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Additive Effects of an External Focus and Enhanced Expectancy in Learning a Motor Skill

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ADDITIVE EFFECTS OF AN EXTERNAL FOCUS AND ENHANCED EXPECTANCY IN LEARNING A MOTOR SKILL

By

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ABSTRACT

ADDITIVE EFFECTS OF AN EXTERNAL FOCUS AND ENHANCED EXPECTANCY IN LEARNING A MOTOR SKILL

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An external focus of attention in has been shown to produce better performance in practice and retention of a motor skill when compared to an internal focus or control conditions in which no attentional focus cues are given to the learner (for a review, see Wulf, 2012). Enhancing learner expectancy (e.g., via positive feedback) has also been shown to improve learning (e.g., Lewthwaite & Wulf, 2010). This study sought to investigate whether combining the positive effects of an external focus of attention with an enhanced learner expectancy (through positive social-comparative feedback) would enhance learning relative to either variable alone or a control condition. Participants were assigned to one of 4 groups: External Focus and Enhanced Expectancy (EF/EE), External Focus (EF), Enhanced Expectancy (EE), and Control (C). Participant practiced an overhand throwing task using their non-dominant arm at a target positioned 7.5 meters away for 65 throws on the first day, with each group receiving the appropriate feedback and attentional cues related to their group assignment. The second day consisted of a retention test of 10 throws at the same target positioned at the practiced distance of 7.5 meters, and a transfer test of 10 throws at the same target positioned at 8.5 meters away with no instructions given to any group to measure learning.

Throwing performance in the group that received both EE and EF was found to be superior to that of the control and the groups that only received one treatment of EE or EF. The EE and EF groups performed at similar levels while outperforming the control group. Self-efficacy also produced similar results with the EF/EE group reporting the highest self-efficacy among all groups. EF and EE were found to each individually have effects on self-efficacy, suggesting independent effects on increased self-efficacy, this could have been a factor on the EF/EE having the highest self-efficacy scores.

The results of this study indicate that EF/EE when combined produces an additive effect to performance and learning of a relatively novel motor skill. Increased self-efficacy can also be observed with the implementation of the combined treatments of EF and EE. The discovery of the additive effect has the potential to open new research possibilities in motor learning on any other possible combination and additive effects.

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CHAPTER 1

INTRODUCTION

Teaching novice learners in acquiring a skill takes time, patience and practice in the part of the learner and the teacher. There are a multitude of methods that a teacher or coach can use to optimize the skill acquisition process for the learner, and one of the most viable and most researched methods is the manipulation of instruction with the use of attention cues. A learner's focus during task acquisition has been studied extensively throughout the years. The results of these studies have been consistent: An "external focus of attention," which is the focus on the intended effect of a given movement, is superior to an "internal focus of attention," which is the focus on the learner's own body while executing a movement (Wulf, 2012).

A second method that can facilitate enhanced skill acquisition for a learner is the use of positive social-comparative feedback that will in essence enhance the expectancy of the learner while performing the given task. The successful use of the social-comparative feedback on skill acquisition and performance improvement has been well examined and has been shown to improve learning and performance (e.g., Lewthwaite & Wulf, 2010). Social-comparative feedback allows for self-efficacy improvement in the learner, which allows them to perform and learn better as they are led to believe that they are performing better than others regardless of whether this feedback is true or a made-up statement.

The combination of these two techniques (external attention focus and enhanced learner expectancy via social-comparative feedback) to enhance learning has yet to be examined, and in theory the combination of these two factors should enhance learning.

The possible implications of this study, should an additive effect be found between external focus and enhanced learner expectancy, can be applied to a broad range of fields as far as teaching and skill acquisition are concerned.

Purpose of the study

The purpose of this study will be to examine if there is a synergistic effect when combining external focused attention (via external focus cues and instruction) and enhanced learner expectancy (via the use of positive social-comparative feedback). I intend to elicit enhanced learner expectancy by giving the learners bogus information as to their performance being superior to a high percentage of other performers who have done the same tasks that they have just performed, and combine that with an external focus instruction/cue. This will be compared with a control where none of the two factors will be introduced and with two groups, each only receiving one of the two factors either a positive social-comparative feedback or the external focus cue alone.

I propose the following hypotheses for the results of this present study:

Research hypotheses

Hypothesis #1: Participants who receive both external focus attention instructions and positive social-comparative feedback (EF/EE group) leading to enhanced learner expectancy will perform better in the non-dominant arm throw task in the retention and transfer tests than external focus instructions alone (EF group), enhanced-expectancy alone (EE group), or no external focus instructions and no enhanced-expectancy feedback (control group).

Hypothesis #2 The EF and EE groups will demonstrate less effective retention and transfer performance than the EF/EE group, and more effective retention and transfer performance than the control group.

Significance of the study

The present study is significant as it seeks to see if there is an additive effect of externally focused attention and enhanced learner expectancy derived from positive social-comparative feedback.

An external focus has been shown to be superior to internal focus in a multitude of studies (for a review, see Wulf, 2007; 2012). Enhanced expectancies (e.g., placebos) have also been shown to enhance the performance of learners and performers of many different levels and a great multitude of various tasks (Clark, Hopkins, Hawley, & Burke, 2000). There however has not been any work that has sought to combine the use of an external focus instruction with enhanced learner expectancy. The realm of motor learning could benefit greatly from the possible synergistic effect of these two separate learning stratagems/factors, as instructors seek to find better ways to teach skills and to expedite the learning process for their pupils. The implication of a more effective learning system not only saves time on both the part of the teacher and student, but money as well, as financial considerations should be taken into account as to the often high cost of hiring private tutors for various sports and activities. Other factors that should be taken into account should a synergistic relationship exist between external focus and enhanced learner expectancy are: the improvement of student/learner compliance to the teacher as more positive gains in skill acquisition can lead to a greater "trust" in how the system of teaching and methods of a coach can positively impact the performance of the student,

and subsequently a better retention of students for the coach that teaches skills with a more effective method that allows for quicker learning and improved performance.

Definition of terms

The following are definitions to terminology that will be used throughout the explanation of this study.

Internal focus

Focus of attention that is directed towards the body during the execution of a movement (e.g., the focus of one's hand motion during a throw)f.

External focus

Focus of attention towards the effect of a movement (e.g., the focus directed towards the intended ball movement during a throw).

Motor learning

A relatively permanent change to motor performance as a result of practice or experience with a task (Schmidt & Lee, 2011).

Retention

The performance of a given skill following a period of practice or task acquisition that does not have the influence of instruction, augmented feedback or any other experimental manipulation that was given during the practice or task acquisition phase.

Transfer of learning

The influence of previous skill experience on performing a new skill in a different context or on learning a new skill (Schmidt & Wrisberg, 2008).

Social-comparative feedback

Social comparison feedback where the learner is given their performance feedback with a comparison to other performers. (This can either be a real comparison or a bogus comparison.)

