University of Nevada, Reno

Mental Toughness:
An Investigation of Verbal Processes on Athletic Performance

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Psychology

by
Emily M. Leeming

Dr. Steven C. Hayes/Dissertation Advisor

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We recommend that the dissertation prepared under our supervision by

EMILY M LEEMING

Entitled

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DOCTOR OF PHILOSOPHY

Steven C. Hayes Ph.D., Advisor

Nora Constantino Ph.D., Committee Member

James Fitzsimmons Ed.D., Committee Member

Victoria M. Follette Ph.D., Committee Member

W. Larry Williams Ph.D., Committee Member

Paul Mitchell, Ph.D., Graduate School Representative

David W. Zeh, Ph.D., Dean, Graduate School

May, 2016
Abstract

Athletes are given many forms of advice about how to think in ways that promote persistence in the face of aversive and fatigue-producing events. This study evaluated the impact of different kinds of verbal statements on task persistence by athletes. Competitive CrossFit athletes from the Western United States were recruited to participate in one of two experiments. Experiment 1 employed a within subject, alternating treatments design (ATD); Experiment 2 used a pre-and-post group comparison. The ATD investigated the efficacy of three kinds of specific statements designed to increase performance during a demanding and stress-producing task: two were suggested by traditional sports psychology (a statement to focus on the task and a statement to distract from the task), and one suggested by Relational Frame Theory (RFT) and the concept of psychological flexibility (a statement to focus on willingness to persist in the face of aversive emotions). The pre/post group design aimed to replicate and statistically improve the power of the effects indicated in Experiment 1. Results from this program of research suggest that the statement focused on openness to experience improved task persistence significantly over baseline, and more so than a statement instructing athletes to distract themselves from the task. The willingness statement was also marginally more effective than the statement prompting the athletes to focus directly on the task.
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# Table of contents

Abstract.........................................................................................................................i
Acknowledgements........................................................................................................ii
Table of Contents............................................................................................................iv
List of Tables...................................................................................................................v
List of Figures.................................................................................................................vi
List of Images...................................................................................................................vii
List of Appendixes.........................................................................................................ix
Introduction.....................................................................................................................1
General Procedures.........................................................................................................32
Method Experiment 1 – Within Subject Alternating Treatments Design.........................42
Results: Experiment 1.......................................................................................................45
Experiment 2 – Between Subjects Pre/Post comparison....................................................59
Results Experiment 2 – Between Subject Pre/Post Design................................................62
Supplementary Study: Follow Up Demographic Assessment..........................................76
General Discussion.........................................................................................................80
Implications......................................................................................................................91
Future Research..............................................................................................................93
Conclusion......................................................................................................................94
References.......................................................................................................................96
Appendixes......................................................................................................................109
List of Tables

Table 2.1: Key Terms........................................................................................................31
Table 2.2: ATD Conditions...............................................................................................42
Table 2.3: Demographic Data for Experiment 1............................................................45
Table 2.4: Delay, Pain and Anxiety Reports.....................................................................47
Table 2.5: Repeated Measures of Analysis of Variance................................................64
Table 2.6: Logarithmic/Adjusted Average Time per Trial.............................................69
List of figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Reflexivity</td>
<td>12</td>
</tr>
<tr>
<td>1.2</td>
<td>Stimulus Equivalence</td>
<td>13</td>
</tr>
<tr>
<td>2.1</td>
<td>Experiment 1 Participant 1 Total Duration</td>
<td>49</td>
</tr>
<tr>
<td>2.2</td>
<td>Experiment 1 Participant 2 Total Duration</td>
<td>50</td>
</tr>
<tr>
<td>2.3</td>
<td>Experiment 1 Participant 3 Total Duration</td>
<td>50</td>
</tr>
<tr>
<td>2.4</td>
<td>Experiment 1 Participant 4 Total Duration</td>
<td>51</td>
</tr>
<tr>
<td>2.5</td>
<td>Experiment 1 Participant 5 Total Duration</td>
<td>52</td>
</tr>
<tr>
<td>2.6</td>
<td>Experiment 1 Participant 6 Total Duration</td>
<td>52</td>
</tr>
<tr>
<td>2.7</td>
<td>Experiment 1 Participant 1 Fatigue Fall Off</td>
<td>54</td>
</tr>
<tr>
<td>2.8</td>
<td>Experiment 1 Participant 2 Fatigue Fall Off</td>
<td>55</td>
</tr>
<tr>
<td>2.9</td>
<td>Experiment 1 Participant 3 Fatigue Fall Off</td>
<td>56</td>
</tr>
<tr>
<td>2.10</td>
<td>Experiment 1 Participant 4 Fatigue Fall Off</td>
<td>56</td>
</tr>
<tr>
<td>2.11</td>
<td>Experiment 1 Participant 5 Fatigue Fall Off</td>
<td>57</td>
</tr>
<tr>
<td>2.12</td>
<td>Experiment 1 Participant 6 Fatigue Fall Off</td>
<td>58</td>
</tr>
<tr>
<td>2.13</td>
<td>Experiment 2 90 Degree Time to Exhaustation</td>
<td>66</td>
</tr>
<tr>
<td>2.14</td>
<td>Experiment 2 Willingness Time to Exhaustion</td>
<td>67</td>
</tr>
<tr>
<td>2.15</td>
<td>Experiment 2 Distraction Time to Exhaustion</td>
<td>68</td>
</tr>
<tr>
<td>2.16</td>
<td>Experiment Time to Exhaustion Across Conditions</td>
<td>70</td>
</tr>
</tbody>
</table>
List of Images

Image 2.1: Experimental setup..........................................................................................35
List of Appendixes

