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The Self: Your own worst enemy? A test of the self-invoking trigger hypothesis

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THE SELF: TOUR OWN WORST ENEMY? A TEST OF THE SELF-INVOKING
TRIGGER HYPOTHESIS

by

Bradley James McKay

Bachelor of Arts
St. Thomas University
2009

A thesis submitted in partial fulfillment
of the requirements for the

**Masters of Science Degree in Kinesiology
Department of Kinesiology and Nutrition Sciences
School of Allied Health Sciences
Division of Health Sciences**

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Bradley James McKay

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ABSTRACT

The Self: Your Own Worst Enemy? A Test of the Self-Invoking Trigger Hypothesis

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The self invoking trigger hypothesis was recently proposed by Wulf and Lewthwaite (2010) as the mechanism underlying the robust effects of attentional focus on motor learning and performance. The hypothesis suggests that causing individuals to access their self schema will negatively impact their ability to learn and perform a motor skill. The purpose of the present study was to provide an initial test of this hypothesis by causing one group of participants to activate their self schema in a straightforward manner. Participants ($N = 32$) were assigned to either a self-activated or control condition and asked to practice a wiffleball hitting task 50 times on two separate days. Participants returned on a third day to perform a retention and transfer test without the self-activating manipulation. Results indicated that the self-activated group learned the hitting task less effectively than controls. The findings reported here provide initial support for the self-invoking trigger hypothesis and future research directions are discussed.

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CHAPTER 1

INTRODUCTION

The role of an individual's focus of attention has been studied for over a decade and the results have been consistent: practicing and performing motor skills with an "external focus of attention," that is, with a focus on the effect of the movement, is superior to practicing and performing with an internal focus, or a focus on the effectors of the movement. Recently, the "self-invoking trigger" hypothesis was proposed as a possible explanation for the robust focus of attention effect in motor learning. Wulf and Lewthwaite (2010) suggested that the mere reference of a body part may be enough to activate one's self-schema, a potentially malignant cognitive process for motor skill acquisition and performance. Indeed, self-focused attention has long been acknowledged as a hindrance to successful skilled motor performance (Baumeister, 1984), and motor learning (Wulf, Höß, & Prinz, 1998). One can confidently infer that self-consciousness (self-focus) involves self-schema activation, but the question remains if self-activation alone will cause the detrimental effects on motor performance associated with self-focused attention. This is not a trivial issue; while self-focused attention has typically been manipulated by giving specific verbal instructions, self-activation can be caused (usually unintentionally) by various factors (Van Dyck, Van Hooft, De Gilder, & Liesveld, 2010). The self concept is a ubiquitous network of thoughts, ideas, definitions, emotions, and possessions that underlies daily existence for most people (Strauman & Higgins,

1993). Effects associated with such an overarching phenomenon will be relevant across the motor learning and control theoretical landscape.

Purpose of the Study

The purpose of the proposed study will be to test the “self-invoking trigger” hypothesis in a straightforward manner. I intend to cause self-schema activation in the experimental participants by having them reflect and write about themselves prior to the acquisition of a motor skill. I will compare the motor learning of self-schema-activated participants to participants in a control group whose self-schemas were not intentionally activated.

In line with the predictions originally posited by Wulf and Lewthwaite (2010), I propose two hypotheses in the present study:

Research Hypotheses

Hypothesis #1: Participants who engage in a self-activating task (writing about themselves) will learn a modified baseball hitting task less effectively than controls.

Hypothesis #2: Participants in the self condition will report higher levels of cognitive and somatic self-activation, and will demonstrate greater signature size growth than controls.

Significance of the Study

The present study is significant for at least two reasons. First, this study is the first to test the “self-invoking trigger” hypothesis directly. Although the “self-invoking trigger” fits the available evidence well, no study to date has directly examined its predictions. Second, because the “self-invoking trigger” can potentially explain a wide range of findings in motor learning and performance literature, this initial test of its predictions will provide foundational evidence on which future studies will build. The “self-invoking trigger” may have been suggested as an explanation for focus of attention effects originally, but its relevance extends well beyond the focus of attention literature into areas of inquiry ranging from augmented feedback (e.g., Winsten & Schmidt, 1990) to conceptions of ability (Wulf & Lewthwaite, 2009).

As previously mentioned, the self is an ever-present, in many ways inescapable cognitive schema possessed by all motor learners. Determining the effect (if any) of self-schema activation will serve both theory and practice. Regarding theory, the “self-invoking trigger” offers a unified explanation for the benefits of an external focus of attention (Wulf, 2007), analogies (e.g., Liao & Masters, 2008), and implicit learning strategies (e.g., Poolton, Masters, & Maxwell, 2005). For coaches, therapists, and trainers, the “self-invoking trigger” describes a primary obstacle to effective learning and offers successful strategies (such as the ones named above) for avoiding self-activation during skill acquisition and performance.

Definition of Terms

The following definitions are given for the purpose of clarification:

External focus

A focus of attention that is directed to the outside of the body, specifically on the effect or outcome of the movement.

Internal focus

A focus of attention directed at one's body movement.

Motor Learning

A relatively permanent change in motor performance as a result of experience with a task over time.

Retention

The performance of a skill subsequent to a period of practice in the absence of instruction, augmented feedback, or any experimental manipulation that was present during practice.