CHAPTER 2

LITERATURE REVIEW

External focus of attention

Attentional focus has been the focal point of many studies conducted in the field of motor behavior in recent years. The two types of attentional focus that have been examined in the literature are an internal focus and an external focus. An internal focus is characterized by its direction of focus on the part of the performer towards their own movements. An external focus, on the other hand, is characterized by the direction of focus on the part of the performer towards the effects of their movements on the environment (Wulf, 2012). Research in motor learning has shown that an external focus is superior to internal focus of attention, or control conditions in which no instructions regarding focus were given, in motor skill acquisition and learning (for a review, see Wulf, 2012).

External focus of attention has also been shown to have a greater effect the greater the distance the attention point is from the body (Wulf, 2012). The distance effect plays a role in increased performance by preventing the performer from reverting to an internal focus as the focal point of their attention is further from the body. In essence the more remote/distant an external focus instruction is there will be a greater effect of external attentional focus and, thus less interruption of automatic processes will take place during the execution of a movement.

External focus has been shown to be superior to internal focus in numerous studies that utilized various tasks. The findings are consistent with the previous assertion that an external focus created better learning and performance in retention tests for the

participants that were given external focus instruction. Tasks such as the golf pitch shot (Wulf & Su, 2007), free throw shooting (Zachary, Wulf, Mercer, & Bezodis, 2005), skiing performed through a simulator (Wulf, Höß, & Prinz, 1998), dart throwing (McKay & Wulf, 2011), discus throwing (Zarghami, Saemi, & Fathi, 2012), and even swimming (Freudenheim, Wulf, Madureira, Pasetto, & Corrêa, 2010), have benefited from external focus instruction/cues.

Constrained action hypothesis

The constrained action hypothesis provides the strongest explanations as to why external focus is superior to internal focus (Wulf, 2012). The constrained action hypothesis proposes that performers who utilize an internal focus during task execution interfere with the automatic processes that that they have available, and that this interference result in performance degradation (McNevin, Shea, & Wulf, 2001). An external focus however has been shown to promote the automatic processes rather than hinder them, according to the constrained action hypothesis (McNevin et al., 2001).

Evidence for the Constrained Action Hypothesis

EMG activity

There is evidence that there is less muscular activity recorded through EMG when a performer adopts an external focus. The increased EMG readings observed when using an internal focus lends further evidence to the constrained action hypothesis. The increased muscular activity is a possible physical manifestation of the interruption of automatic neural processes that occur during a task or movement. Studies that show this increased EMG activity when adopting an internal focus include a bicep curl task (Vance, Wulf, Töllner, McNevin, & Mercer, 2004) and a basketball free throw shooting task

(Zachry, Wulf, Mercer, & Bezodis, 2005), as well as many other tasks (see review, Wulf, 2012).

In the study conducted by Vance et al. (2004), the comparison between internal and external focus was conducted using a bicep curl task. The external focus condition was to focus on the movement of the curl bar whereas the internal focus condition was to focus on the arm movement during the curl. This study showed that EMG activity was lower for external focus when compared to internal focus (Vance et al., 2004). This suggests that the external focus resulted in a more efficient movement pattern and the use of more automatic processes.

The study by Zachry et al. (2005), used EMG to measure muscular function during free throw shooting when comparing internal and external focus. The study compared the same participants as they performed free throws with both an internal and external focus of attention. The internal focus condition of this experiment was the snapping motion of the wrist during the free throw and the external focus condition was to focus on the center of the rear of the basketball hoop during the free throw shot. The EMG recorded the muscular activity of several muscles: flexor carpi radialis, biceps brachii, triceps brachii and the deltoid of each of the participant's shooting arm. The study showed a significantly more accurate shot performance for participants when they were executing the free throws with an external focus of attention and the EMG results mirrored that of Vance et al., 2005. The triceps brachii and the biceps brachii exhibited less EMG activity when the participants performed the shots with an external focus compared to an internal focus, which points to greater movement efficiency and provides support for the constrained action hypothesis, once again allowing more automatic

processes to take action during a motor skill when adopting an external focus of attention. The increase in accuracy of shooting coupled with the results of the EMG readings from this study when using external focus provides further backing of the effectiveness of adopting an external focus of attention.

Probe reaction times and frequency of movement adjustments

Another finding that supports the constrained action hypothesis and its role in explaining the positive effect of external focus of attention in motor learning is the reduction of reaction times when adopting an external focus of attention. The reduced reaction times on a balancing measured by the study conducted by Wulf et al., 2001, shows how the automatic processes that take place during a motor skill allow for greater stability and balance on a stabilometer task as there was a greater frequency of adjustments in the participants that adopted an external focus when compared to the participants that adopted an internal focus. The external focus condition of this particular study was to keep the markers on the stabilometer platform horizontal, while the internal focus condition was for the participants in the internal focus group to keep their feet horizontal. The researchers in this study found that there was a significant difference in the retention tests in improved balance scores for the external focus group and more frequent postural adjustments with less magnitude of movement during the adjustments meaning greater control of posture during the balance task. The researchers of this study have asserted that their findings give further evidence to the constrained action hypothesis, in how reaction times and better postural control are a manifestation of how automatic neural processes are promoted by an external focus.

The Constrained Action Hypothesis helps to provide some explanation as to how the mind is better able to move the body in a more efficient manner when performing and subsequently learning a motor skill when adopting an external focus of attention. The EMG findings showed how there is a more efficient movement pattern displayed by the activation of muscles directly involved in the task. The findings of the increased frequency of adjustments with lesser magnitude of movements showed how there is a greater control of movement while focusing externally, and finally the decreased reaction times point towards the direction of overall movement efficiency while adopting an external focus. The efficient activation of muscles thus lead to a more automatic and streamlined movement pattern that allows for greater performance and learning.

A golf shot is by nature a complex motor skill that involves a good deal of coordination and skill. The complex movements that golf shots incorporate make it an ideal task to measure motor performance and learning.In experiment one of Wulf and Su's in 2007 participants with little or no golf experience were assigned to do a golf pitch shot. It is of note that the design of this experiment was similar to that of Wulf, Lauterbach, and Toole (1999) in having a comparison of novice golfers in the golf pitch shot. This particular study elaborated on the work of Wulf et al., 1999, by adding a control group to the internal and external groups for performance and learning comparison. The performance measure for this particular study was accuracy of the golf shots taken by the participants. The participants were to hit the golf ball with a 9-iron golf club from an artificial turf mat to a target center that was located 15 meters away from the turf mat. The target in this experiment utilized four concentric circles with radii of 1.5, 2.5, 3.5 and 4.5 m from the center to the most outer circle respectively. The scoring

system the very center of the target (the bull's eye) was scored as 5 points and each circle following the bull's eye mark was scored from 4, 3, 2, and 1, respectively. The participants were randomly assigned to the control, internal focus or external focus groups. Prior to the practice phase of this experiment the experimenter demonstrated the pitch shot to each participant, and each group received similar instruction on grip, stance and posture for the pitch shot. The only difference among the groups in terms of instruction was the focus instructions. The internal focus group had their focus directed on the movement of their arms during instruction, while the external focus group had their focus on the movement of the club and its pendulum like movement during instruction, whereas the control group received no attentional focus instructions. Retention tests conducted the immediate following day of the practice phase where focus instructions were given revealed similar results to that of Wulf et al., 1999. The external focus group performed significantly better than internal focus, with the new finding that external focus also performed significantly better than the control. There was also no significant difference between control and internal focus in the retention test (Wulf & Su, 2007).