<table>
<thead>
<tr>
<th>Appendix 2.1: Baseline Instructions</th>
<th>110</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix 2.2 90 Degree Instructions</td>
<td>111</td>
</tr>
<tr>
<td>Appendix 2.3 Willingness Instructions</td>
<td>112</td>
</tr>
<tr>
<td>Appendix 2.4 IV Distraction</td>
<td>113</td>
</tr>
<tr>
<td>Appendix 2.5 Sport and Competition Monitor</td>
<td>114</td>
</tr>
<tr>
<td>Appendix 2.6: PowerPoint Example</td>
<td>116</td>
</tr>
<tr>
<td>Appendix 2.7 AAQ-II</td>
<td>112</td>
</tr>
<tr>
<td>Appendix 2.8: Sport and Competition Questionnaire (Initial Experiment 1)</td>
<td>123</td>
</tr>
<tr>
<td>Appendix 2.9: Sport and Competition Questionnaire (Post Experiment 1)</td>
<td>126</td>
</tr>
<tr>
<td>Appendix 2.10: Sport and Competition Questionnaire (Initial Experiment 2)</td>
<td>130</td>
</tr>
<tr>
<td>Appendix 2.11: Sport and Competition Questionnaire (Post experiment 2)</td>
<td>133</td>
</tr>
<tr>
<td>Appendix 2.12: In Session Verbal Responses</td>
<td></td>
</tr>
<tr>
<td>Top 5 Performers 90 Degree</td>
<td>136</td>
</tr>
<tr>
<td>Appendix 2.13: In Session Verbal Responses</td>
<td></td>
</tr>
<tr>
<td>Mid 5 Performers 90 Degree</td>
<td>137</td>
</tr>
<tr>
<td>Appendix 2.14: In Session Verbal Responses</td>
<td></td>
</tr>
<tr>
<td>Low 5 Performers 90 Degree</td>
<td>138</td>
</tr>
<tr>
<td>Appendix 2.15: In Session Verbal Responses</td>
<td></td>
</tr>
<tr>
<td>Top 5 Performers Willingness</td>
<td>139</td>
</tr>
<tr>
<td>Appendix 2.16: In Session Verbal Responses</td>
<td></td>
</tr>
<tr>
<td>Mid 5 Performers Willingness</td>
<td>140</td>
</tr>
<tr>
<td>Appendix 2.17: In Session Verbal Responses</td>
<td></td>
</tr>
<tr>
<td>Low 5 Performers Willingness</td>
<td>141</td>
</tr>
<tr>
<td>Appendix 2.18: In Session Verbal Responses</td>
<td></td>
</tr>
<tr>
<td>Top 5 Performers Distraction</td>
<td>142</td>
</tr>
<tr>
<td>Appendix 2.19: In Session Verbal Responses</td>
<td></td>
</tr>
<tr>
<td>Mid 5 Performers Distraction</td>
<td>143</td>
</tr>
<tr>
<td>Appendix 2.20: In Session Verbal Responses</td>
<td></td>
</tr>
<tr>
<td>Low 5 Performers Distraction</td>
<td>144</td>
</tr>
</tbody>
</table>
Introduction

Mental toughness and other similar constructs—resiliency, hardiness, and grit—have received considerable attention in high performance domains such as business, military, and competitive athletics (Casey, 2011; Maddi, Matthews, Kelly, Villarreal & White, 2012; Maddi, Kahn, & Maddi, 1998; Reivich, Seligman & McBride, 2011). Used interchangeably within the sports literature, researchers define both mental toughness and resiliency in a variety of ways but have yet to agree on a definition (Maddi, Matthews, Kelly, Villarreal & White, 2012). Jones et al., (2002) say, “The general lack of clarity and precision surrounding the term ‘mental toughness’ is unfortunate, since it is arguably one of the most important psychological attributes in achieving performance excellence” (p. 206).

Mental toughness and resiliency have been broken down into two conceptual components: hardiness and grit (Maddi, Mathews, Kelly, Villarreal & White, 2012). Hardiness refers to behavioral responses that promote the accomplishment of long-term goals and that allow an individual to adjust to changing circumstances during the pursuit of delayed outcome goals. Grit represents the ability to persist under immediately aversive circumstances to achieve goals that may or may not be long-term.

The amount of research on mental toughness demonstrates the social interest in the topic, but reliable results are elusive (Clough & Earle, 2002; Connaughton, Wadey, Hanton & Jones, 2008; Creasy, 2005; Crust, 2011; Crust & Azadi, 2010; Crust & Clough, 2005; Durand-Bush & Salmela, 2002; Gucciardi, Gordon & Dimmock, 2009; Gucciardi, Gordon & Dimmock, 2008; Harmison, 2012). Empirically supported knowledge regarding mental toughness is desired in that athletes have a strong interest in being able to push themselves further or to exceed imposed limits more readily. In competitive athletic settings, such ability is an asset.
The present study seeks to test different approaches to the components of “mental toughness.” Using both between-group and within-subject design methodologies, it investigates the limits of athletic performance in the presence of specific verbal statements that suggest different psychological perspectives on how best to deal with situations producing pain and fatigue.

**Historical Perspectives**

Coaches and athletes looking for a competitive edge are turning to the psychological aspects of competitive events in hopes of continuing to achieve competitive advantages (Crust, 2005; Harmison, 2006). This pursuit began in part because the developments in the area of physical conditioning, technical training, and the analysis of human mechanics have been so great that the additional gains from these areas seem likely to be very small going forward (Gucciardi, Gordon, Dimmock, 2008; Ravizza & Hanson, 1995). The value of the “mental game” in athletics is often noted (Harmison, 2006; Ravizza & Hanson, 1995) but knowledge in this area is less robust hence advances seem possible.

Mental toughness and resiliency are examples of psychological events that seem worthy of additional experimental attention. This is especially true as they are considered prominent features of successful elite athletes. It is commonplace for athletes selected for their promise and physical talent to fail to achieve the success predicted. The history of athletics is also filled with descriptions of individuals who exhibit less physical aptitude than their peers but are noted for their records and achievements. Psychological factors are often credited for these victories (Clough & Earle, 2002; Connaughton, Wadey, Hanton, Jones, 2008; Crust, 2011; Crust & Azadi, 2010; Crust & Clough, 2005; Durand-Bush & Salmela, 2002; Gucciardi, Gordon & Dimmock, 2009; Gucciardi, Gordon & Dimmock, 2008).
The concept of mental toughness has struggled to be examined with the same scientific rigor as other areas of athletics and performance (Jones, Hanton, Connaughton, 2002). This state of affairs is due in part to loose definitions, construct inconstancies, and mentalistic and dualistic notions that have limited the progress of scientific research (Crust, 2011; Jones, Hanton, Connaughton, 2010).