Self-schema

Conceptually defined as a functional network in the brain that represents both ownership and agency. That is, the neural circuitry that codes for things belonging or referring to one's self, and to activities endorsed or controlled by one's self.

Transfer of learning

The degree to which performance improvements generalize to unpracticed, but related skills.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Self-Invoking Trigger Hypothesis

Recently, Wulf and Lewthwaite (2010) proposed a novel hypothesis that may unite diverse motor learning and performance findings under a common framework. Wulf and Lewthwaite suggest that aspects of the practice environment, for example instructions provided by a coach, may cause the learner to access their self-schema, which in turn may degrade skill learning. In this perspective, environmental cues that cause self-activation are referred to as “self-invoking triggers.” Self-invoking triggers may be present in coaching instructions (e.g., internal-focus instructions), augmented feedback (e.g., exposure to performance errors), contextual cues (e.g, presence of others or a video camera), stereotype threats (e.g., race or gender-relevant stereotypes about a skill), personal characteristics (e.g., an entity-based conception of ability), perceptions of ability (e.g., low outcome expectancies, low self-efficacy), and practice design (e.g., blocked practice). Given the myriad potential self-invoking triggers in typical practice environments and the ubiquitous nature of the “self” in general, the self-invoking trigger hypothesis could provide a parsimonious explanation of motor learning and performance degradation.

Wulf and Lewthwaite (2010) propose two potential etiological mechanisms of the hypothesized self-invoking trigger effect: competition for cognitive resources, and increased self-regulation leading to conscious control of movements. A competition for resources may occur if attention is divided between the motor

task and the self (i.e., self-evaluation of performance, self-monitoring of movements, thoughts about the self that are unrelated to the performance at all). Additionally, self-regulatory processes may be triggered, particularly in response to performance errors (Van Dyck et al., 2010), which may impact performance by creating a competition for resources or by leading to conscious control of movements. Numerous studies have shown that distracting participants (which causes a competition for resources) while they learn a task reduces skill acquisition (e.g., McMahon & Masters, 2002). One study found that distracting a monkey during motor learning greatly reduced the neural representation of the task, relative to non-distracted monkeys (Gilbert, Sigmen, & Crist, 2001). Further, conscious control of movements has been demonstrated to degrade motor performance in multiple studies and research paradigms (e.g., Baumeister, 1984; Wulf, Höß, & Prinz, 1998; for a review of a decade of research on the subject: Wulf, 2007).

Focus of Attention

The effect of focus of attention on motor learning and performance has been examined in over a decade of research (Wulf, 2007). The divergent effects of internal (focus on the effector of a movement) versus external (focus on the effect of a movement) foci of attention seem to be robust phenomena, with nearly all of the evidence suggesting that an internal focus degrades learning and performance, while an external focus enhances it (Wulf, 2007).

To explain the effects of focus of attention, Wulf and others (Wulf, McNevin, & Shea, 2001) have proposed the “constrained action hypothesis.” According to

this view, an internal focus of attention “constrains” the motor system, interfering with what would otherwise be more efficient, automatic movement. According to this hypothesis, the benefit of an external focus is that it prevents the learner from interfering with said automatic functioning. In other words, an external focus is advantageous because it prevents an internal focus, and the more effectively external foci can prevent internal focusing (i.e., by being more distal to the performer), then the more advantageous the foci are (Bell & Hardy, 2009; McNevin, Shea, & Wulf, 2003).

The “constrained action hypothesis” is supported by numerous lines of evidence. For example, adopting an internal focus has resulted in increased electromyography (EMG) in activities like bicep curls (e.g., Vance, Wulf, Töllner, McNevin, & Mercer, 2004), free throw shots (e.g., Zachry, Wulf, Mercer, Bezodis, 2005), and dart throwing (e.g., Lohse, Sherwood, & Healy, 2010). This increase in EMG resulted in a decrease in performance and has been interpreted as representing inefficient muscle recruitment and coordination. Additional evidence for the constrained action hypothesis comes from the analysis of movement adjustments in balancing tasks. Learners who adopted an internal focus were slower to correct deviations from the horizontal in a balancing task, and also made larger-amplitude and lower-frequency corrections, relative to externally focusing participants (e.g., Wulf, McNevin, & Shea, 2001). Making faster corrections of smaller amplitude during a balance task is indicative of more automatic, reflexive performance, rather than the consciously controlled, long-loop corrections that tend to be slower and larger.

In addition to the behavioral evidence reviewed above, imaging studies have examined changes in brain activity when participants perform novel tasks, well-learned (automatic) tasks, and well-learned tasks with an internal focus (Jueptner, Stephan, Frith, Brooks, Frackowiak, & Passingham, 1997; Wu, Kansaku, & Hallett, 2004). As tasks became automatic, there was a reduction of activity in several cortical regions, most interestingly prefrontal (PFC) and anterior cingulate cortices (ACC) (Jueptner et al., 1997; Wu et al., 2004). When instructed to attend to their actions while performing a well-learned task, activation increased in ACC and PFC structures, a pattern of activity that resembled neural functioning during practice of a novel task (Jueptner et al., 1997). These neural correlates of internally focused attention provide some support for the “constrained action hypothesis.” Increased activity in the PFC might represent a break from automatic processes and the adoption of conscious, “noisy,” intentional control strategies that constrain the efficient functioning of the motor system.