The superior performance of the external focus group compared to the internal focus group and control, using inexperienced golfers in the previous experiment provides evidence for the constrained action hypothesis and its explanation of the phenomenon of increased performance when using external focus. The automatic processes involved with coordinating the complex pitch shot in novice golfers allowed for them to execute the shot with greater movement accuracy, and thus achieve more accurate final ball placement in the target. It is of note that the golf pitch shot is a complex motor skill that

involves multiple degrees of freedom such as appropriate time and force modulation, and despite all these variables involved with the execution of the pitch shot, external focus still proved to be an effective modality for enhancing learning for novices (Wulf & Su, 2007).

Positive social-comparative feedback and enhanced expectancy

Positive feedback in the form of social-comparative feedback has recently seen increased interest in the field of motor learning. Feedback is thought to have several functions in learning. The most common function of feedback is its use as an informational tool during learning, but feedback is also thought to have a motivational function during the learning process (Schmidt & Lee, 2011). The motivational aspect of feedback in research has shown that learners perform better when the feedback given to them is of a positive nature (Chiviakowsky & Wulf, 2007). Enhanced learning after successful trial feedback has been attributed to the motivational aspect of feedback (e.g., Wulf, Chiviakowsky, & Lewthwaite, 2010).

Normative feedback involves the comparison of an individual's performance to other groups of performers (i.e., norms). This type of social-comparativefeedback has been shown to affect motivation as well as learning. Different studies involved the use of normative feedback, where the learner received (false) feedback about the individual's peer group in addition to information of their score on a given task. The effects social-comparative feedback on learning and motivation have been varied depending on whether a positive or negative comparison was given to the learner. The positive comparison has been shown to increase motivation and performance; conversely, a negative comparison has been shown to decrease motivation and performance (e.g.,

Hutchinson, Sherman, Martinovic, & Tenenbaum, 2008). The Hutchinson et al. study found that positive feedback, where participants that were told to have had above-average performances when compared to a bogus peer group, resulted not only in better performance on isometric handgrip force production, and increased time to exhaustion on the submaximal handgrip test, but also increased task enjoyment during the self-survey. The negative feedback condition on the other hand, where participants were told that they performed below average, resulted in decreased performances in maximal force production, time to exhaustion on the submaximal test and lower task enjoyment scores when compared to the positive feedback group (Hutchinson et al., 2008).

Positive social-comparative feedback serves to increase self-efficacy in learners. In other words, it enhances learners' expectancy for future performance. Increased self-efficacy and enhanced expectancies presumably lead to the observed learning advantages (Lewthwaite & Wulf, 2010; Wulf et al. 2010). The increased self-efficacy seen in groups that are given positive normative feedback is seen throughout the literature to increase skill performance. The study conducted by Lewthwaite and Wulf (2010) found that there is also a relatively more permanent effect of the normative feedback in learning. The stabilometer balancing task was used in this study. The positive and negative feedback of scores given for feedback after each practice trial were based on adding or subtracting 20% of the individual's score, respectively. False social-comparative feedback was given in addition to veridical feedback, while a control group received only veridical feedback. The results of this study showed that the better group had significantly better scores when compared to the worse and control groups on the balancing task during the delayed retention test where there was no feedback given. It was also observed that the better

group had more automatic control of their movements during the balancing task as exhibited by their higher frequency and lower amplitude of adjustment during the balancing task, which could help to explain the superior performances for the better group (Lewthwaite & Wulf, 2010).

The two positive influences on learning with an external focus of attention or enhanced performance expectancies is well documented. However, there has been no research that examined whether there is an increase in learning from *combining* external focus of attention with enhanced expectancy (e.g., positive social-comparative feedback). This study seeks to find if there is an added benefit when the two independent variables of external focus and positive social-comparative feedback are combined, relative to the presence of only factor or none.

CHAPTER 3

METHODS

Participant characteristics

This study utilized non-ambidextrous participants who have no prior experience throwing with their non-dominant arm. Each participant was asked if they have had experience throwing with their non-dominant arm. No participant who took part in this study answered yes to the previous question. The participants were drawn from the UNLV student population. Fifty-two undergraduate students (21 men, 31 women) participated in this study. The participants were randomly assigned into one of the four following groups: External Focus & Enhanced Expectancy (EF/EE), External Focus (EF), Enhanced Expectancy (EE), and a control group (C).

Apparatus and task

The experiment was conducted indoors in a racquetball court (Motor Learning Lab 2) in the MPE building of UNLV. A net in which a target with 8 concentric circles was placed was utilized in this study. All participants threw regulation-sized tennis balls at this target. The target, which was made from a canvas tarp, consisted of 8 concentric circles. The smallest circle of the "bull's eye" had a diameter of 7.5 centimeters, and each following circle had a radius that was 7.5 centimeters larger than the previous, terminating in the eighth and largest circle which had a diameter of 60 centimeters.

The task required participants to perform an overhand throw with their non-dominant arm. A line placed at a distance of 7.5 meters from the target served as the location where the participants were instructed to throw from during the practice phase

and the retention test of this study. A second line positioned at 8.5 meters was used for the transfer test for this study.

Procedure

External focus for this study was elicited by instructing the participant to focus on the target. These instructions were given prior to each 10-trial block on the practice day for the participants in the (EF/EE) and (EF) groups.

The enhanced performance expectancy was elicited via the use of normative feedback that was provided in addition to the veridical feedback that all groups received after each trial block during the practice phase. The normative feedback provided to the (EF/EE) and (EE) groups was similar in fashion to that given in the study by Lewthwaite and Wulf (2010). In addition to the average score of the trial block (i.e., veridical feedback), which was given to all groups, normative feedback was provided. It involved a bogus score that was 20% lower than the participant's actual score. This "norm" was calculated by subtracting 20% of the participant's score after every trial block for which normative feedback was given. The participants were told that this score was the average score that previous participants had achieved. Thus, EF/EE and EE group participants were led to believe that they performed above average.

The throws were measured via a zone scoring system similar to the ones used in the studies by Perkins-Ceccato, Passmore, and Lee (2003), Wulf, Lauterbach and Toole (1999) and Wulf and Su (2007) where concentric circles were used as a target. There were 8 concentric circles and a center circle that served as the bull's eye and had a 7.5 cm radius. The surrounding circles had radii of 22.5 cm, 30 cm, 37.5 cm, 45 cm, 52.5 cm, and 60 cm. Eight points were given for hitting the center circle/bull's eye, 7 points for

hitting the 15 cm circle, 6 points for hitting the 22.5 cm circle, 5 points for the 30 cm circle, 4 points for the 37.5 cm circle, 3 points for the 45 cm circle, 2 points for the 52.5 cm circle, 1 point for the 60 cm circle, and finally 0 points for complete misses of the target.

