Tsutsui[18] examined whether or not contextual interference effects were found in learning new patterns of bimanual coordination. He used two groups of subjects, a blocked practice group and a random practice group. He revealed that during practice sessions the random group initially performed better than the blocked

group, however, the random group performed better than the blocked group in a delayed (one week) retention test.[18]

Goode and Magill conducted a similar study using badminton serves and three groups of subjects: blocked practice group, serial practice group, and a random practice group. Results supported the contextual interference effect with the random practice group performing better on retention and transfer tasks than the blocked group.[20] Similar results continue to be found in contextual interference research. Li and Wright revealed that blocked practice groups showed better performance during training, however, random practice groups show better retention. The authors attribute this finding to the idea that there is a higher attentional demand for individuals during trials in the random practice groups than the blocked practice groups.[22] This effect is also attributed to the idea that when a skill is practiced repeatedly over a period of time, as in a blocked situation, the learner focuses on that one particular task. There is trial-to-trial repetition with no chance for the task to be forgotten by the learner. Therefore, there is little interaction between working memory and long-term memory, as well as hardly any reconstruction taking place. When skills are randomly practiced, the learner must process new information every time a new skill is presented. Therefore, new information is presented into working memory each time a new skill is presented for the entire duration of practice, hence making cognitive processing more difficult than blocked practice.

Del Ray[23] studied the effects of the random practice of specific sports skills. Results showed that participants in the random practice group performed worse on acquisition, but better on retention and transfer tasks.[23] The author explains that subjects in the

blocked practice group may have learned automated responses, therefore performing better initially. However, the blocked practice group performed worse on retention and transfer tests, which are measures of actual learning.

Incorporating variable practice will also provide a high contextual interference during practice conditions. Variable practice has been shown to have positive effects on retention as well as transfer of psychomotor skills.[19, 24-25] Carson and Wiegand tested the variability of practice hypothesis by administering pre, post, and retention tests to ninety-two pre-school subjects on three motor skills. They revealed that all groups except the high-variability practice groups had inferior retention of the skills practiced. They also revealed that the high-variability group showed superior transfer than the specific practice groups.[24] This effect is attributed to the idea that individuals develop a schema for a task based on experiences. Varied practice provides chances for different experiences to occur. Providing numerous conditions and situations to the learner during practice conditions can expand their schema, thereby promoting better transfer skills. An application of practice variability on athletic training education is providing different models for performing psychomotor skills on. Students can practice on individuals of different genders, body types, medical histories, etc.

Similar findings are found across the board. Moxley[25] had similar findings in his experiment with a high variable and a low variable practice group. The results supported the variability of practice hypothesis in that the high variability group experienced superior performance on a novel task than the low variable group.[25] Shea and Kohl[19] contrasted the specificity of learning principle to the variable practice hypothesis using

two separate experiments. They revealed that the groups that incorporated variable practice in both experiments demonstrated superior retention scores than the control groups. These results support the theory that variable practice (high CI) can help promote retention of psychomotor skills in learning.

Summary of Literature Review

Fitts and Posner[2], in 1969, first proposed a three-stage model for perceptual motor learning which is applicable to psychomotor skill learning. Performance and learning are two different educational measures. Shea and Wright suggest that performance happens during the acquisition stage, and retention and transfer are more accurate learning measures.[8] Many believe in the dual-store model of memory which includes the sensory register, working memory, and long-term memory. Working memory has been found to be limited in capacity, holding information for five to twenty seconds.[5] Working memory can, however, be extended by rehearsal. Chunking, first proposed by Miller[14], has been shown to be effective in learning a complex skill. Incorporating a high degree of contextual interference has also been shown to be effective in retention and transfer in regards to psychomotor skill acquisition.[6-8,11,18-21] Both of these organization strategies can be incorporated in athletic training education.

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Appendix C

INSTITUTIONAL REVIEW BOARD
RESEARCH PROPOSAL FORM FOR
RESEARCH INVOLVING HUMAN PARTICIPANTS

The purpose of this information is to provide the IRB with sufficient data to understand the use of and safeguards for human participants in your research proposal. The Board is not concerned with evaluating the quality or focus of your research, but only the use of human participants. Please reproduce this form (exactly) on your word processor. Please be as concise and brief as possible in providing the requested information.