While evidence for the “constrained action hypothesis” seems to abound, the explanation for the focus of attention effects does have important theoretical limitations. Most importantly, the “constrained action hypothesis” is somewhat limited in its scope of explanation. It is a “theory” that explains only one phenomenon. Few, if any, predictions can be derived from the “constrained action hypothesis” other than the effects of attentional foci. Thus, there is still need for a theoretical explanation of focus of attention that can spawn new predictions and explain a broader range of phenomena.

There is support for the notion that an internal focus of attention leads to a competition for cognitive resources. Wulf and colleagues (2001) reported that participants who performed a balancing task with an internal focus of attention had longer reaction times to a probe reaction time task they performed concurrently with the balance task. This indicates that performers who were focusing externally required less attentional resources to perform the balance task, allowing more resources for the probe reaction time task.

One implication of the “self-invoking trigger” hypothesis is that access to the self can have a detrimental effect on expert performance as well as on skill acquisition. One hallmark of expertise is that experts require less cognitive resources to perform their skills than do novices. For example, a series of experiments conducted by Gray (2004) demonstrated that requiring novice hitters to perform an extraneous dual-task (attend to the frequency of tones) while performing a baseball hitting simulation degraded their performance, while the performance of experts was unaffected by performing the dual-task. However, when the experts demonstrated sub-par performance, they simultaneously demonstrated improved performance on a dual-task that required them to track their bat as they attempted to hit simulated pitches. Thus, it seems that increased self-awareness can negatively impact performance, even in experts. Indeed, an internal focus of attention has also been demonstrated to degrade expert performance (Stoate & Wulf, 2009), and these related findings may be explained by the “self-invoking trigger” hypothesis.

While the self-invoking trigger provides a plausible account of focus of attention effects, its real compliment to the “constrained-action hypothesis” is its ability to explain other findings in motor learning. For example, Van Dyck and colleagues (Van Dyck, Van Hooft, De Gilder, & Liesveld, 2010) found that errors during performance can lead to self-focus, but the effect is apparently moderated by underlying conceptions of ability (COA) and goal orientations. In light of these findings, it seems possible that results from augmented feedback studies may be explained by the self-invoking trigger. For example, a common finding is that learners benefit from reduced knowledge of results (KR) during acquisition (e.g., Winstein & Schmidt, 1990). Further, learners’ performance on the trials that they receive KR after is important. Wulf and Chiviacowsky (2007) found that learning was enhanced by providing KR feedback after successful trials rather than poor trials. This pattern of results can be explained by the self-invoking trigger: A reduction in frequency of KR means that learners do not see as many errors as they would during 100% KR practice. Further, by providing KR only after the most successful trials, the experience of errors is greatly attenuated for the learner. Since errors can lead to self activation, it seems that the KR literature is consistent with the tentative predictions of the self-invoking trigger hypothesis.

Another finding of Van Dyck *et al.* (2010) that is consistent with the self-invoking trigger hypothesis is the moderating effect of COA. Individuals termed “incremental theorists,” people who believe that skill is acquirable and their ability is malleable, are less likely to become self-activated than those termed “entity theorists,” people who believe that skill is reflective of inherent aptitude. Wulf

and Lewthwaite (2009) found that by inducing an “incremental theory” of ability in learners it was possible to enhance skill acquisition relative to controls and those induced to have an “entity theory” of ability.

It seems then that access to the self may be a common denominator in a variety of findings in motor learning. Not only can it potentially explain the focus of attention results, it may also explain results in seemingly unrelated paradigms. While the self-invoking trigger hypothesis seems plausible, it is currently just speculation. There has yet to be a single study aimed at directly testing its predictions, which is the goal of the current proposal.

In order to determine the plausibility of the self-invoking trigger hypothesis, it is necessary to establish a causal role of self-schema activation in motor learning degradation. To do so, I propose activating the self-schema in a straightforward manner that has not been previously examined in motor learning literature. Further, to test for a mediating role of self-schema activation in learning degradation, I intend to measure access to the self with both an explicit and implicit measure. The explicit measure, adopted from Bagozzi, Verbeke and Gavino (2003), is a questionnaire designed to assess self-focused attention during performance. The implicit measure will compare pre-test signature size (on the informed consent) with signature size measured each day on a post-experimental session document. The signature size measure has been used successfully in the past to assess self-activation and self-esteem compensation (Rudman, Dohn, & Fairchild, 2007; Stapel & Blanton, 2004). Signature size measures automatic, nonreactive processes; that is, participants are unaware

they are providing data when they sign their names and therefore have no self-presentation motives. If an intervention designed to induce self-schema activation in learners results in reduced motor learning and increased access to the self, the currently speculative “self-invoking trigger” hypothesis will be supported and subsequent investigation will be necessary.

CHAPTER 3

METHODS

Participant Characteristics

Thirty-two undergraduate students (16 men, 16 women) with a mean of 8-years previous baseball or softball experience ($SD = 5.87$) participated in this study. The participants had not played organized baseball or softball for at least one year prior to participation in the study. The participants were assigned to groups based on gender and years of experience. The control ($M = 8.06$, $SD = 6.01$) and self ($M = 7.93$, $SD = 5.74$) groups did not differ on years of experience, $t(30) = .06$, $p = .95$.