All participants were instructed on the execution of an overhand throw with their non-dominant arm which consisted of instructing the participant to keep their opposite foot forward and a demonstration of the overhand motion with the opposite arm by the experimenter, prior to any throws performed by the participant. The participants used a common set of regulation tennis balls for this study. The starting point of the throw was placed 7.5 meters away from the target. Prior to the practice phase, each participant performed 5 throws in a pretest block to establish a baseline score. Upon completion of the pretest block the participants were randomly assigned to one of four test groups: EF/EE, EF, EE, or C. The practice phase of the study had 6 practice blocks with 10 throws per block with each group receiving the appropriate instruction or feedback, depending on which group they were assigned to. There was a 2-minute rest period in between each block of trials in both the practice day and the retention/transfer test day.

One day later, a retention test and a transfer test that (8.5 meters away from the target) were performed. Each test consisted of 10 throws. No instruction or feedback were given to the participants on Day 2.

To assess motivational influences of the independent variables in this study, all participants were asked to fill out 3 questionnaires (see Appendix I-III). The questionnaires were given after the pre-test block, at the end of the practice phase and prior to the retention test. These questionnaires included questions related to

positive/negative affect (Positive and Negative Affect Schedule, PANAS; Watson, Clark, & Tellegan, 1988), task motivation, attentional focus, and self-efficacy. .

The PANAS includes words that describe positive and negative feelings or emotions, and participants are asked to rate them on a scale from 1 (very slightly or not at all) to 5 (extremely), depending on how they feel at the present moment. For the present study, 7 words that clearly described positive feelings (interested, excited, strong, enthusiastic, proud, inspired, determined) and 8 words that reflected negative ones (distressed, upset, scared, irritable, ashamed, nervous, jittery, afraid) were selected. Task motivation was also measured in this study. Each participant was asked on Questionnaire 1 on how motivated they were to learn the task on a 1 to 10 scale (see Appendix I). Furthermore, participants were also asked what they focused on during their throws after the end of the practice day via a question in Questionnaire 2 (see Appendix II). The responses given for this question were grouped into either an internal focus (form-based focus) or an external (target-based focus). If both internal and external foci of attention were given as a response (i.e., the participant logged both a form-based response and a target-based response) they were grouped into a target/form category.

Data analysis

Throwing performance scores were analyzed separately for the pretest, practice, retention, and transfer phases. The accuracy scores were averaged across the 5 pretest trials and analyzed in a 2 (external focus instruction: yes, no) x 2 (enhanced expectancy: yes, no) analysis of variance (ANOVA). The practice data were averaged across 6 blocks of 10 trials and analyzed in a 2 (external focus instruction: yes, no) x 2 (enhanced expectancy: yes, no) x 6 (block) ANOVA with repeated measures on the last factor. The retention and transfer data were each averaged across all 10 trials and analyzed in a 2 (external focus instruction: yes, no) x 2 (enhanced expectancy: yes, no) ANOVA.

To assess the motivational effect of the experimental manipulations in this study, the self-efficacy scores were analyzed separately for each of the questionnaires. The score means were analyzed in a 2 (external focus instruction: yes, no) x 2 (enhanced expectancy: yes, no) ANOVA. The score means of positive and negative affect were also analyzed separately for each of the questionnaires in a 2 (external focus instruction: yes, no) x 2 (enhanced expectancy: yes, no) ANOVA. Task motivation scores were analyzed in a 2 (external focus instruction: yes, no) x 2 (enhanced expectancy: yes, no) ANOVA.

The answers to the attentional focus question ("What did you mostly focus your attention on while throwing the balls?") were classified into those that indicated an external (i.e., target or outcome related) focus or internal (i.e., movement-form related) focus, or both. The number of responses that clearly reflected an internal or external focus were submitted to a chi-square test.

CHAPTER 4

RESULTS

Throwing performance

Baseline

There were no significant differences among the four groups during the five throws that were performed by each group during the baseline test (*Figure 1)*. The main effects of EF and EE were not significant, *F*s (1, 48) = < 1. Also, there was no interaction between EF and EE, F (1, 48) < 1.

Practice

All four groups improved their throwing performance across the six practice blocks. The EF/EE group performed best during practice, followed by the EE and EF groups that performed at similar levels to one another. The control group produced the least accurate throws during practice (*Figure 1)*. The main effect of block, F (5, 240) = 17.886, p < .001, partial $\eta 2$ = .271, was significant. The main effects of both EF, F (1, 48) = 22.803, p <. 001, partial $\eta 2$ = .322, and EE, F (1, 48) = 14.929, p <. 001, partial $\eta 2$ = .237, were significant. There was no interaction of EF and EE, F (1, 48) = .269, p =. 606, partial $\eta 2$ = .006. Also, none of the other interactions were significant, F (5, 240) < 1.

Retention/Transfer

The EF/EE group outperformed the other groups during the retention test. The EE and EF groups were virtually identical coming in at second and third among the groups and the control group performed the worst of all the groups (*Figure 1*). The main effect of EF was significant, F (1, 48) = 42.849, p < .001, partial $\eta 2$ = .472. The main effect of

EE was also significant, F (1, 48) = 39.817, p < .001, partial $\eta 2$ = .453. There was no significant interaction between EF and EE, F (1, 48) < 1.

On the transfer test, the EF/EE group had the highest accuracy scores. The EF and EE groups performed similarly to one another and were in between the EF/EE and control group, which showed the poorest performance in the transfer test (*Figure 1).* The main effect of EF was significant, F (1, 48) = 30.759, p < .001, partial $\eta 2$ = .391. The main effect of EE was also found to be significant, F (1, 48) = 27.051, p < .001, partial $\eta 2$ = .360. The interaction of the two factors was not significant, F (1, 48) < 1.