I. Statement of the problem to be studied.

The purpose of this research is to investigate if the organizational strategy of chunking with high contextual interference is a more effective class model in the acquisition of psychomotor skills in athletic training education when compared to a more traditional method with low contextual interference?

II. Describe your research design.

Prior to the study, a pilot test will be conducted to determine the reliability of the evaluation forms that will be used to evaluate the participants in the study. Approximately fifteen certified and student athletic trainers at Georgia Southern University will be evaluated simultaneously by three separate evaluators on three separate skills (two basic and one difficult). Scores will then be compared to determine the reliability of the forms.

Following the pilot study, twelve undergraduate athletic training students at Georgia Southern University who have given prior informed consent will participate in the study. The students will be registered in KINS 2322 (Clinical Skills in Sports Medicine II) for the spring semester. Each student will fill out a questionnaire that will ask prior educational and athletic training experience, as well as demographic data. Each student will also be pre-tested on the skills that will be taught during the experimental sessions. The skills being taught will consist of various manual muscle testing (MMT) skills. The students will then be assigned to one of two groups, either the experimental group or the control group based on their pre-test scores and prior experience. Lesson plans for the four days of instruction will be developed according to the organizational strategy used(either chunking with high contextual interference or traditional with low contextual interference).

The first day of instruction will include information to the participants about participating in the research study, as well as obtaining informed consent from each individual who decides to participate. In the event that a student

decides not to participate, they will be assigned to the traditional group since this is the way the skills would have been taught normally in class. The principles of manual muscle testing will also be instructed to the students on this day. The three class periods following will consist of actual instruction for the participants in particular manual muscle testing skills. The psychomotor skill that will be taught and tested will be manual muscle testing of three extremities: foot and ankle, hip, and shoulder. The material that will be instructed during the experiment is normal content match with the material already in the class syllabus. Two blind instructors, who will be first year graduate students in clinical instruction, will be responsible for instructing each group of students on the six assigned class days. The instructors will be blind to the purpose of the study. One instructor will follow the chunked, high contextual interference lesson plan, while the other will follow the traditional, low contextual interference lesson plan. The instructor will follow the lesson plan exactly as written, and will be filmed for qualitative analysis. The instructional session for each group will last two hours. Three sessions will be included for experimental purposes.

At the end of each two-hour session, the students will be asked to perform skills taught on that day. The skills will be chosen at random. Their performances will be filmed for analysis by a blind outside evaluator using the forms that had been previously validated. At the end of the third session, two additional manual muscle testing skills on the knee and elbow will be presented to the students. These will be tests they have not been instructed on and will therefore assess the transfer and application of the previously learned skills to related areas of the body. Three weeks following the end of the instructional sessions, each student will again be tested on the skills that were previously tested during the three-day instructional period. This evaluation will take place outside of class time. This will assess retention of the skills learned. Statistical analyses will be performed to determine if significant differences exist between the experimental and the control organizational strategy groups on the dependent variables of performance, transfer, and retention. A questionnaire will be given to all students who participated in the study to gather qualitative data concerning the sessions of instruction. Only myself and faculty advisor Bryan Riemann will have access to individual student results.

III. Description of possible risk to human participants. If procedures involve the use of any biohazardous materials or substances (including, but not limited to, hazardous chemicals, restricted drugs, needles or other contaminable materials, and/or infectious agents) the researcher must complete the IBC Biosafety Protocol (See the DIRB Chair for appropriate forms).

No risks to human participants.

IV. Description of possible benefits to human participants and society in general.

This research will largely benefit athletic training education, as well as other allied health professions, by identifying effective organizational strategies for promoting learning and acquisition of psychomotor skills. Currently there is

no scientific data to support the rationale that one organizational strategy in teaching psychomotor skills in athletic training is more effective than another. This research will provide some data, which can then be applied to the development of courses that teach psychomotor skills in athletic training, especially the methods by which instructors present the material to be learned in class.