Instrumentation

Explicit Self-Activation

The self-focused attention measure developed by Bagozzi, Verbeke, and Gavino (2003) has been adapted to measure cognitive self-activation in the present study. The questionnaire measured aspects of self-activation related to self-awareness (e.g., “I think the experimenter scrutinizes my every move and pays attention to every detail”), and threat to the self (e.g., “I think that the experimenter considers me to be a failure as a hitter”). The full measure can be found in Appendix I. Four questions from the Somatic Anxiety Questionnaire (DeGood & Tait, 1987) and one question from the physiological symptoms subscale of the self-focused attention measure discussed above were combined to form a measure of somatic self-activation. The questionnaire measured the

somatic manifestation of self-activation (e.g., “I felt tense in my stomach”). The full measure can be found in Appendix II.

Implicit Self-Activation

Signature size, a measure first validated by Zweigenhaft and Marlowe (1973), was measured by drawing the smallest possible rectangle around the pre-test and post-experimental session signatures. The pre-test signature was taken from the original informed consent form, then at the end of each day participants were asked to sign identical consent forms to measure any changes in signature size. The area of the rectangle was ascertained by multiplying its height and width (in mm), and the percent change between pre-experiment and post-experimental session was analyzed.

Hitting Performance

Participants' hitting performance was measured based on where each ball was hit, if it all. The task was performed in a converted racquetball court that was divided into zones. Each hit was given a score depending on which zone the ball hit first. Pitches that were swung at and missed received a score of 0. Pitches that were fouled off received a 1. Forward moving hits that struck the floor within 20 feet of the participant received a 2. Forward moving hits that landed past the initial 20-foot zone but did not reach the far wall (35 feet from the hitter) in the air received a 3. Forward hits that contact the far wall below a line 10 feet from the ground received a score of 4. Hits that struck the far wall above the 10-foot line received a 5. Balls that hit the ceiling were judged by the zone they struck first. Lines on the walls demarcated where the foul line first hit the side

wall, and rose vertically to a height proportional to the 10-foot line on the far wall. Balls that hit the side wall between the initial foul line (10-feet from the hitter) and the 20-foot line were awarded a 3 for striking below the proportional line, and a 4 for striking above it. Hits that passed the 20-foot line and struck the side walls were scored identical to hits that struck the far wall. A small door frame behind the area representing home plate served as an indication of “hittable pitches.” Balls that struck outside the door frame and were swung at and missed were not counted in the analysis and the hitters were allowed an extra swing in that trial block. This occurred very infrequently.

Collection of the Data

Prior to the practice stage of the study, participants completed a 10-trial warm up to acclimatize to the task. This warm-up block was initially intended to serve as a pre-test of hitting performance; however, there were qualitative changes in performance from the warm-up block to the first practice block observed by the experimenter, so it was decided that the first practice block would serve as a better indication of initial ability at the task. Indeed, while the first practice block was significantly related to all subsequent performance, the warm-up block was not, $F(1, 29) = 1.34, p = .256$.

The practice stage of the experiment consisted of two sessions on separate days. The hitting task required participants to hit golf ball-sized wiffleballs with a HitMaster GroBat (Sports Products Consultants, San Diego, CA) that was 32 inches in length and 1 inch in diameter. The balls were pitched at approximately 25 miles per hour by a Personal Pitcher pitching machine (Sports

Products Consultants, San Diego, CA). Participants completed 50 swings per session, taking a break after every 10 swings to complete the experimental manipulation. Participants were instructed that they did not have to swing at every pitch, so it was 10 swings – not pitches – that constituted one block of practice (the groups did not differ on number of pitches taken, $t(30) = .583$, $p = .564$).

Between trial blocks, participants in the self-activated group were asked to write continuously for one minute about their experience with baseball or softball, their personal attributes as an athlete, emotional experiences related to baseball or softball, and strengths and weaknesses as a hitter (see Appendix III). Subsequent to each period of writing, the experimenter read what the self-activated participants wrote to increase the self-activating effect of the manipulation. Control participants wrote for the same length of time and were given the task of ordering the objects in the laboratory by various qualities - including size and color (see Appendix IV). Participants in each group completed item one from their respective questionnaire following the first practice block of each day, then item two, three, and four after the next four blocks. Following each practice session participants in both groups completed the implicit self-activation (first) and explicit self-activation measures (second).

On a third day, retention and a transfer tests were conducted. The retention test consisted of 50 swings with rest periods after every 10 swings. There was no writing task during retention. The transfer task consisted of 20 swings at balls traveling at approximately 35 miles per hours. Following retention

and transfer tests participants completed the implicit (first) and explicit (second) self-activation measures.

Data Analysis Methods

Practice data were analyzed in a 2 (group) x 9 (trial block) analysis of covariance (ANCOVA) with repeated measures on the second factor and initial performance (practice block one) included as a covariate. Retention data were analyzed in a 2 (group) x 5 (trial block) ANCOVA with repeated measures on the second factor and initial performance included as a covariate. Transfer data were analyzed in a 2 (group) x 2 (trial block) ANCOVA with repeated measures on the second factor and initial performance included as a covariate. To test the effect of the experimental manipulation on measures of implicit and explicit self-activation, separate mixed 2 (group) x 2 (day) ANOVAs with repeated measures on the second factor were conducted on each measure during practice, while separate independent *t*-tests were conducted on each measure during retention.