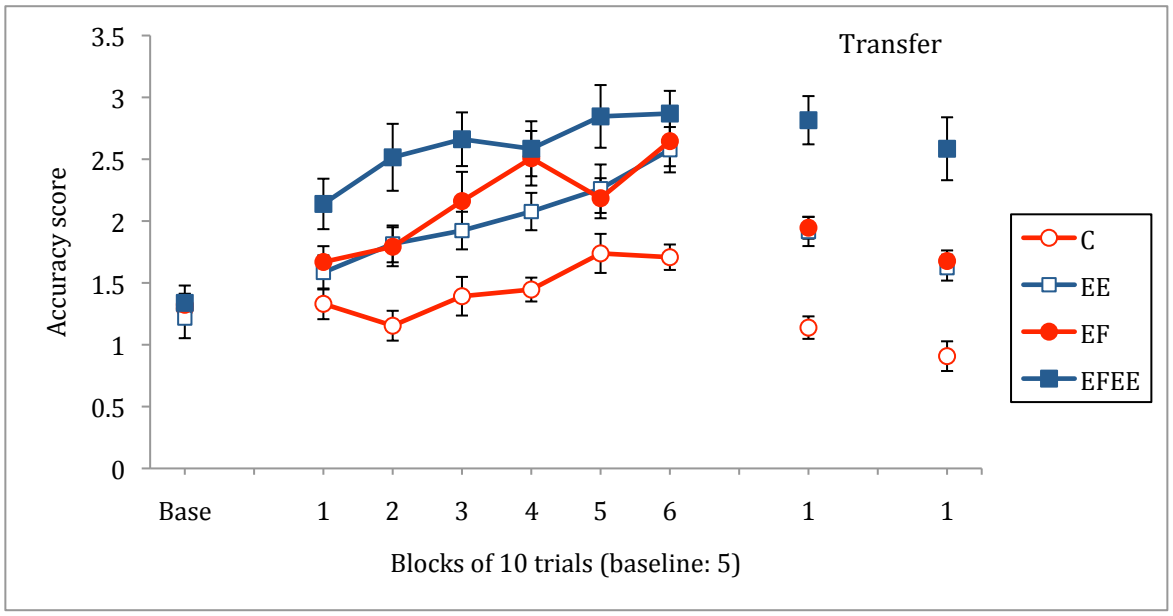

Figure 1. Throwing performance of the four groups during baseline, practice, retention, and transfer.

Task motivation

Task motivation was measured after baseline testing. There was no significant difference in task motivation among the groups. < 1. The main effects of EE, F (1, 48) < 1, and EF, F (1, 48) = 1.144, $p > .05$, were not significant. Interaction of EE and EF failed to reach significance, F (1, 48) < 1.

Self-efficacy

Baseline

There were no significant group differences after baseline for SE (*Figure 2*). The main effects of EF, F (1, 48) = 1.806, $p > .05$, and EE, F (1, 48) = 1.374, $p > .05$, were not significant. There was also no interaction between EF and EE, F (1, 48) = 1.119, $p > .05$.

Practice

After the end of all practice trials, the EE/FE group showed the highest self-efficacy scores, while the EF and EE groups had scores that were between the EF/EE and C groups (*Figure 2).* There were significant main effects of EF, F (1, 48) = 4.937, $p < .05$, partial $\eta 2 = .093$, and EE, F (1, 48) = 9.366, $p < .01$, partial $\eta 2 = .163$. There was no significant interaction between EF and EE, F (1, 48) = 1.188, $p > .05$.

Retention/Transfer

There were significant group differences in self-efficacy on the retention/transfer day, F (3, 48) = 5.164, $p = .004$, partial $\eta 2 = .244$. The EF/EE group reported the highest self-efficacy scores ($M = 5.92$, $SD = 1.92$), while the EF group ($M = 4.02$, $SD = 1.63$), and EE ($M = 4.4$, $SD = 1.25$) group were in between the EF/EE group and the control ($M = 3.5$, $SD = 1.74$), which reported the lowest self-efficacy scores among all the groups

(*Figure 2*). The main effect of EF was significant, F (1, 48) = 4.937, $p < .05$, partial $\eta 2$ = .093. The main effect of EE was also significant, F (1, 48) = 9.366, $p < .01$, partial $\eta 2$ = .163. There was no significant interaction between EF and EE, F (1, 48) = 1.188, $p > .05$.

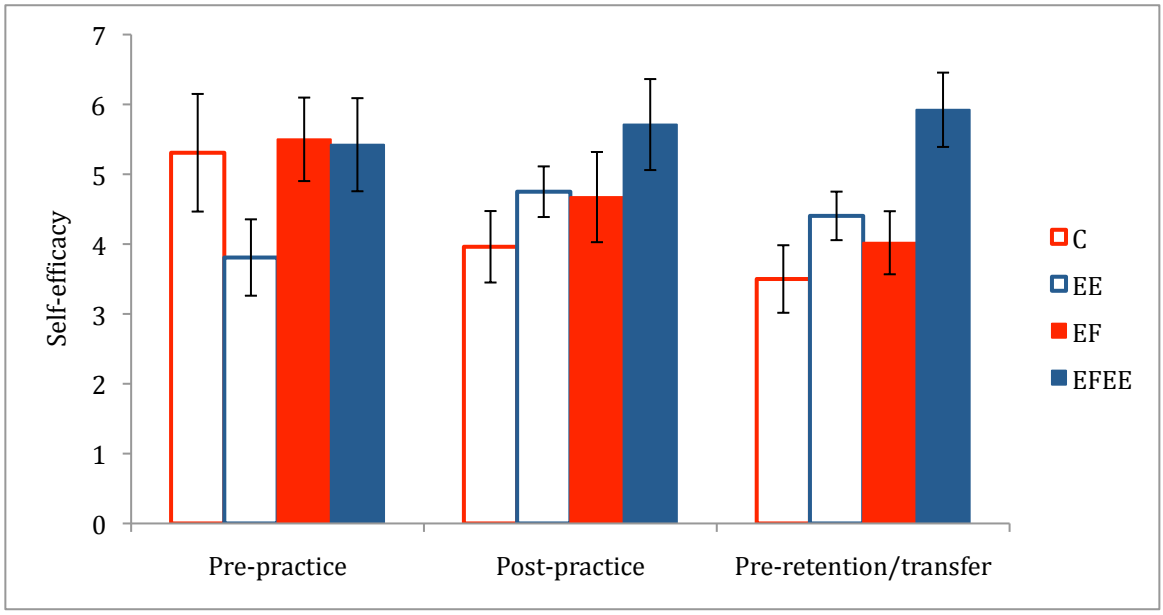

Figure 2. Mean self-efficacy scores on day one (pre-practice and post-practice) and day two (pre-retention/transfer)

Positive and negative affect

Baseline

After baseline testing, there were no significant differences among the groups for positive affect or negative affect. For positive affect, the main effect of EE, F (1, 48< 1, the main effect of EF, F (1, 48) = 1.970, $p > .05$, and the interaction between EF and EE, F (1, 48) = 1.608, $p > .05$, all failed to reach significance.

For negative affect, the mean effects of EE, F (1, 48) < 1, and EF, F (1, 48) = 1.766, $p > .05$, failed to reach significance. The interaction between EF and EE was also found to be insignificant, F (1, 48) < 1.

Practice

After the end of practice, however, there was a significant main effect of EE for positive affect, F (1, 48) = 4.488, $p < .05$, partial $\eta 2$ = .085. The groups that received EE (M = 3.819, SE = .178) yielded higher positive affect scores than those that did not receive EE treatment (M = 3.286, SE = .178). There was no main effect of EF for positive affect, F (1, 48) < 1. Also, there was no interaction of EF and EE, F (1, 48) < 1.