**Toughness as a Trait**

Mental toughness and its conceptual counterparts of resiliency, grit, and hardiness, are traditionally considered personality traits. In this approach “tough” athletic behaviors are thought to be caused by internal dispositional processes (Middleton, Marsh, Martin, Richards, Savis, Perry, & Brown, 2003). “Tough” individuals are said to possess “self-discipline,” “motivation,” “persistence,” and “determination.” Less “tough” individuals are considered to lack these traits. Psychometric tests built from this perspective have yielded descriptions of top athletes’ views and beliefs about training and competition (Crust, 2011; Jones, Hanton, Connaughton, 2010; Nichollas, Polman, Levy & Backhouse, 2008) but successful intervention programs linked to this trait-based approach are few. Even preliminary outcome evaluations are difficult to identify. A thorough search of the literature yielded only two studies that tested programs linked to preliminary psychometric evaluation tools (Clough & Earle, 2002; Crust & Clough, 2005). These evaluations evaluated the scores of athletes on psychometric scales and performance in athletic standings across multiple disciplines and levels of performance. Athletes who scored well in toughness traits tended to perform better in their specific sporting disciplines.

**Psychological Skills Training**

Another research approach to mental toughness and resiliency is psychological skills training (PST), which attempts to use variations of thought suppression and cognitive restructuring to promote knowledge and skill development (Dugdale & Eklund,
2002; Reivich & Seligman & McBride, 2011). This approach argues that performance can be enhanced when thought suppression is used with replacement cognitive statements that reorient the athlete toward key tasks: “Thought suppression, for example, can be an effective mental control strategy if used in conjunction with a strategy to direct one’s attention to task-relevant cues.” (Dugdale & Eklund, 2002 p.317).

A hallmark of these interventions is using statements that aim to promote effective behavior by overriding immediate environmental contingences. For example, statements such as, “just put one foot in front of the other,” direct an athlete to the contingences relevant to performance, and to ignore other potentially competing contingencies such as, fatigue, cramping, being passed by other competitors, or focusing on the distance to the finish. People using the PST approach hope to teach individuals to control thoughts or self-statements (Ravizza & Hanson, 1995). Drawn from traditional cognitive behavioral models, the techniques operate under the assumption that when an individual can successfully control or remove unwanted thoughts, they can improve their performance.

Two main strategies have been studied by PST researchers: association and dissociation (Antonini-Philippe, Reynes, Bruant, 2003; Hutchinson & Tenenbaum, 2007; Morgan & Pollock 1977; Silva III & Appelbaum, 1989). Association strategies focus the athlete’s attention toward performance relevant physiological sensations so that they can make adjustments to their performance related to these sensations, perhaps reducing the impact of fatigue on athletic technique. Dissociation strategies are used to distract athletes from attending to difficult physiological sensations which arise in athletic competition and training—such as pain and fatigue—in an attempt to push through aversive experiences that may limit performance.

People using associative and dissociative statements assume they compete with and suppress unwanted, naturally-occurring self-statements which hinder performance.
For example, trainers hope an athlete taught to “focus on form and technique of foot fall when running," may not attend to the naturally occurring and aversive fatigue ("I'm too tired") or pain ("I'm going to throw up") associated with running, and thus may mitigate its effects.

Research on the impact of these associative and dissociative statement strategies generally focuses on self-report measures such as Ratings of Perceived Effort (RPE), task intensity, and focus type. Much of the research is correlational not experimental. For example, Hutchinson and Tenebaum (2007) evaluated naturally-occurring verbal responses during a grip strength and cycling tests. Non-competitive exercisers participated. During the tasks, individuals were instructed to self-report their thoughts (covert verbal behavior). These statements were recorded and coded for analysis. Results indicated that as the effort required to execute the task increased, so did the association like responses. The researchers concluded that associative responses are “almost unavoidable” the longer one engages in a high-effort task. Results of the RPE measures were mixed providing information on the use of both strategies but little in terms of how such strategies affected performance outcomes (Hutchinson & Tenebaum 2007).

Silva and Applebaum (1989) evaluated self-reported attention strategies among US Olympic Marathon Trial competitors. Thirty-two athletes participated by answering a 12-question survey the night before the Olympic Trial race. Responses to survey questions showed differences between top race performers (top 50 finishers) and lower performers. Athletes who reported using both association and dissociation strategies throughout the race but who finished using dissociation strategies also finished faster. Individuals who relied primarily on dissociation strategies early in the race also had poorer performance times (Silva & Applebaum, 1989). In general, data suggest association strategies used among effective athletes throughout most of the race and
dissociation only toward the end of the competition, athletes with lower performance standings relied on dissociation longer. These results may suggest that association and dissociation strategies may be useful in certain contexts. Such evidence produces questions regarding these specific contexts and how athletes should employ them. (Dugdale, Eklund, 2002).

Studies evaluating the effects of verbal statements on the accuracy of performance in athletics indicate specific types of focus statements can improve performance, where as instructions to think of things other than the desired target are detrimental to performance (referred to as ironic processing). In 2002, Dugdale and Eklund evaluated the ability of college students to ignore Australian Rules Football umpires. In this series of studies, individuals who were given specific cue words to focus performed better than those who were told to simply ignore umpires. Woodman and Davis (2008) investigated the accuracy of golf putting and repression statements. Distance of the ball from the target increased when golfers were instructed to “land the ball on the target, but be particularly careful not to over-shoot the target.” Marchant, Clough, Crawshaw (2011, p. 187) reported athletes improved their dart throwing accuracy when given specific and external focus cues. Such evidence suggests that associative statements may improve performance more so than dissociate strategies, however performance-based research in competitive populations is rare. Such studies in the literature were all for novice athletes.