CHAPTER 4

RESULTS

Practice

Hitting Performance

Both groups showed improvement in hitting performance across the nine practice blocks while controlling for initial performance on the first practice block (*Figure 1*). The control group tended to perform more effectively during the practice phase of the study. The main effect of practice block, $F(8, 232) = 2.553$, $p = .01$, partial $\eta^2 = .08$, was significant. The main effect of group just failed to reach conventional significance levels, $F(1, 29) = 4.02$, $p = .054$, partial $\eta^2 = .12$. Initial performance was linearly related to, and accounted for a great deal of the variance in practice performance, $F(1, 29) = 33.20$, $p < .001$, $\eta^2 = .53$, and was thus included in the model as a covariate. The Group x Trial block interaction was not significant, $F(8, 232) < 1$.

Figure 1. Estimated marginal means of hitting performance during practice, retention, and transfer.

Explicit Self-Activation

Both groups reported less cognitive self-activation on the second day of practice than on the first (*Figure 2*). In general, it appeared that the self group reported greater self-activation on both days. The main effect of day was significant, $F(1, 30) = 31.99, p < .001, \eta^2 = .52$. The main effect of group did not reach conventional levels of significance, $F(1, 30) = 2.23, p = .15$. There was no Group x Day interaction, $F(1, 30) < .1$.

Figure 2. Mean cognitive self-activation scores on days one, two, and three.

Similarly, both groups reported less somatic self-activation on day 2 than on day one. The control group (Day 1: $M = 16.06$, $SD = 4.09$; Day 2: $M = 13.38$, $SD = 4.47$) tended to report greater somatic self-activation on both days, relative to the self group (Day 1: $M = 14.74$, $SD = 5.62$; Day 2: $M = 10.81$, $SD = 5.46$). The main effect of day was significant, $F(1, 30) = 17.90$, $p < .001$, $\eta^2 = .37$. The main effect of group failed to reach significance, $F(1, 30) = 1.53$, $p = .23$. There was no Group x Day interaction, $F(1, 30) < 1$.

Implicit Self-Activation

Signature size change did not appear to differ between control and self conditions (see Table 1). The main effect for day, $F(1, 30) < 1$, and for group, $F(1, 30) < 1$, were not significant. There was no Group x Day interaction, $F(1, 30) < 1$.

Table 1 *Signature Size Percent Change*

<i>Group</i>	<i>Signature size change day 1</i>	<i>Signature size change day 2</i>	<i>Signature size change day 3</i>
Control	8.46 (30.25)	11.09 (43.12)	10.16 (41.77)
Self	17.41 (48.99)	20.66 (52.53)	21.11 (41.41)

Standard deviations in parentheses.

Retention and Transfer

Hitting Performance

On a retention test with no writing manipulation, the control group tended to outperform the self group on the hitting task while controlling for initial performance. The main effect of group was significant, $F(1, 29) = 4.642$, $p = .04$, partial $\eta^2 = .14$. The main effect of trial block was significant, $F(4, 116) = 2.57$, $p = .041$, partial $\eta^2 = .08$, and the Group x Trial Block interaction approached significance, $F(4, 116) = 2.38$, $p = .056$, partial $\eta^2 = .08$. Post-hoc analysis revealed that the control group did not increase performance across trial blocks during retention, $F(4, 56) = .272$, $p = .90$, while the self group showed a significant improvement in performance across retention trial blocks, $F(4, 56) =$

4.09, $p = .006$, partial $\eta^2 = .23$. Initial practice performance was linearly related to retention performance, $F(1, 29) = 7.18$, $p = .012$, partial $\eta^2 = .20$, and was therefore included in the model as a covariate.

The control group tended to perform more effectively on a transfer test that required participants to hit balls pitched at a faster velocity (*Figure 1*). The main effect of trial block, $F(1, 29) = .585$, $p = .45$, and the Trial Block x Group interaction, $F(1, 29) = 1.43$, $p = .24$, were both non-significant. The main effect of group, $F(1, 29) = 3.20$, $p = .084$, failed to reach significance. Initial performance was linearly related to transfer test performance, $F(1, 29) = 7.64$, $p = .01$, partial $\eta^2 = .21$, and was therefore included in the model as a covariate.

Explicit Self-Activation

The self group ($M = 25.94$, $SD = 8.07$) reported slightly higher cognitive self-activation on day three than the control group ($M = 22.38$, $SD = 8.38$), but this difference was not significant ($t(30) = 1.22$, $p = .23$).

The control group reported higher somatic self-activation on day three ($M = 15.25$, $SD = 4.71$) than the self group ($M = 11.44$, $SD = 5.34$). The difference between groups on somatic self-activation was statistically significant, $t(30) = 2.14$, $p = .041$.

Implicit Self-Activation

There did not appear to be any differences between groups (see Table 1) on the signature size measure on day three ($t(30) = .772$, $p = .46$).