The negative affect scores after practice did not reach any significant levels for the main effects of EE, F (1, 48) = 2.740, $p > .05$, or EF, F (1, 48) = 1.881, $p > .05$. There was no significant interaction of EF and EE, F (1, 48) < 1.

Retention/Transfer

The positive affect scores for the retention/transfer day yielded no significant group differences. There was no significant main effect for either EF, F (1, 48) < 1, or EE, F (1, 48) < 1. The interaction of EF and EE, F (1, 48) = 3.125, $p > .05$, was not significant either.

The negative affect scores yielded no significant differences among the groups. There were no significant main effects for either EF, F (1, 48) < 1, or EE, F (1, 48) = 1.941, $p > .05$. Also, there was no interaction of EF and EE, F (1, 48) < 1.

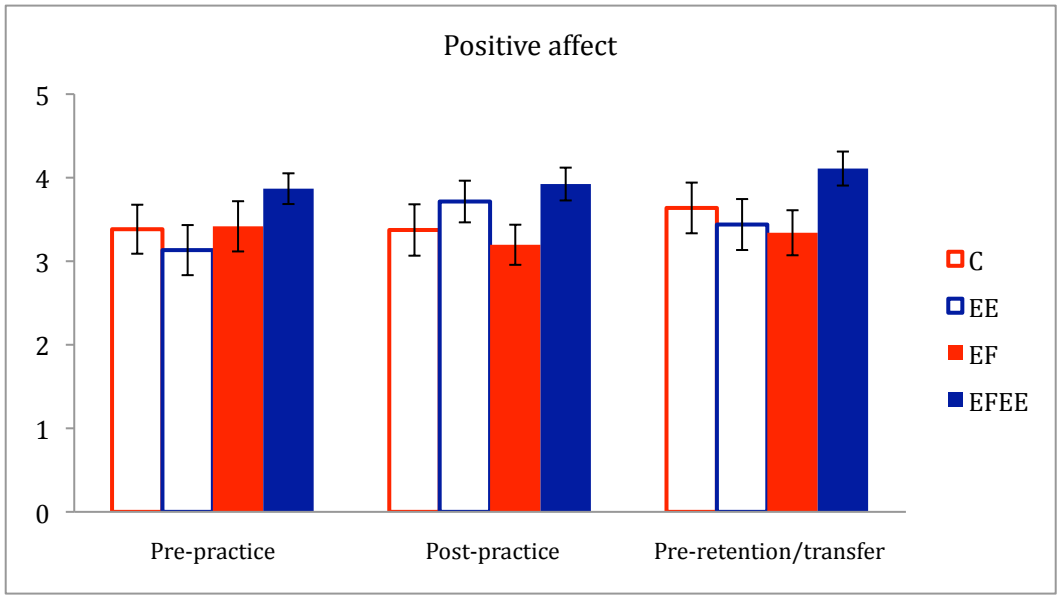

Figure 3. Mean positive affect scores on day one (pre-practice and post-practice) and day two (pre-retention/transfer)

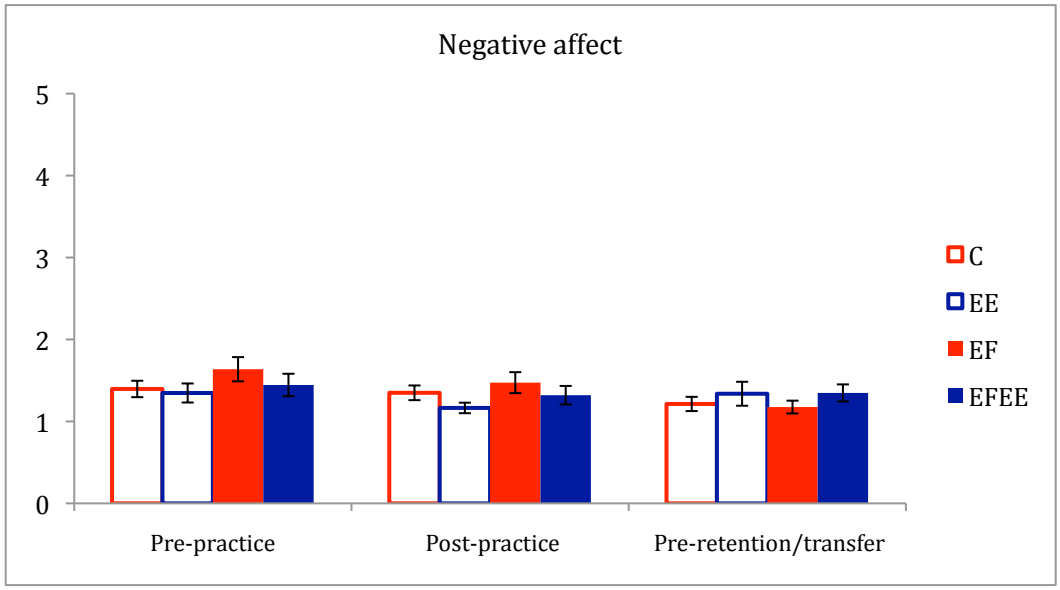

Figure 4. Mean negative affect scores on day one (pre-practice and post-practice) and day two (pre-retention/transfer)

Attentional focus

Groups that received external focus instructions (EF, EF/EE) were more likely to focus on the target than on movement form than the other two groups (EE, C), and vice versa (see Table 1). A chi-square test showed that there was a significant relation between external focus instructions and reported attentional focus, X^2 (2, N = 52) = 14.21, p = .001.

Table 1 Attentional Focus Results

			Attentional Focus			Total
			both	target	form	
	EF, EF/EE	Count	6	16	4	26
		Expected Count	5.0	10.5	10.5	26.0
	EE, C	Count	4	5	17	26
		Expected Count	5.0	10.5	10.5	26.0
Total		Count	10	21	21	52
		Expected Count	10.0	21.0	21.0	52.0

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Discussion

The purpose of this study was to see if there was an additive effect of an external focus of attention and enhancing learners' performance expectancy. The task selected for this study (i.e., non-dominant arm throw) allowed for a reasonably difficult and relatively novel motor skill to be learned. Evidently, it was sensitive to the experimental manipulations of enhanced expectancy and external focus. Questionnaires were strategically placed at certain points of this study to measure the motivational influences of the experimental manipulations that were used. The questionnaires' information allowed for the quantification of the participants' self-efficacy as well as any possible positive and negative affect resulting from the practice conditions.

The hypothesis that the combination group of external focus and enhanced expectancy (EF/EE group) would result in the most effective learning was supported by the data. The C group's hypothesized performance of being the least effective of all groups during the retention and transfer test was also supported by the data. The EE and EF groups' performances in retention and transfer were in-between the C and EF/EE. This result supported the groups' hypothesized performance.

Task motivation data indicated that there was an equal level of task motivation among different groups. This eliminated the possibility that there was an imbalance of one group trying harder than the other during the throwing task in this experiment.