Although these studies indicated a difference between elite athletic performance (dissociative strategies at the end of the race) and typical responding among non-competitive exercisers (associative strategies at the end of tasks), their qualitative and correlational methodology does not allow them to be taken as evidence for applied sports psychology interventions. In addition, research in other applied areas shows mixed and problematic results from thought replacement strategies (Friman, Hayes &
Wilson, 1998; Braams, Blechert, Boden & Gross, 2012). For example, an extensive body of research in the area of psychological distress suggests that a common form of thought replacement, thought suppression, generally leads to long run negative outcomes (Coiffi & Holloway, 1993; Wegner, Schneider, Carter & White, 1987). In cognitive behavior therapy, direct cognitive modification is designed to avoid thought suppression, but meta-analyses suggest it produces weak and mixed results (Longmore & Worrell, 2007).

The present study examined association and dissociation strategies and their impacts on athletic performance specifically targeting persistence. The present study also contrasted these approaches with an intervention drawn from a behavior analytic approach designed to avoid possible problems with direct cognition change interventions.

**Behavior Analytic Approach to Athletic Improvement**

Behavior analysis views behavior as any and all actions of the whole organism, and it studies behavior as a function of *manipulable* environmental events (Skinner, 1953). According to the behavior analytic perspective, behavior is a natural outcome of an individual’s environment and history (Hayes, Strosahl & Wilson, 1999; Martin, 2003; Skinner, 1974). This approach investigates functional relationships between behavior and environment and seeks to predict and influence the future probably of responding (Hayes, Barlow & Nelson-Gray, 1999; Skinner, 1953).

Behavior analysis has been effective across multiple areas of application: education, developmental disabilities, occupational safety, performance management, animal training, and mental health (Cooper, Heron & Heward, 2007; Daniels & Daniels, 2004; Miltenberger, 2004). Additionally, behavior analysis has a long history in sports, fitness, and athletics, with validated procedures yielding successful changes in performance. These tools are frequently used in the development of technical skills (Heward, 1978, Komaki & Barnett, 1977; Martin, 2003; Martin & Tkachuk, 2002; Martin,
Behavioral concepts and interventions. The behavioral contingency is a functional construct used to analyze behavior and develop interventions from a natural science perspective. At its most basic conceptualization, the behavioral contingency is composed of an antecedent, behavior, and consequence (A→B→C). This construct was developed from animal models (Skinner, 1974) and has been shown successful when applied to numerous human activities, including athletics. Interventions can focus on antecedents, consequences, or both. It is important to note however, that complex human responding also often includes verbal (or “cognitive”) behavior. While all behaviors potentially affect other actions, verbal behavior’s impact is difficult to account for with the simple, three-term contingency. The subsequent sections will thus elaborate on the role of language as human action and attempt to apply that perspective to verbal interventions in sports, mental toughness, and athletic resiliency.

Any intervention that occurs prior to the target behavior’s occurrence is classified as an antecedent intervention. The most common types of antecedent-based interventions used in sports include: goal setting, modeling, instruction, imagery/mental rehearsal, and self-talk (Allison & Ayllon, 1980; Flora, 2010; Martin, 2003; Ward & Carnes, 2002).

Antecedent-based interventions are heavily used in human psychology but among non-language able organisms, evidence of their effect is mixed unless consequences related to the antecedent change are managed or maintained. For example, antecedent control (descriptive stimuli) impacts behavior, but only if the probability of reinforcement is reliably related to the antecedent event. Antecedents are more broadly effective when they are applied to language capable humans in the forms of instructions or rules (Haas & Hayes, 2006; Jackson, 2007; O’Hora & Maglieri, 2006).
Individuals with intact verbal repertoires (language) can, under specific contexts, have their behavior influenced in such ways that do not comport with their direct learning history. Language can also alter effectiveness of antecedent and consequent stimuli thus when dealing with antecedent verbal interventions a theoretical understanding of language is necessary. The following sections will present advances in behavioral theory that address this area.

**Consequence interventions** in sports psychology include rewards and feedback. Reward-based, reinforcement interventions have a long history of producing behavior change in human situations, and in athletics they are primarily used to teach new skills (Martin, 2003 & Miltenberger, 2004). Reward-based interventions are useful in a sports psychology context primarily because they reduce the time needed to teach skill mastery (Cooper, Herron & Heward, 2007; Daniels & Daniels, 2004; Flora, 2010). Behavior analysis research also suggests that for intervention packages to be maximally effective, they should be designed so consequences become naturally reinforcing thus self-sustaining.

Penalty-based interventions also fit within the concept of a consequence-based intervention. Although these interventions are effective in curbing undesired behavior under specific conditions (Daniels & Daniels, 2004), aversive consequences often induce emotional responding and counter-control. They are generally avoided in applied sports psychology.

Interventions that include feedback are among the most effective and efficient across numerous behavior-change initiatives (O'Hora & Maglieri, 2006; Ward & Carnes, 2002). Feedback can be thought of as an intervention that alters consequences (Martin, 2003) but the broader literature is unclear on the classification of feedback as response consequence or an antecedent or motivating operation for future responses (Mazur, 2006; Newsome, 2012). These classification problems appear to turn on the same
issues as those encountered with verbal antecedents. For example, feedback interventions provide individuals with information about their performance and its effectiveness. Feedback improves multiple domains of athletic performance (Jackson, 2007; Komaki & Barnett, 1977; Martin, 2003) but an account of the role of verbal information in feedback interventions is needed.