V. Information on participants to be utilized in the research. Describe the sample and sampling technique. If flyers or advertisements are used include a copy. If using in-class methods, please provide a rationale for why the data has to be collected during class time as well as the educational benefits that the students will realize by participation.

The sample will be a convenience sample that will consist of twelve first year undergraduate athletic training students at Georgia Southern University who are enrolled in KINS 2322 for the spring semester. The skills that will be taught during the experimental sessions are already part of the course content. Additionally the period of time over which the content will be taught will remain consistent with normal time allocation

All participants will be debriefed at the conclusion of the study. Thus, by participating in the study, the students will gain a better understanding of how organizational strategies can influence learning. This will allow them to not only understand the numerous available organizational strategies of teaching a lesson, but also give them experience in the areas of research and conducting a research study.

In the event that one organizational strategy is determined to be significantly more effective, additional instruction and supervision on the material taught will be given to the group demonstrating inferior performance. This supplemental instruction will be scheduled at convenient times for the students involved.

VI. Materials and procedures to be used. Please attach a copy of any questionnaire, interview questions, flyers and/or newsprint or other materials that may be used.

Please see attached questionnaires and evaluation forms that will be used in the study.

VII. Procedures to secure informed consent. Please attach a copy of the Informed Consent Form. When deception is necessary, attach a copy of the debriefing plan.

All participants will give informed consent. Please see attached.

VIII. Procedures to gain consent and utilize minors in the research.

No minors will be used in the research.

IX. Please provide an explanation, if any of how the data collected will relate to illegal activities.

No illegal activities will occur

GEORGIA SOUTHERN UNIVERSITY
Department of Health & Kinesiology
College of Health & Professional Studies

CONSENT TO PARTICIPATE IN A RESEARCH PROJECT FORM

I understand that the consent form I am about to complete is part of a research project entitled "Organizing Learning and Practice to Enhance the Acquisition of Psychomotor Skills in Athletic Training Education" conducted by Ansley Hendrick, 912-871-5969. The purpose of this study is to compare two different organizational strategies of teaching a lesson. At any time during the study, I agree not to discuss my coursework with any other classmates or anyone outside of class. I also agree to not engage in any practice of the skills taught outside of class, or to ask other clinical instructors for added instruction on the skills taught during the time the study is conducted. I understand that my skills will be videotaped and evaluated by the traditional clinical skills forms that are used in class. I understand that I will be videotaped only for evaluative purposes and my performance will not be shown at any other time. I also understand that I will be debriefed at the conclusion of the study concerning the purpose, details, and results of the study. By signing below, I am agreeing to allow Ansley Hendrick and colleagues to use the information I provide in presentations and publications.

I understand that any relationship between myself and the information I contribute to this study will be kept confidential. I understand that only Ansley Hendrick and faculty advisor Bryan Riemann will have access to the results. I understand that I may terminate my participation in this study at any time without prejudice to myself, course

grade, or any other personal matter. Given the nature of this study, I further acknowledge that the investigator may, at (his/her) discretion, terminate my participation in this project at any time deemed appropriate. I understand that if I choose to not participate in the study, I will not be penalized in any way. I understand that if I choose to not participate in the study, I will be not be included in any experimental group.

If I have any questions about this research project, I may contact Ansley Hendrick at 912-9871-5969. If I have any questions or concerns about my rights as a research participant in this study, I may contact the Internal Review Board Coordinator at the Office of Research Services and Sponsored Programs 912-681-5465.