Attentional focus data indicated that groups that were given the external focus instruction had a higher tendency to focus on the target during the practice phase of the

study. This means that the groups that were told to focus on the target for the most part did, and allowed the throwing results and other data of the groups with the external focus instruction to be attributed to that group having an external focus of attention. Adopting the external focus was expected to give the learners an increase in learning and performance when compared to those that did not as suggested by previous literature (for a review, see Wulf, 2007; 2012).

The throwing performance results suggests that there is an increased effect of motor learning when external focus instruction is combined with an enhanced expectancy condition. The virtually equal performance of enhanced expectancy alone to external focus alone suggests that improved throwing accuracy and performance achieved by these two groups did so via different mechanisms. This would help to explain the superior performance of the combination group (EF/EE) that received both of these treatments when comparing it to just the groups that just received one of the treatments. The present findings suggests that there is an "additive" effect of combining the two positive motor learning treatments of inducing an external focus of attention and eliciting an enhanced learner expectancy.

Self-Efficacy

All four groups in this study initially had similar self-efficacy scores. The results of the subsequent questionnaires showed that the EF/EE group reported the highest self-efficacy scores post-practice, and pre-retention/transfer.

The results of self-efficacy starting with the EF and EE effects on the scores reported suggests that the two individual treatments each have an effect on the participants' self-efficacy. The elevated self-efficacy scores are expected when it comes

to the enhanced expectancy group, as feedback is believed to have an effect on motivation (Lewthwaite & Wulf, 2010). The EE treatment is inherently related to increasing self-efficacy measures by giving feedback to the learners that they are better than a bogus norm However, the effect of external focus on self-efficacy is somewhat surprising. It suggests that external focus of attention can improve a learner's self-efficacy and improve their confidence/conceptions of their ability without giving a direct feedback in regards to their performance. A possible explanation for this could very well be how the participants who were given the external focus instruction made more accurate throws and this improvement in performance throughout practice facilitated a higher level of self-efficacy on participants that were placed in groups that had external focus instructions. The combination group having the highest self-efficacy scores could be explained by the different ways that external focus and enhanced expectancy can increases self-efficacy.

Positive and Negative Affect

The initial questionnaire yielded no differences among the groups when it came to measuring the positive or negative affect scores. However, following the end of practice in the second questionnaire there was an observed effect of enhanced expectancy on the positive affect scores. The increase in the positive affect for participants that received enhanced expectancy following practice could be explained by the way enhanced expectancy (i.e., giving the participants normative feedback that was lower than theirs) can result in increased positive feelings and emotions.

Negative affect scores remained relatively unchanged throughout the study among all the groups, leading to no significant differences among the groups. This could be due

to the low initial scores reported on the negative scores and how participants may have had a greater inclination to change the scores of the words associated with positive affect than they were to change the scores of the negative affect words.

There were no significant results in regards to positive and negative affect in the third questionnaire, which was given during the second day of testing. This can presumably be explained by the lack of positive feedback on that day.

Conclusions and recommendations for further study

This present study has found that there is an improved level of learning when external focus instruction was combined with enhanced learner expectancy. The additive effect of these variables can help learners to acquire a motor skill at a faster rate, which would in turn, expedite the learning process. The increased self-efficacy observed with the combination of external focus and enhanced learner expectancy has to potential to keep learners motivated during the learning process. The present study utilized a fairly large sample size ($N = 52$), which suggests a high level of generalizability towards practical application. However, further study utilizing different motor skills is recommended to measure the aforementioned generalizability of the improved learning, performance and self-efficacy observed from the combining external focus and enhanced expectancy.

There was also a possible independent effect towards throwing performance/learning and self-efficacy scores in regards to external focus and enhanced expectancy. The improved performance of the two groups during the practice and retention/transfer days suggested that their individual influences on the learner increased their learning of the non-dominant arm throw. The improved throwing performance of

external focus when compared to the control condition supports the results found in previous studies (for a review, see Wulf, 2007; 2012). This present study also found that the external focus of attention also has a positive effect on self-efficacy. This increased self-efficacy in participants that received external focus instruction could possibly be attributed to the increased performance noted by the participants during the practice phase. Further investigation on the motivational effects of self-efficacy is warranted.

Enhanced expectancy in this present study increased not only self-efficacy, but also positive affect scores involving the quantification of positive emotions and feelings of participants during the study. The findings of this study support the previous lines of research such as that of Lewthwaite & Wulf, 2010, of the positive effects of the augmented feedback given that elicited enhanced expectancy. Participants were altogether found to be more interested, excited, strong, enthusiastic, proud, inspired and determined, after practice when they were given the enhanced expectancy treatment. The positive emotional effect of enhanced expectancy can help to explain at least in part the higher-self efficacy scores for participants who received enhanced expectancy. The findings of self-efficacy and improvements in performance were in line with the previous research and provided supporting evidence to the findings of Chiviakowsky and Wulf in their 2007 experiment that increased learning is facilitated by the presence of positive feedback after practice trials.

This study is one of the first of its kind, combining external focus of attention with enhanced expectancy. The possibility of the "additive" effect of combining the two positive effects found in external focus with enhanced expectancy on learning has wide reaching practical applications for coaching, teaching and rehabilitation. Replication of

this study as well as further research into the combination of external focus and enhanced expectancy is essential before any solid recommendations to practical application can be made. The results of this study also have interesting theoretical implication as they suggest that different mechanisms may underlie the effects of attentional focus and enhanced performer expectancies. These should be explored further in future studies.

APPENDIX 1

QUESTIONNAIRE 1

Instructions: Please answer the following questions.

1. I am confident that I can achieve an average score of at least 3 on the last 10 trials today.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

2. I am confident that I can achieve an average score of at least 4 on the last 10 trials today.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

3. I am confident that I can achieve an average score of at least 5 on the last 10 trials today.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

4. I am confident that I can achieve an average score of at least 6 on the last 10 trials today.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

5. How motivated are you to do well on this task?

1	2	3	4	5	6	7	8	9	10
Not at all									Very

The scale below consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way right now, that is, at the present moment.

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

_____ interested	_____ hostile	_____ nervous	_____ surprised
_____ distressed	_____ enthusiastic	_____ determined	_____ tired
_____ excited	_____ proud	_____ attentive	_____ calm
_____ upset	_____ irritable	_____ jittery	_____ bored
_____ strong	_____ alert	_____ active	_____ relaxed
_____ guilty	_____ ashamed	_____ afraid	
_____ scared	_____ inspired	_____ confident	

APPENDIX 2

QUESTIONNAIRE 2

Instructions: Please answer the following questions.

1. I am confident that I can achieve an average score of at least 3 tomorrow.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

2. I am confident that I can achieve an average score of at least 4 tomorrow.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

3. I am confident that I can achieve an average score of at least 5 tomorrow.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

4. I am confident that I can achieve an average score of at least 6 tomorrow.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

5. What did you mostly focus your attention on while throwing the balls?

The scale below consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way right now, that is, at the present moment.