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Discussion of Results

The purpose of the present study was to provide an initial test of the recently proposed “self-invoking trigger” hypothesis by manipulating self-activation during practice in a straightforward manner. While practicing a challenging motor skill – wiffleball hitting – participants in the experimental condition were asked to write about themselves between trial blocks. Following each of two practice sessions, two measures of explicit self-activation (cognitive and somatic) were administered, as well as a measure of implicit self-activation (change in signature size). During a third session, participants were asked to perform a retention test of the hitting task they had practiced without the intermittent writing task they completed during practice. Subsequent to the retention test, participants were asked to perform a more challenging transfer task (hit balls pitched at a faster velocity) to assess the generalizability of their motor skill learning. Finally, participants were administered the two explicit measures and one implicit measure of self-activation before terminating participation in the study. The prediction that participants in the experimental condition would score higher on measures of self-activation and lower on measures of motor performance and learning were partially supported. The failure to support all hypotheses may have been due to insufficient sample size, the use of measures that assess a slightly different construct than what was affected by the experimental

manipulation, and a potentially confounding effect of motor performance in between the administration of the experimental manipulation and the measurement of its effects.

Hitting Performance

Both groups demonstrated significant improvement in wiffleball hitting across practice blocks, while there was a trend for the self group to perform less effectively during the practice phase of the study. On the retention test, the self group performed significantly less effectively than the control group.

Interestingly, there was evidence that the self group continued to improve across the retention blocks while the control group appeared to plateau. This may indicate that the control group was able to reach a level of relatively stable performance on the task after two days of practice, while the self group, possibly hindered by the self-activating manipulation, still had room to improve on the third day. The self group tended to perform less effectively on the transfer task as well, indicating a lack of ability to generalize to the more challenging task.

Explicit Self-Activation

On the measure of cognitive self-activation, the self group tended to report higher levels of self-activation, as predicted. However, the group differences did not reach significance, possibly because of inadequate sample size. Further, the timing of the measure's assessment may have negatively affected its sensitivity to group differences caused by the experimental manipulation. Since participants performed a block of 10 trials between the last writing manipulation of each session and the administration of the questionnaire, it is possible that

“self-invoking triggers” present in the hitting task (e.g., swings and misses) blurred group differences in self-activation caused by the manipulation.

Interestingly and unexpectedly, both groups reported less cognitive self-activation on the second practice session than on the first. There are at least two possible reasons for this change: first, it is possible that the reduction in self-activation was caused by the general increase in performance by both groups. Since errors have been found to induce self-activation (Van Dyck et al., 2010), it is possible that the general reduction in errors experienced on the second day of practice is responsible for the overall reporting of less self-activation. A second possibility is that the participants in both groups were more comfortable with the research setting (i.e., the laboratory, the task, the experimenter) on the second day, resulting in a general reduction in self-activation.

The results of the somatic measure of explicit self-activation were similar to the cognitive measure during practice in that they significantly decreased on the second day. The group differences were in the opposite direction of the research hypothesis though, as the control group tended to report greater somatic self-activation than the self group on each day. This difference was not significant during practice, but did reach significance during retention. The etiology of this effect is difficult to explain. However, there are a couple strong reasons for refraining from interpreting this finding as evidence of greater self-activation in the control group: first, the measure assessed participants’ reported experience of somatic symptoms of anxiety and self-consciousness. Many of these symptoms are also consistent with moderate levels of physical activity. For

example, two items ask participants to indicate their level of agreement with the statements “My heart beat faster,” and “I perspired.” Full agreement with these two items would be expected from some participants after just finishing 50 to 70 swings, and would also result in an above average score even if the remaining items were answered with a one. Second, the self group indicated greater cognitive self-activation than the control group, a measure much closer to the conception of self-activation implicated in the “self-invoking trigger” hypothesis. Since it is a strong possibility that the somatic measure of self-activation was influenced by motor performance between experimental manipulation and its assessment, and since the measure of cognitive self-activation was in the predicted direction, it seems an unlikely scenario that the control group experienced greater self-activation than the self group throughout the study.

Implicit Self-Activation

There were no significant changes in signature size measured in this study. While previous research has demonstrated that change in signature size is a reliable measure of threats to the self (Rudman, Dohn, & Fairchild, 2007; Stapel & Blanton, 2004), the present study did not aim to threaten the self, necessarily. Instead, the goal of the experimental manipulation was simply to activate the self-schema, a process that may not impact signature size alone. Still, it seemed likely that there would be some degree of threat to the self experienced by the self group, and the failure to find such an effect may be due to at least two reasons: first, signing a signature requires fine motor control that could possibly have been impacted by the preceding physical activity. Since both groups

signed larger signatures than their baseline at the end of each day, it is possible that hitting wiffleballs immediately prior to signing a signature somewhat degrades handwriting performance, producing both larger and potentially more variable signatures and thus masking any self-activation effects. A comparison of the standard deviations found in this study with those reported by Rudman and colleagues (2007) reveals that there was 20 to 40 percent greater variability in signatures collected in this study. This comparison offers some support to the contention that the hitting task in this study may have caused some error in the signature size measure. A second possible reason for the failure to find an effect on signature size is the testing of a sample made up mostly of people who played baseball or softball in the past, but who have not played in years and thus do not consider “hitter” as a major part of their identity. Since signature size typically measures a threat to some aspect of the self, if “hitter” is not part of a participant’s conception of self then signature size may not have been the appropriate measure for the effect of the manipulation employed in this study.

Conclusions and Recommendations

For Further Study

The present study provides initial support for the “self-invoking trigger” hypothesis. A strength of the design is that one could have reasonably predicted *a priori* that the self group would perform more effectively than a control group. After all, as one participant commented, reminding someone of their “glory days” could have boosted confidence or activated forgotten movement patterns. Instead, the ostensibly innocuous activity of contemplating one’s own

experiences, emotions, strengths, weakness, and attributes seemed to activate a lurking neural self-network that interfered with the process of motor learning. This initial test provides preliminary evidence that self-activation is detrimental to motor learning and performance, but replication is necessary to confirm the existence of the self-activation effect and improved methodology is necessary to shed light on the underpinning etiology.