Print Participant's Name _____

Participant's Signature _____

Date _____

Georgia Southern University
Office of Research Services & Sponsored Programs

Institutional Review Board (IRB)

Phone: 912-681-5465
Fax: 912-681-0719
Ovrsight@gasou.edu
P.O. Box 8005
Statesboro, GA 30460-8005

To: Ansley Hendrick
Health and Kinesiology

Cc: Bryan Riemann, Faculty Advisor
Health and Kinesiology

From: Mr. Neil Garretson, Coordinator
Research Oversight Committees (IACUC/IBC/IRB)

Date: February 5, 2002

Subject: Status of Application for Approval to Utilize Human Subjects in Research

After an expedited review of your proposed research project titled "The Effectiveness of the Organiational Strategy of Chunking and Contextual Interference in the Acquisition of Psychomotor Skills in Athletic Training Education," it appears that the research subjects are at minimal risk and appropriate safeguards are in place. I am, therefore, on behalf of the Institutional Review Board able to certify that adequate provisions have been planned to protect the rights of the human research subjects. This proposed research is approved through an expedited review procedure as authorized in the *Federal Policy for the Protection of Human Subjects* (45 CFR §46.110(7)), which states:

> (7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

This IRB approval is in effect for one year from the date of this letter. If at the end of that time, there have been no changes to the exempted research protocol, you may request an extension of the approval period for an additional year. In the interim, please provide the IRB with any information concerning any significant adverse event, **whether or not it is believed to be related to the study**, within five working days of the event. In addition, if a change or modification of the approved methodology becomes necessary, you must notify the IRB Coordinator **prior** to initiating any such changes or modifications. At that time, an amended application for IRB approval may be submitted. Upon completion of your data collection, please notify the IRB Coordinator so that your file may be closed.

Appendix D

Educational Background and Athletic Training Experiences Questionnaire

Name_____ Date_____

Gender **M** **F** Height_____ Weight_____

Age_____ Year in School **Fr.** **Soph.** **Jr.** **Sr.** Year in ATEP _____

Please list all courses previously taken that pertain to athletic training (i.e. anatomy, prevention and care, etc.)

Please list all clinical experiences in athletic training/physical therapy you have had up until now. This includes all sports at Georgia Southern University, as well as any other schools, internships, jobs, or volunteer work.

Student's Perceptions of Instructional Method-Evaluation Form

Name_____ Date_____

Please respond to the following questions as truthfully as possible. Please only evaluate the method of instruction for your class. This includes the way the material was presented, the time allotted for each subject, the arrangement of the practice sessions, etc. Please do not evaluate the individual instructor.

1. What, if any, did you feel were the strengths of the method that the material was presented in class?

2. What, if any, did you feel were the weaknesses of the method that the material was presented in class?

3. What do you feel could have been done better to help you as a student learn the material more effectively?

SKILL EVALUATION FORM

Name_____ **Date**_____

1. Shoulder External Rotation

____(3) Takes body part through full AROM to establish Grade 3-externally rotates to 0° with minimal horizontal abduction
____(4) Places athlete in appropriate position and correctly performs desired grade—prone w/arm ABD 90°, elbow flexed 90°, & neutral rotation
____(3) Grade 5
____(3) Grade 4
____(3) Grade 3
____(3) Grade 2—prone with arm hanging down from table and elbow extended, ERs around long axis of arm
____(3) Grade 1—same as Grade 2, but only palpates contraction
____(3) Notes active muscle(s)—infraspinatus and teres minor

2. Hip Flexion, Abduction, & External Rotation with Knee Position—Sartorius

____(3) Instructs pt. to take body part through full AROM—ability indicates minimal **Grade 3**
____(4) Positions athlete appropriately for grade being tested— seated in neutral posture w/knee & hip flexed to 90°, & ER
____(3) Grade 5-Holds end point against maximal resistance (hand on thigh should resist in a downward and inward direction, hand at ankle should resist up and outward)
____(3) Grade 4-Tolerates moderate resistance
____(3) Grade 3-Completes movement against gravity with **no** resistance
____(3) Grade 2 (gravity independent-pt. is supine and athlete attempts to slide test heel along shin to knee)
____(3) Grade 1 (therapist supports in slight flexion, abduction, and ER, have pt. attempt to slide heel while palpating for a contraction)

3. Ankle Plantarflexion (Gastrocnemius and Soleus)

____(4) Places athlete in appropriate position-**unilaterally** standing with knee extended but not locked
____(3) Grade 5 (Minimum of 20 calf raises)
____(3) Grade 4 (10-19 calf raises)
____(3) Grade 3 (1-9 calf raises)
____(3) Grade 2 (Standing-patient can't complete at least 1 full heel raise)
____(3) Grade 1 (Prone-no visible movement(PF)/palpate contraction)
____(3) Indicates primary muscle/groups being tested

Name_____ **Date**_____

Please answer the following questions as truthfully as possible. The first three questions are based on a Likert-type scale and the last is open-ended.