When used purely as part of direct contingencies, consequences are maximally effective when delivered immediately following the occurrence of desired behaviors. In non-humans and humans without verbal abilities, basic and applied research demonstrates the more delayed the consequences, the less effective they are (Cooper, Heron & Heward, 2007; Lattal, 2010; Mazur, 2006). However, under some conditions, language-able human beings appear to respond to delayed consequences as if there were no delays (Hayes, Strosahl & Wilson, 1999; Lattal, 2010; Gardner & Moore, 2004; Gardner & Moore, 2007; Hasker, 2010; Jackson, 2007). This effect requires explanation because it has direct implications for the desired outcomes of athletic training and competition.

Many athletic outcomes may be considered products of delayed contingencies. For example, fitness, improvement and mastery of a technical skill, goal achievement, and consistency in performance are all delayed outcomes that, because of their delays, are thought to be unable to provide reinforcement for the component behaviors that produce them. These delayed contingency effects involve the use of verbal behavior, specifically instructions, feedback, and rules.

**Rule-Governed Behavior.** Skinner (1957) attempted to develop a model by which verbal behavior can be classified functionally. In Skinner’s account of verbal events (1957), verbal stimuli were argued to be merely the products of verbal behavior, and the behavior of the listener was not verbal at all.
Skinner defined rules as “contingency-specifying stimuli” (Skinner, 1969, p. 148) In essence, rules are verbal stimuli that describe environmental contingencies and functional aspects of the environment (Jackson, 2007; Pelaez & Moreno, 1999) but they are not the physical contingencies themselves. Skinner (1974) further defined a rule as functioning to change how a person behaves with regard to the physical contingencies described in the statement. Rules clearly are advantageous when consequences for behavior are delayed and uncertain. For example, a runner who, after receiving recommendations, performs long training runs prior to her first half marathon is less likely to experience the severe aversive consequences of not engaging in appropriate training (e.g., blisters, hypernatremia, gastrointestinal discomfort). Similarly, an athlete who has experienced the aversive consequences of participating in a race without adequate training may generate a rule for future races such as “always plan long training runs for distance races.” Both examples might result in predictable changes in future rule-following.

While the concept of rule-governed behavior led to applied interventions and useful research (see Hayes and Hayes, 1989 for a book-length analysis), there was an inconsistency between this approach to rules and Skinner’s concept of verbal behavior (Parrott, 1984). If verbal stimuli are merely the product of verbal behavior and the behavior of the listener is not verbal then it was not clear to what extent rules can “specify” events (Hayes & Hayes, 1989; 1992; Parrott, 1984). Discriminative stimuli presumably do not “specify” contingencies—otherwise the concept of a rule would be superfluous because it would be synonymous with discriminated operants more generally. But if the listener is actively involved in the meaning making of a verbal rule when a contingency is “specified,” then this action of a listener is behavior and requires an account. That is precisely what Skinner said should not be done, which created an irresolvable conflict inside Skinner’s analysis (Hayes & Hayes, 1989; 1992). Relational
frame theory, described in the next sub-section, stepped into this conceptual gap and attempted to answer these questions in a behavioral way.

**Relational Frame Theory.** Relational Frame Theory (RFT) is an account of language and human cognition. RFT works to extend upon Skinner’s definition of verbal behavior. In so doing, it also accounts for the listener’s behavior, how verbal stimuli specify events, and how verbal antecedents impact complex human behavior. Key to this theory is the idea that human verbal behavior is composed of relational responses. A relational response is defined as responding to one event in terms of another (Hayes, Barnes-Holmes, Roche, 2001). Researchers argue language is based on derived stimulus relations among events under arbitrary contextual control as opposed to simply the form of the related events or even direct contact with them (Barnes-Holmes & Barnes-Holmes, 2000; Hayes, Barnes-Holmes & Roche, 2001; Hayes, 1994).

RFT begins with the phenomenon of stimulus equivalence. Stimulus equivalence was discovered while evaluating methods to teach reading comprehension (Sidman 1971). Sidman, working with a learning disabled student, directly trained two stimuli sets: (A) spoken words to (B) pictures then separately trained (A) spoken words to (C) printed words. After this match training, Sidman observed the individual reverse the directly-trained relations; (B) to (A), and (C) to (A). But of greater interest, this individual was able to relate (B) to (C)—pictures to printed words—a response not directly trained.

Stimulus equivalence was put into mathematical terms and its component properties identified as reflexivity, symmetry, and transitivity (Sidman & Tailby 1982). Reflexivity is defined as the ability to match a novel stimulus to an identical novel stimulus without training (See Figure 1.1). Symmetry is demonstrated when a sample and comparison reversal are demonstrated. Transitivity, or equivalence, is a relation requiring three stimuli and is composed of responses that require symmetry and reflexivity as well as the third derived relation (Sidman, 1994; Sidman & Tailby 1982).
See Figure 1.2 for an example of stimulus equivalence. The main excitement behind stimulus equivalence research was the idea that it might help define the difference between linguistic and non-linguistic functions of behavior (Devany, Hayes, & Nelson, 1986). In subsequent research, language-able individuals were able to demonstrate transitivity while non-language-able individuals did not readily learn this skill, if at all (Devany, Hayes & Nelson, 1986).

Figure 1.1 depicts the concept of a reflexive response a novel response is matched with an identical novel response.

Figure 1.2: depicts the trained and derived relations in Sidman’s stimulus equivalence.
Stimulus equivalence was, however, merely a behavioral finding—not an explanation for that finding. RFT explained stimulus equivalence as learned relational responding, arguing that multiple exemplar training of learned relations produces a generalized operant class that results in derived relational responding. In RFT, derived relational responding is a learned operant of relating events under arbitrary contextual control (Hayes, 1994). Once a “frame of coordination” is established, any event can be arbitrarily related to other events in an equivalence class. For example, once the sound “dog” is trained as an equivalent to a sufficient number of objects with four legs, a tail, and barks, a person will respond to novel but similar objects the same way.

If stimulus equivalence is a generalized operant, RFT argued, that same process of learning verbal relations through multiple exemplars should apply to relations other than just equivalence. Arbitrary relations of difference, size, opposition, time, sameness, among many others, should be trainable and should be linkable to verbal abilities.