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

_____ interested	_____ hostile	_____ nervous	_____ surprised
_____ distressed	_____ enthusiastic	_____ determined	_____ tired
_____ excited	_____ proud	_____ attentive	_____ calm
_____ upset	_____ irritable	_____ jittery	_____ bored
_____ strong	_____ alert	_____ active	_____ relaxed
_____ guilty	_____ ashamed	_____ afraid	
_____ scared	_____ inspired	_____ confident	

APPENDIX 3

QUESTIONNAIRE 3

Instructions: Please answer the following questions.

1. I am confident that I can achieve an average score of at least 3 today.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

2. I am confident that I can achieve an average score of at least 4 today.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

3. I am confident that I can achieve an average score of at least 5 today.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

4. I am confident that I can achieve an average score of at least 6 today.

1	2	3	4	5	6	7	8	9	10
Not confident at all									Extremely confident

The scale below consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way right now, that is, at the present moment.

1	2	3	4	5
Very slightly or not at all	A little	Moderately	Quite a bit	Extremely

_____ interested	_____ hostile	_____ nervous	_____ surprised
_____ distressed	_____ enthusiastic	_____ determined	_____ tired
_____ excited	_____ proud	_____ attentive	_____ calm
_____ upset	_____ irritable	_____ jittery	_____ bored

_____ strong	_____ alert	_____ active	_____ relaxed
_____ guilty	_____ ashamed	_____ afraid	
_____ scared	_____ inspired	_____ confident	

APPENDIX 4

IRB APPROVAL

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

Biomedical IRB – Expedited Review
Modification Approved

NOTICE TO ALL RESEARCHERS:

Please be aware that a protocol violation (e.g., failure to submit a modification for any change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation, suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Officer.

DATE: April 3, 2013

TO: **Dr. Gabriele Wulf**, Kinesiology & Nurtition Sciences

FROM: Office of Research Integrity – Human Subjects

RE: Notification of IRB Action
Protocol Title: **Learning to Throw with the Non-Dominant Arm**
Protocol #: 1212-4330M
Expiration Date: December 20, 2013

The modification of the protocol named above has been reviewed and approved.

Modifications reviewed for this action include:

- Task revised from golf picth shot to throwing with the non-dominant arm.
- Title changed from "Learning a Golf Pitch Shot" to "Learning to Throw with the Non-Dominant Arm".
- All documents revised to reflect new task.

This IRB action will not reset your expiration date for this protocol. The current expiration date for this protocol is December 20, 2013.

PLEASE NOTE:
Upon approval, the research team is responsible for conducting the research as stated in the protocol most recently reviewed and approved by the IRB, which shall include using the most recently submitted Informed Consent/Assent forms and recruitment materials. The official versions of these forms are indicated by footer which contains approval and expiration dates.

Should there be *any* change to the protocol, it will be necessary to submit a **Modification Form** through ORI - Human Subjects. No changes may be made to the existing protocol until modifications have been approved by the IRB. Modified versions of protocol materials must be used upon review and approval. Unanticipated problems, deviations to protocols, and adverse events must be reported to the ORI – HS within 10 days of occurrence.

Should the use of human subjects described in this protocol continue beyond December 20, 2013, it would be necessary to submit a **Continuing Review Request Form** *30 days* before the expiration date.

Office of Research Integrity – Human Subjects
4505 Maryland Parkway • Box 451047 • Las Vegas, Nevada 89154-1047
(702) 895-2794 • FAX: (702) 895-0805

If you have questions or require any assistance, please contact the Office of Research Integrity - Human Subjects at IRB@unlv.edu or call 895-2794.

Office of Research Integrity – Human Subjects
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INFORMED CONSENT

Department of Kinesiology and Nutrition Sciences

TITLE OF STUDY: Learning to throw with the non-dominant arm

INVESTIGATOR(S): Gabriele Wulf, Ph.D., Luigi Pascua

CONTACT PHONE NUMBER: 702-895-0938 (Wulf) or 702-461-0843 (Pascua)

Purpose of the Study

You are invited to participate in a research study. The purpose of this experiment is to study the learning of throwing with the non-dominant arm.

Participants

You are being asked to participate in the study because you are a healthy adult between the ages of 18 and 40 years.

Procedures

If you volunteer to participate in this study, you will be asked to do the following: You will be asked to throw tennis balls with you non-dominant arm at a target (in a net). There will perform 65 trials during this first session. On the following, you will perform 20 trials. There will be a 2-min. rest period after every 10-trial block. You will also be asked to fill out questionnaires after the first 10 trials, at the end of the first session, and at the beginning of the second session. All testing will take place in MPE Racquetball Court 5.

Benefits of Participation

There may not be direct benefits to you as a participant in this study. However, we hope to learn more about motor learning in young adults.

Risks of Participation

There are risks involved in all research studies. In this study, there may be minimal risks that include muscular fatigue, and perhaps some muscle soreness the next day.

Cost /Compensation

There will not be financial cost to you to participate in this study. The study will take about 45 minutes of your time on Day 1 and about 15 minutes on Day 2. You will receive extra course credit if you complete both sessions of the study. If you decide not to participate, you will have the option of completing a small project in order to earn extra credit (i.e., reading a paper on a topic discussed in class and answering short questions about the paper), which should take approximately the same amount of time as participating in this experiment.

Participant Initials _____

Approved by the UNLV IRB. Protocol #1212-4330M
Received: 03-23-13Approved: 04-03-13Expiration:12-20-13

TITLE OF STUDY: Learning to throw with the non-dominant arm

Contact Information

If you have any questions or concerns about the study, you may contact **Dr. Gabriele Wulf at 702-895-0938 (or gabriele.wulf@unlv.edu).** For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact **the UNLV The Office of Research Integrity - Human Subjects at 702-895-2794.**

Voluntary Participation

Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with the university. You are encouraged to ask questions about this study at the beginning or any time during the research study.

Confidentiality

All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link you to this study. All records will be stored in a locked facility at UNLV for 3 years after completion of the study. After the storage time the information gathered will be destroyed.

Participant Consent:

I have read the above information and agree to participate in this study. I am between 18 and 40 years of age. A copy of this form has been given to me.

_____ _____

Signature of Participant Date

_____

Participant Name (Please Print)

Participant Initials _____

Approved by the UNLV IRB. Protocol #1212-4330M
Received: 03-23-13Approved: 04-03-13Expiration:12-20-13

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VITA

GRADUATE COLLEGE
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Degrees: Bachelor of Science (Magna Cum Laude) in Kinesiology

Special Honors and Awards:
- University of Nevada Las Vegas Dean's list (all years)
- Magna Cum Laude honors (2011)
- Phi Kappa Phi Honor Society inductee (2013)
- Golden Key Honor Society inductee (2010)

Thesis Title: Additive Effects of an External Focus And Enhanced Expectancy In Learning A Motor Skill

Thesis Examination Committee:
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