1. When compared to previous experiences this year when you were formally evaluated on clinical skills, how **prepared** did you feel when being evaluated on the skills presented today?

1	**2**	**3**	**4**	**5**
Not at all		No response		Very Prepared

2. When compared to previous experiences this year when you were formally evaluated on clinical skills, how **confident** did you feel when being evaluated on the skills presented today?

1	**2**	**3**	**4**	**5**
Not at all		No response		Very Confident

3. When compared to previous experiences this year when you were formally evaluated on clinical skills, how **anxious** did you feel when being evaluated on the skills presented today?

1	**2**	**3**	**4**	**5**
Not at all		No response		Very Anxious

4. List, if any, strategies you may have used to help remember how to perform the skills you were just evaluated on.

Lesson Plan For Day 1
Instructor-xxxx
KINS 2322
Control Schedule

Topic: MMT Skills

Materials: None

Purpose: The purpose of this lesson is to provide background information and instruction to the student, and for the student to learn and practice the proper technique in performing manual muscle testing for various joint motions.

Learning Objectives: After this lesson the student will be able to:

1-Understand principles and concepts of manual muscle testing
2-Demontrate the correct way to manual muscle test each joint motion
3-Correctly assign grades to the joint motion based on the patient's ability

Outside Learning Assignment:
Students will be given a handout prior to class that lists the basic principles of manual muscle testing, as well as the different grades and what each grades means. After reading the handout, students will be able to:

1-Be aware of the different principles of MMT
2-Know the five grades assigned when manual muscle testing and what each grade means

OUTLINE:
Introduction-5 minutes (verbal)
What is manual muscle testing?
Manual assessment of a muscle(s) strength
Why do we manual muscle test?
To identify weakness, to have a baseline measure to chart improvements
In what situations do we manual muscle test?
PPE's, orthopedic evaluations
What are the benefits?
Easy, convenient

Instruction-20 minutes
Hip Flexion
Hip Flexion, Abduction, and ER (Sartorius)
Hip Extension
Hip Abduction-TFL
Hip Abduction-Gluteus medius/minimus
Review-2 ½ minutes

Instruction-20 minutes
Hip Adduction
Hip External Rotation
Hip Internal Rotation
Great Toe Flexion and Extension
Toe Flexion and Extension
Review-2 ½ minutes

Practice-55 minutes
Students will practice in one group of two and one group of three. The partner the student is assigned to today will be his or her partner for the remaining class session on MMT. Only the instructor will facilitate practice and provide cues during practice on the skills taught that day.

Conclusion-5 minutes (verbal)

Lesson Plan For Day 2
Instructor-xxxx
KINS 2322
Control Schedule

Topic: MMT Skills

Materials: None

Purpose: The purpose of this lesson is to provide background information and instruction to the student, and for the student to learn and practice the proper technique in performing manual muscle testing for various joint motions.

Learning Objectives: After this lesson the student will be able to:
1-Understand principles and concepts of manual muscle testing
2-Demontrate the correct way to manual muscle test each joint motion
3-Correctly assign grades to the joint motion based on the patient's ability

OUTLINE:

Introduction-5 minutes (verbal)
Review of previous class day instruction
Hip MMT/Great Toe and Toe flexion and extension (all verbal)

Instruction-20 minutes
Ankle Plantarflexion
Ankle Dorsiflexion
Ankle Inversion
Ankle Eversion
Knee Extension
Review-2 ½ minutes

Instruction-20 minutes
Cervical Extension
Cervical Flexion
Cervical Rotation
Trunk Rotation
Elevation of Pelvis
Review-2 ½ minutes

Practice-55 minutes
Students will practice in one group of two and one group of three. The partner the student was assigned to on the first day of class will be his or her partner for the remaining class

sessions on MMT. Only the instructor will facilitate practice and provide cues during practice on the skills taught that day.