A range of RFT research (Dymond & Barnes, 1995; Greenway, Dougher, & Wulfert, 1996; Roche & Barnes, 1997; Wulfert & Hayes, 1991) soon provided evidence that relational responding can develop through a history of multiple exemplar training with stimuli placed in a wide variety of arbitrarily applicable relations. Regardless of the specific relation, results could be defined by three properties of “relational frames:” mutual entailment, combinatorial entailment, and transformation of function. Mutual entailment is the generic form of symmetry: a derived bidirectional relation between and arbitrarily-trained relation. For example mutual entailment is shown when a specific relation from (A) to (B) leads to the derivation of a relation from (B) to (A). Combinatorial entailment is a derived relation based on a network of two or more relations. For example, if (A) is related to (B), and (B) is related to (C) then (A) and (C) and (C) and (A) must also share some relation. Unlike stimulus equivalence these combinatorial and
mutually entailed relations can be dynamic i.e., they can include “not,” “opposite,” “bigger/les than,” relations.

Transformation of stimulus function, the third defining property of relational frames, occurs when a stimulus in a relational network has psychological functions that change those of others in the network based on the derived relations between them and contextual cues indicating the relevant functions (Barnes & Keenan, 1993; Cahill, Barnes-Holmes, Barnes-Holmes, Rodriguez, Luciano & Smeets, 2007). For example, an individual who is chased by an angry dog may develop a fear response to the word “dog” which may extend to, say, “cachorro” when they later learn Portuguese. The transformation of functions through verbal relations has been shown to impact a variety of behavioral functions, including discriminative control, perspective taking, ordinal functions, eliciting reflexive reprocesses, and consequential functions including reinforcement and punishment (Augustson, Dougher, Markham, 2000; Carpenteir, Smeets & Barnes-Holmes, 2002; Geenway, Dougher & Wulfert, 1996; Wulfert, Hayes, 1988; Hayes, Brownstein, Devany, Kohlenberg & Shelby, 1987).

Such transfer helps explain how rule governed behavior occurs. Rule-governed behavior can be broadly defined as behavior controlled by verbal stimuli. In an RFT perspective, stimulus events are “verbal” when their functions occur because these events participate in relational frames. Thus verbal stimuli are stimuli that are effective for the listener because they participate in the relational framing behavior done by the listener. Unlike in Skinner’s analysis (1957), in RFT verbal stimuli are functionally defined by the history of the listener (for Skinner, the term was based on the history of the speaker not of the listener) and the behavior of the listener is verbal in precisely the same way the behavior of the speaker is verbal.

When rules are a part of a complete relational network, they can transform the stimulus functions of non-arbitrary environmental events that are part of the network
(Hayes, Barnes-Holmes, Roche, 2001). These changes affect either the antecedent or the consequence side of environmental contingencies. For example, a rule such as “break in your shoes to avoid blisters in the race” may alter the functions of the shoes prior to the race, because “blisters in the race” function as an aversive event even before the race is run via a transformation of stimulus functions. Similarly, it has been shown that the verbal description of the relation between athletic activity and its outcomes alters exercise levels and persistence through motivational operations (Jackson, Williams, & Hayes, 2016). In principle, the aversive effects of the sensory or perceptual consequences of athletic performance can be altered during competition and training via a transformation of stimulus functions established by how the individual frames those consequences verbally. A similar effect that has been empirically shown in the physical activity of people who avoid pain (e.g., Vowles et al., 2007).

RFT provides advantages in the degree of precision possible when analyzing verbal inputs to complex human behavior. When applied to the topic of this dissertation, it provides a preliminary behavioral account for temporal delays and a unit of analysis to explain how specific verbal statements come to exert control over responding (Carpentier, Smeets & Barnes-Holmes, 2002; Barnes & Keenan, 1993). RFT also conceptually helps explain the mixed results in attention strategies described above (Hayes, Barnes-Holmes & Roche, 2001). From an RFT perspective, both association and dissociation approaches can miss the challenges presented by multiple stimulus relations and the transformation of stimulus function that frequent sporting environments and related language.

Traditional sport approaches argue that associative strategies work by providing an individual with a statement related to their physical performance (e.g., “keep your eye on the ball”) Proponents argue these statements function by competing with other, performance distracting self-statements (e.g., I’m tired). From an RFT perspective, the
association approach could be helpful but could also present potential costs to performance under some circumstances. First, all rules narrow stimulus control to a degree and the narrowing caused by specification of a desired response class could lead to relatively ridged responses that do not change when contexts change. Take, for example, a runner who is following an association rule and is focused on footfall. When passed by a fellow athlete, it might be more useful for the runner to focus on race strategy—association strategies do not account for scenarios such as this.

Secondly, focusing on physiological performance is part of a larger verbal network and the other things in that network contains could affect the associative strategy. A verbal response cannot be readily isolated to a specific environmental context because of the arbitrary nature of language. This arbitrary quality allows for the impact of verbal rules to spread (Hayes & Barnes-Holmes & Roche, 2001; Jackson, 2007). If an association rule was functioning under the auspices of controlling, mitigating, or eliminating unwanted experiences it could establish a failure criterion that could easily undermine the impact of the rule. Athletes often engage in tasks that produce discomfort and fatigue. If the hidden goal of the associative strategy is alleviation of discomfort and fatigue, when these natural emotional consequences occur, it could undermine the plausibility of the rule itself. One goal of the present study is to evaluate the effect of such statements on performance.

Dissociative statements aim to suppress or control unwanted experiences by providing alternative verbal responses in which to engage. Whereas association responses specify what to focus on, dissociation responses specify what not to focus on (“anything but”). Unfortunately, relational framing itself suggests that specifying what not to focus on could produce a focus on these very events. This is an issue of multiple stimulus relations: logically an “is not” relation between two events may suggest they are not related, but psychologically “is not” is a powerful verbal relation. Paradoxical effects
are common in verbal interventions and are well documented within the domain of suppression and performance. These effects have been referred to as “ironic processing” (Wegner, Ansfield & Pilloff 1998; Wegner & Erber, 1992). The development of multiple stimulus relations research and transformation of function now offers a new level of precision in explaining these “ironic” findings. It also leads to new suggestions of interventions, as we shall see later.