One key limitation of the present study was its inability to measure self-activation or test for its possible mediating effect. Future studies must address two key issues in endeavoring to measure a mediating effect of self-activation on motor learning degradation: determining the appropriate tool to measure the specific phenomenon responsible for the self-activation effect, and ensuring that said tool can be administered prior to practice or performance without causing self-activation. The present study was unable to measure differences in self-activation caused by the experimental manipulation, although it seems the measure of cognitive self-activation employed may have been effective with a larger sample. That said, it seems unlikely the measure used in this study could be used to evaluate a mediating effect of self-activation because the completion of the measure by a participant is likely to result in self-activation. This is an issue that will likely plague any explicit measure of self-activation. Since the implicit measure employed in this study was unsuccessful as well, it seems another direction would be appropriate. A lexical decision task has been used to successfully measure self-activation implicitly and with a sample size similar to the present study ($N = 36$; Hall & Crisp, 2010). Further, there is some face

validity to the way a lexical decision task measures self-activation (by determining if self-related words are recognized preferentially quick relative to non-self words) with regards to the way the self was ostensibly activated in the present study. An implicit measure like a lexical decision task could be assessed immediately following the experimental manipulation but before motor performance without concern for the measure itself causing self-activation. If an explicit measure (such as the one used in this study) is employed, a variant of the Solomon four group design might be appropriate to control for the possible effects of measuring self-activation.

While reliably measuring self-activation (and its possible mediating effect) is an essential step in the study of the “self-invoking trigger,” it does not bring us any closer to understanding why self-activation is detrimental to motor learning and performance. There are at least three potential mechanisms for the self-activation effect: competition for cognitive resources (Wulf & Lewthwaite, 2010), self-activation leads to an internal focus (the inverse of the original explanation, not yet ruled out), and self-activation leads to reinvestment of explicit rules (Masters, 1992; 1993). A replication of Gray (2004; Experiment 2) with the experimental manipulations used in the present study and an opportunity to list as many explicit rules as possible at the end of the study would likely rule out at least one of the possible explanations. The extraneous dual-task would test the competition for cognitive resources hypothesis; the skill-focused dual-task would test the self-activation leads to an internal focus hypothesis; and the opportunity

to list explicit rules would determine if self-activation causes participants to access their declarative knowledge-base associated with hitting performance.

It seems to me that the above suggestions are the next logical steps towards understanding the possible self-activation effect discovered in the present study. Once the results of the above studies are known, it may be possible to determine the extent to which the self-invoking trigger is responsible for other patterns of findings beyond the attentional focus literature. At this point, one must be cautious in interpreting the present findings. This study was the first of its kind, and replication (perhaps with the methods described above) is essential before one may draw any firm conclusions.

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APPENDIX 1

COGNITIVE SELF-ACTIVATION SCALE

Strongly disagree

Strongly Agree

1 2 3 4 5 6 7

1. I have the sense that the experimenter was psychoanalyzing my motives and me.
2. I think the experimenter knew what I am thinking and feeling.
3. I think the experimenter watched all my body movements, gestures, and reactions.
4. I think the experimenter scrutinized my every move and payed attention to every detail.
5. I noticed the experimenter saw through me.
6. I think that the experimenter saw me as an incomplete and inadequate hitter.
7. I think that the experimenter considered me to be a failure as a hitter.
8. I tended to avoid eye contact with the experimenter.

APPENDIX 2

SOMATIC SELF-ACTIVATION SCALE

Strongly disagree

Strongly Agree

1

2

3

4

5

6

7

Scale 2

1. I felt jittery in my body.
2. My heart beat faster.
3. I felt a bit physically weak.
4. I felt tense in my stomach.
5. I perspired.

APPENDIX 3

SELF-ACTIVATING MANIPULATION

1. Please write continuously for 1 minute about your own personal experience participating in baseball or softball. The experimenter will time you.

2. Please write continuously for 1 minute about your strengths and weaknesses as a hitter. Give examples from personal experience. The experimenter will time you.

3. Please describe your emotional response to baseball or softball. How has performing in baseball or softball made you feel in the past? Please write for 1 minute- the experimenter will time you.

4. Please describe your own physical attributes and how they have helped or hindered your athletic performance in the past. Please write continuously for 1 minute while the experimenter times you.

APPENDIX 4

CONTROL MANIPULATION

1. Please list every item you can see in the laboratory from largest to smallest. The experimenter will ask you to stop after 1 minute.
2. Please list every item in the room alphabetically, beginning with the letter A. The experimenter will ask you to stop after 1 minute.
3. Please list every item in the room by color; list as many blue objects as possible, then as many red, then as many black, then as many yellow. The experimenter will ask you to stop after 1 minute.
4. Please list every item in the room by shape: list the items with straight edges first, then the items that are curved, and finally list any irregularly shaped items. The experimenter will ask you to stop after 1 minute.

APPENDIX 5

CONTENT OF SELF MANIPULATION

Participants in the self group wrote overwhelmingly positive responses to the first question of the manipulation. Typical positive answers recalled enjoying baseball or softball, spending time with family and friends, and being successful at the game. Some of the negative responses included losing interest, finding the game boring or slow, and enduring injury.