Conclusion-5 minutes (verbal)

Lesson Plan For Day 3
Instructor-xxxx
KINS 2322
Control Schedule

Topic: MMT Skills

Materials: None

Purpose: The purpose of this lesson is to provide background information and instruction to the student, and for the student to learn and practice the proper technique in performing manual muscle testing for various joint motions.

Learning Objectives: After this lesson the student will be able to:
1-Understand principles and concepts of manual muscle testing
2-Demontrate the correct way to manual muscle test each joint motion
3-Correctly assign grades to the joint motion based on the patient's ability

OUTLINE:

Introduction-5 minutes (verbal)
Review of previous class day instruction
Ankle/knee/cervical/trunk/pelvis

Instruction-20 minutes
Lumbar Spine Extension
Trunk Extension
Trunk Flexion
Trunk Rotation-Abs, Obliques, multifidi
Scapular Elevation
Review-2 ½ minutes

Instruction-20 minutes
Scapular Retraction
Elbow Flexion
Elbow Extension
Wrist Flexion
Wrist Extension
Review-2 ½ minutes

Practice-55 minutes
Students will practice in one group of two and one group of three. The partner the student was assigned to on the first day of class will be his or her partner for the remaining class

sessions on MMT. Only the instructor will facilitate practice and provide cues during practice on the skills taught that day.

Conclusion-5 minutes (verbal)

Lesson Plan For Day 4
Instructor-xxxx
KINS 2322
Control Schedule

Topic: MMT Skills

Materials: None

Purpose: The purpose of this lesson is to provide background information and instruction to the student, and for the student to learn and practice the proper technique in performing manual muscle testing for various joint motions.

Learning Objectives: After this lesson the student will be able to:
1-Understand principles and concepts of manual muscle testing
2-Demontrate the correct way to manual muscle test each joint motion
3-Correctly assign grades to the joint motion based on the patient's ability

OUTLINE:

Introduction-5 minutes (verbal)
Review of previous class day instruction
Trunk/Scapula/elbow/Wrist

Instruction-20 minutes
Shoulder Flexion
Shoulder Extension
Shoulder Scaption
Shoulder Horizontal Abduction
Shoulder Horizontal Adduction
Review-2 ½ minutes

Instruction-20 minutes
Shoulder Abduction
Shoulder External Rotation
Shoulder Internal Rotation
Finger Flexion/Extension
Thumb Flexion/Extension
Review-2 ½ minutes

Practice-55 minutes
Students will practice in one group of two and one group of three. The partner the student was assigned to on the first day of class will be his or her partner for the remaining class sessions on MMT. Only the instructor will facilitate practice and provide cues during practice on the skills taught that day. **Conclusion-5 minutes (verbal)**

Lesson Plan For Day 1
Instructor-xxxx
KINS 2322
Experimental Schedule

Topic: MMT Skills

Materials: None

Purpose: The purpose of this lesson is to provide background information and instruction to the student, and for the student to learn and practice the proper technique in performing manual muscle testing for various joint motions.

Learning Objectives: After this lesson the student will be able to:

1-Understand principles and concepts of manual muscle testing
2-Demontrate the correct way to manual muscle test each joint motion
3-Correctly assign grades to the joint motion based on the patient's ability

Outside Learning Assignment:
Students will be given a handout prior to class that lists the basic principles of manual muscle testing, as well as the different grades and what each grades means. After reading the handout, students will be able to:

1-Be aware of the different principles of MMT
2-Know the five grades assigned when manual muscle testing and what each grade means

OUTLINE:
Introduction (5 minutes)-mix
What is manual muscle testing?

Manual assessment of a muscle(s) strength
*Actual demonstration of MMT of student model

Why do we manual muscle test?

To identify weakness, to have a baseline measure to chart improvements

In what situations do we manual muscle test?

PPE's, orthopedic evaluations

What are the benefits?