A history of multiple exemplar training between arbitrary stimuli makes human beings uniquely able to derive relations of all kinds. Some of the relations possible include, same, different, and opposite. Mutual and combinatorial entailment between dissociative statements and distressing statements can then be related in a “not” relational frame. This can produce situations in which, while attempting to think of something other than the undesired statement, an individual engages in a self-defeating process. You have to notice what you are supposed to not notice in order to know if the rule is working. Take the simple rule “don’t think of a white bear.” In order to know you are following the rule you have to note whether a thought of a white bear has occurred—but this very process requires thinking of the white bear.

Given the theoretical and empirical concerns raised in other domains, it is interesting that elite athletes report employing both of these types of strategies during events, especially when under final and stressful especially during stressful parts of activity, including the final moments of the event (Silva & Applebaum 1989). Providing functional comparisons between these strategies throughout an experimental task designed to fatigue and physically stress athletes may provide insight into the impact of these processes on performance. The present study was designed to provide data in this regard.
Constructing an Alternative Approach: Psychological Flexibility

Psychological flexibility is a model based on Relational Frame Theory (RFT) and is used for understanding how rule-following behavior can lead to unhelpful repertoire-narrowing effects (Gardner & Moore, 2004; Gardner & Moore, 2007; Gross & Fox, 2009; Hasker, 2010; Hayes, Strosahl & Wilson, 1999; Jackson, 2007; Newsome & Alavosius, 2012). This psychological model attempts to understand and alter how people interact with their own language processes (Bond, Hayes, Barne-Holmes, 2006). Psychological flexibility is argued to consist of six primary components: defusion, acceptance, self as context, contact with the present moment, values, and committed action. Psychological inflexibility is the opposite: fusion, experiential avoidance, the conceptualized self, rigid attention to the past or future, unclear values, and inaction, impulsivity, or avoidance persistence. In what follows, I will briefly describe these six flexibility processes and relate them to athletic performance.

Defusion: A defining concept of psychological flexibility is defusion. In situations where fusion occurs, individuals respond to the content of their language as if those descriptions are literally occurring, increasing the behavior—regulating impact of verbal events (Hayes, Strosahl, & Wilson, 1999). Defusion is the use of function-altering cues and strategies to reduce the transformation of stimulus functions in such cases, thus changing the impact of verbal events on other behavioral processes. For example, phobic individuals may experience physiological sensations when the object or event of their fear is described (increased heart rate, shallow breathing, eye dilation, and shunting blood to the body’s extremities). These experiences occur even though the object and event are not present or occurring. A defusion practice, such as repeating the name of the feared object until it loses meaning, may reduce the impact of this description. Similarly, a runner experiencing physiological distress during a run may engage in verbal behavior that describes the context as “this is too difficult, I can’t finish
the race.” When this verbal behavior is seen as a literally description of an event, the runner may stop running and start to jog, walk, or even pull out of the race prematurely as a function of the description of the event and not as function of what they are physically capable of achieving. Singing the same thought, or saying it in the voice of an opposing coach, may alter its behavioral impact.

Acceptance: Acceptance, from the psychological flexibility model, occurs when an individual experiences automatic, and sometimes unwanted, emotions or sensations without attempting to control the form, frequency, or situational sensitivity of these experiences (Bond, Hayes, Barnes-Holmes, 2006). The psychological flexibility model contends it is not the content of emotions that become problematic to a quality life but rather problems arise when individuals interact with these events in an avoidant way (Bond, Hayes, Barnes-Holmes, 2006). An athlete who experiences pre-competition anxiety may avoid situations where competition occurs (e.g., signing up for events or engaging friendly, team-training competition). An athlete who experiences pre-competition anxiety and engages in acceptance responses would instead notice anxiety with a sense of dispassionate curiosity. For example, the athlete might be asked to give the emotion a color, size, shape or weight and then to consider if this object really needs to go away. Scores of studies have shown that such strategies increase task persistence (Levin, Hildebrant, Lillis, & Hayes, 2012). If these findings apply to athletic behavior, acceptance should help athletes compete and train with a team while experiencing anxiety and still be able to focus on the task at hand.

Contact with the Present Moment: Human beings are uniquely apt at problem solving and planning. While these behaviors are often beneficial, they can sometimes be maladaptive, especially when language patterns become fused with temporal and evaluative statements. Problem solving always requires for examination of the past and future (e.g., “How did I get here?” “Where am I going?”) but can overwhelm flexible
attention to the present environment, both external and internal. Working in coordination
with acceptance and defusion, contact with the present moment helps individuals
respond while in touch with current environmental demands rather than merely the “what
if” contexts reflective of rumination over past experiences and anxious anticipation of
future ones (Bond, Hayes, Barnes-Holmes, 2006). Contact with the present moment
occurs when individuals attend flexibly, fluidly, and voluntarily to the immediately—
relevant environmental performance demands as they are presently occurring (running
footfall, the presence of competitors, monitoring pace, changing dynamics of terrain,
etc.). Behavior that does not comport with present-moment awareness involves focusing
on other events—such as, when the training session will be finished, how long they have
left, or what they will do when their training is completed for the day—in a way that is
rigid and automatic.

Self-as-Context: The concept of self-as-context refers to the perspective skills
needed for an individual to report on their own behavior from a consistent perspective or
point of view. Skinner defined self-awareness as one’s ability to (1) report on the causes
of their behavior (2) in correspondence to their responding (Skinner, 1974). Skinner thus
distinguished between responding and responding to one’s own responding. Within an
RFT approach, perspective-taking relational frames are argued to permit responding to
one’s own responding from a consistent perspective or point of view (Hayes, 1984). RFT
research shows three key deictic relational frames are involved: I/YOU, HERE/THERE,
and NOW/THEN (Hayes, Luoma, Bond, Masuda & Lillis, 2005). When “I/HERE/NOW”
comes together, it yields a sense of self as an observer. Thus, while Skinner
distinguished between seeing, and seeing seeing (1974), RFT adds the importance of
seeing seeing from a consistent perspective or point of view. An individual, who can see
and recognize their own verbal descriptions of themselves as distinct from the
“I/HERE/NOW” perspective, may feel less threatened by negative statements about the
self. For example, a runner thinking “I’m a loser” might more readily recognize that statement merely as a thought that does not summarize themselves as a totality and may thus be better able to reorient toward task demands.