Although item two on the self manipulation asked for strengths and weaknesses, almost all participants wrote the majority of their response about their personal strengths as a hitter.

Response to the third item of the self questionnaire was unanimously positive as everyone cited having fun with the sport and enjoying their time in the game.

Similar to the second item, response to the final question on the self manipulation was predominately positive, although participants were asked to include negative attributes as well. Typically, participants would list 2 or 3 strengths for every one weakness.

APPENDIX 6

IRB APPROVAL

Biomedical IRB – Expedited Review Approval Notice

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: December 6, 2010

TO: **Dr. Gabriele Wulf**, Kinesiology and Nutrition Sciences

FROM: Office of Research Integrity - Human Subjects

RE: Notification of IRB Action by /Charles Rasmussen/ Dr. Charles Rasmussen, Co-Chair
Protocol Title: **Motor Performance in Wiffle Ball Hitting**
Protocol #: 1011-3643M
Expiration Date: December 5, 2011

This memorandum is notification that the project referenced above has been reviewed and approved by the UNLV Social/Behavioral Institutional Review Board (IRB) as indicated in Federal regulatory statutes 45 CFR 46 and UNLV Human Research Policies and Procedures.

The protocol is approved for a period of one year and expires December 5, 2011. If the above-referenced project has not been completed by this date you must request renewal by submitting a Continuing Review Request form 30 days before the expiration date.

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.

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.

INFORMED CONSENT

Department of Kinesiology and Nutrition Sciences

TITLE OF STUDY: Motor Performance in Wiffle Ball Hitting

INVESTIGATOR(S): Gabriele Wulf, Ph.D., and Brad McKay

CONTACT PHONE NUMBER: 702-895-0938 (Wulf)

Purpose of the Study

You are invited to participate in a research study. The purpose of this study is to analyze the learning of a wiffle ball hitting task in a controlled environment.

Participants

You are being asked to participate in the study because you are between the ages of 18 and 45, you are healthy, and you have good visual acuity or corrected vision. Further, you have had some experience playing baseball or softball in the past, but do not currently play on a team.

Procedure

If you volunteer to participate in this study, you will be asked to do the following: First, you will be asked to complete two sets of 10 swings (20 in total) at pitches being projected at 30 miles per hour from a wiffle ball pitching machine using a broomstick-sized bat. You will then be asked to complete two questionnaires. This phase of the study is termed the pre-test and it establishes a baseline for future comparison. Second, you will be asked to complete 5 sets of 10 swings (50 in total) in two separate practice sessions. During each practice session there will be rest periods between sets of swings. During that time, you will be asked to answer a few more generic questions about your experiences with baseball/softball hitting or about the objects in the room. After each practice session you will be asked to complete the same two questionnaires you completed during the "pre-test." Finally, you will be asked to come for one final session called a retention and transfer test. The retention test is identical to the practice sessions you will do during the first two sessions. The transfer test involves a slight change in the task: You will be asked to complete 2 more sets of 10 swings, this time at 40 miles per hour. The final task you will be asked to complete is to answer the two questionnaires a final time.

Benefits of Participation

There may not be direct benefits to you as a participant in this study. However, we hope to learn more about WIFFLE BALL batting performance from this study.

Participant Initials _____

1 of 2

Approved by the UNLV IRB. Protocol #1011-3643M

Received: 11-23-10 Approved: 12-06-10 Expiration: 12-05-11

TITLE OF STUDY: Motor Performance in Wiffle Ball Hitting

Benefits of Participation

There may not be direct benefits to you as a participant in this study. However, we hope to learn more about WIFFLE BALL batting performance from this study.

Risks of Participation

There are risks involved in all research studies. This study may include only minimal risks. You may experience delayed-onset muscle soreness a day or two after the experiment.

Cost /Compensation

There will not be financial cost to you to participate in this study. The study will take 90 minutes of your time.

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 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 at least 18 years of age. A copy of this form has been given to me.

Signature of Participant

Date

Participant Name (Please Print)

Participant Note: Please do not sign this document if the Approval Stamp is missing or is expired.

Participant Initials _____

2 of 2

Approved by the UNLV IRB. Protocol #1011-3643M

Received: 11-23-10 Approved: 12-06-10 Expiration: 12-05-11

VITA

Graduate College
University of Nevada, Las Vegas

Bradley James McKay

Degrees: Bachelor of Arts (Hons.) in Psychology

Special Honors and Awards:

Bombardier Grant for Master's Students (\$17, 500), SSHRC of Canada
(unable to accept due to attending school in USA)
Ray and Lorain Irving Prize for Best Thesis in Psychology (2008)
Third Year Award for the Highest G.P.A in Psychology (2007)
Data-Tel Outstanding Scholar Award (2007)
St. Thomas University Outstanding Scholar (2006, 2007, 2008)
St. Thomas University Dean's List (all years)

Thesis Title: The Self: Your Own Worst Enemy? A Test of the Self-Invoking
Trigger Hypothesis

Thesis Examination Committee:

Chair, Gabriele Wulf, Ph. D.
Committee Member, Rebecca Lewthwaite, Ph. D.
Committee Member, Richard Tandy, Ph. D.
Committee Member, Janet Dufek, Ph. D.
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