Easy, convenient

Scapular Elevation
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

*When practicing students will have a different partner with each skill for all skills every class day. Before practicing a card will be chosen that will tell the order in which they grade the test (i.e. start at grade 3, go to grade 1 or 5).

Trunk Flexion
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Hip Flexion
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Ankle Plantarflexion
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Trunk Rotation-Abs, Obliques, Multifidi
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Knee Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Elbow Flexion
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Shoulder Flexion
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Hip Abduction-Gluteus minimus/medius
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Cervical Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Conclusion (5 minutes)-mix
Students will randomly draw a skill and be asked to demonstrate it to the class and explain the steps and grades of MMT.

Lesson Plan For Day 2
Instructor-xxxx
KINS 2322
Experimental Schedule

Topic: MMT Skills

Materials: None

Purpose: The purpose of this lesson is to provide background information and instruction to the student, and for the student to learn and practice the proper technique in performing manual muscle testing for various joint motions.

Learning Objectives: After this lesson the student will be able to:
1-Understand principles and concepts of manual muscle testing
2-Demontrate the correct way to manual muscle test each joint motion
3-Correctly assign grades to the joint motion based on the patient's ability

OUTLINE:
Introduction (5 minutes)-mix
Practical Review of MMT skills learned previous day

Hip Flexion, Abduction, External Rotation
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

*When practicing students will have a different partner with each skill for all skills every class day. Before practicing a card will be chosen that will tell the order in which they grade the test (i.e. start at grade 3, go to grade 1 or 5).

Shoulder Horizontal Abduction
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Toe Flexion and Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Shoulder Internal Rotation
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Ankle Dorsiflexion
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Cervical Flexion
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Thumb Flexion/Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Trunk Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Shoulder Abduction
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Hip Adduction
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Conclusion (5 minutes)-mix
Students will randomly draw a skill and be asked to demonstrate it to the class and explain the steps and grades of MMT.

Lesson Plan For Day 3
Instructor-xxxx
KINS 2322
Experimental Schedule

Topic: MMT Skills

Materials: None

Purpose: The purpose of this lesson is to provide background information and instruction to the student, and for the student to learn and practice the proper technique in performing manual muscle testing for various joint motions.

Learning Objectives: After this lesson the student will be able to:
1-Understand principles and concepts of manual muscle testing
2-Demontrate the correct way to manual muscle test each joint motion
3-Correctly assign grades to the joint motion based on the patient's ability

OUTLINE:
Introduction (5 minutes)-mix
Practical Review of MMT skills learned previous day

Shoulder Scaption
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

*When practicing students will have a different partner with each skill for all skills every class day. Before practicing a card will be chosen that will tell the order in which they grade the test (i.e. start at grade 3, go to grade 1 or 5).

Cervical Rotation
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Hip External Rotation
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Ankle Inversion
Instruction-2 ½ minutes
Practice 5 ½ min

Review 2 ½ minutes

Hip Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Scapular Retraction
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Trunk Rotation
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Wrist Flexion
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Shoulder Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Finger Flexion/Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Conclusion (5 minutes)-mix
Students will randomly draw a skill and be asked to demonstrate it to the class and explain the steps and grades of MMT.

Lesson Plan For Day 4
Instructor-xxxx
KINS 2322
Experimental Schedule

Topic: MMT Skills

Materials: None

Purpose: The purpose of this lesson is to provide background information and instruction to the student, and for the student to learn and practice the proper technique in performing manual muscle testing for various joint motions.

Learning Objectives: After this lesson the student will be able to:
1-Understand principles and concepts of manual muscle testing
2-Demontrate the correct way to manual muscle test each joint motion
3-Correctly assign grades to the joint motion based on the patient's ability

OUTLINE:
Introduction (5 minutes)-mix
Practical Review of MMT skills learned previous day

Elevation of Pelvis
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

*When practicing students will have a different partner with each skill for all skills every class day. Before practicing a card will be chosen that will tell the order in which they grade the test (i.e. start at grade 3, go to grade 1 or 5).

Hip Abduction-TFL
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Great Toe Flexion and Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Shoulder Horizontal Adduction
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Hip Internal Rotation
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Wrist Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Ankle Eversion
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Lumbar Spine Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Elbow Extension
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Shoulder External Rotation
Instruction-2 ½ minutes
Practice 5 ½ min
Review 2 ½ minutes

Conclusion (5 minutes)-mix
Students will randomly draw a skill and be asked to demonstrate it to the class and explain the steps and grades of MMT.

Appendix E
Pilot Data

Percent Agreement of Evaluators on Items in Pilot Testing #2

Shoulder External Rotation MMT Skill

Item	Percentage Agreement
Full AROM	86.67
Patient positioning	100.00
Grade 5	100.00
Grade 4	100.00
Grade 3	80.00
Grade 2	100.00
Grade 1	100.00
Notes active muscles	86.67

Hip Flexion, Abduction, & External Rotation-Sartorius

Item	Percentage Agreement
Full AROM	86.67
Patient positioning	100.00
Grade 5	73.34
Grade 4	73.34
Grade 3	100.00
Grade 2	93.33
Grade 1	80.00

Ankle Plantar Flexion

Item	Percentage Agreement
Full AROM	60.00
Patient Position	93.33
Grade 5	73.33
Grade 4	73.33
Grade 3	66.67
Grade 2	100.00
Grade 1	53.33
Notes active muscles	100.00

Percent Agreement of Evaluators on items in Pilot Testing #3

Hip Flexion, Abduction, & External Rotation-Sartorius

Item	Percentage Agreement
Full AROM	100.00
Patient positioning	100.00
Grade 5	81.82
Grade 4	72.73
Grade 3	100.00
Grade 2	100.00
Grade 1	100.00

Ankle Plantarflexion

Item	Percentage Agreement
Full AROM	Omitted
Patient Position	81.82
Grade 5	81.82
Grade 4	63.64
Grade 3	72.73
Grade 2	90.91
Grade 1	81.82
Notes active muscles	100.00

Intraclass Correlation Coefficients (2,K)

MMT Skill	ICC
Shoulder External Rotation	.9882
Hip Flexion, Abduction, & External Rotation	.9795
Ankle Plantarflexion	.9193

Absolute Reliability of Evaluators (N=3)
Standard Error of Measurement (SEM)

MMT Skill	SEM
Shoulder External Rotation	2.9
Hip Flexion, Abduction, & External Rotation	5.56
Ankle Plantarflexion	6.90

*with respect to a perfect score of 100

Appendix F
Free Communications Abstract

Organizing Learning and Practice to Enhance the Acquisition of Psychomotor Skills in Athletic Training Education

Hendrick, A Y: Georgia Southern University, Statesboro, GA

The purpose of this study was to determine if the organizational method of chunking instructional episodes, coupled with variable and random practice is more effective in the retention and transfer of psychomotor skills in athletic training than a more typical, massing of instructional episodes together with blocked/serial practice. Ten undergraduate students in their first year of a Commission on Accreditation of Allied Health Education Program accredited athletic training education program (ATEP) institution participated in the study. Prior to the study, lesson plans were developed for four days of instruction according to the organizational strategy used (either chunking with random/ variable practice (experimental) or traditional with blocked/serial practice (control)). The psychomotor skills instructed consisted of various manual muscle testing skills. We pre-tested all participants on three selected manual muscle testing skills. Students were randomly assigned by pairs to one of two groups based on pre-test scores. At the conclusion of the four instructional days, the participants were evaluated on the three skills previously pre-tested to assess performance. The participants were also evaluated on two skills that were not instructed to assess transfer. Two weeks following the last instructional day the participants were again evaluated on the same three skills to assess for retention. All participants (n=10) increased their scores from the pretest to the posttest. Only one participant from the control group decreased in performance from the post-test to the retention test (retention), while three actually improved their scores. For the retention variable, two participants from the experimental group stayed the same from post-test to retention test, one participant increased, and one participant actually decreased in performance from posttest to the retention test. From the results it can be concluded that qualitative data seemed to support the organizational method of chunking a psychomotor skill lesson coupled with random and variable practice. Due to the small number of subjects, it is recommended that more research be conducted to further explain the qualitative results.