Values: Values are defined as chosen immediate qualities of ongoing patterns of action that are verbally established as reinforcers (Hayes et al., 1999). For example, an athlete may value “competing with integrity” during athletic events. Such a statement is differentiated from a goal in that a value is not a tangible outcome of action such as “winning the race” but is instead a quality of action. Values are known to increase task persistence in areas such as academic performance (e.g., Chase, Houmanfar, Hayes, Ward, Vilardaga, & Follette, 2013) and intense exercise (Jackson et al., 2016).

Committed Action: In clinical settings, committed action looks much like traditional behavioral approaches (Bond, Hayes, Barnes-Holmes, 2006). As part of psychological flexibility, committed action takes the roll of expanding an individual’s valued responses into larger and larger patterns of activity. Larger patterns can be built by obtainable, intermediary obtainable goals that comport with pre-established values. For example, an athlete who experiences race anxiety and has historically pulled out of a race early may now set the goal of finishing a race in alignment with their value of “competing with integrity.”

Proponents argue psychological flexibility is key to an individual’s ability to operate effectively in the current environmental context. It promotes behavior that aligns with the individual’s values rather than interpretations of events and personal experiences. Conversely, psychologically rigid behavior is defined as avoidance of and insensitivity to changes in behavioral contingencies relevant to one’s values.

The concept of psychological flexibility was initially applied in clinical settings (Hayes et al., 1999) but its breadth of application has increased over time. Longitudinal outcomes within these clinical settings have shown good long-term results (Ruiz, 2010).
Psychological flexibility interventions are used to address the ways in which individuals respond to their own private events such as painful memories, feelings, and emotions. In that sense, these interventions are contextual—they are designed to change the person’s relationship to private events, not the events themselves. Such a perspective takes a radically functional approach (Biglan, Hayes, & Pistorello 2008) in which increased contact with environmental contingencies and greater values-based action are encouraged by altering the person’s relationship to private events. For example, a social phobic who would typically avoid events, like a daughter’s dance recital, would be taught skills that allow the experience of fear to occur while attending the recital. This is different than trying to teach an individual to control or eliminate their fears before attending social events. Given the centrality of this issue it is unsurprising that applications of this model has broadened to public health, education, occupational safety, and environmentally relevant behaviors, with promising results (Biglan, Hayes & Pistorello, 2008; Bond & Flaxman, 2006; Gardner & Moore, 2007; Hayes, Strosahl & Wilson, 1999; Newsome & Alavosius, 2011; Newsome & Alavosius, 2012).

Component analyses of psychological flexibility interventions have been shown to improve pain tolerance and persistence under aversive stimulation in populations outside of athletics. Both pain tolerance and persistence can be identified as necessary components of mentally tough behavior. In a 2012 meta-analysis of psychologically flexible treatment components, Levin et al. identified 19 studies related to pain tolerance and/or perseverance. Outcomes from these investigations indicate psychological flexibility training improves perseverance and pain tolerance over focus, suppression, and distraction training. These effects were consistent in all 19 studies. Examples will be presented below.

The impact of acceptance versus control/focused strategies on pain tolerance was directly tested in a laboratory evaluation with typical college students (Hayes,
Researchers used a pre- and post-intervention cold pressor test to assess the effects of control/suppression strategies compared to acceptance-based (contextual) strategies. Cold pressors are used for their ability to produce pain by maintaining water temperature just above freezing. Participants submerge their hands in the near-freezing water and hold them there as long as possible while various physiological and psychological measures are recorded. Results indicate that acceptance-based strategies, used to teach individuals to feel emotions and sensations without avoidance or an attempt to comply with their self-statements, produced significantly longer duration than control strategies and a placebo condition. Additionally these acceptance approaches also influenced the participants self reports of believability regarding their experience of pain perception. In sum, acceptance protocols were more successful in increasing overall cold pressor duration, decreasing perceived severity of pain, and decreasing thought believability.

Comparisons have also been made between distraction and contextual approaches. For example, McMullen, Barnes-Holmes, Barnes-Holmes, Steward, Luciano, and Cochrane (2008) evaluated participant tolerance and persistence while engaging in a self-delivered shock task. Pre-task acceptance versus distraction exercises affected the willingness of participants to continue engaging in the task. Individuals persisted longer, perceived pain as less severe, and were more willing to administer shocks in acceptance/willingness conditions. People who received distraction exercises rated pain more severely and were less likely to select options to continue the task when doing so required an electric shock.

These findings, and others like them, indicate that acceptance, willingness, and contextually-based perspectives, in accordance with psychological flexibility, appear to present advantages over focus and distraction approaches in some contexts. Extending these findings to athletic populations is a goal of the present study.
Gordon Paul’s (1969) discussion of socially valuable treatment research should work to answer “what treatment, by whom, is most effective for this individual with, that specific problem under which set of circumstances and how does it come about? ” (p. 44). At present, research regarding the direct effects of associative, dissociative, and contextual approaches on performance have been investigated for their effectiveness to populations outside of athletics. Research within the athletic domain is lacking. Furthermore, evidence for the effects of association, dissociation, and contextual strategies have been collected in the literature, but they have yet to be compared in a study using tasks relevant to competitive sport. This study tested the effects of each approach, compared those findings, and tested the generalizability of the effects to other settings.

Conceptually applying the psychological flexibility model to sports performance is potentially relevant because numerous athletically-relevant behaviors occur under environmental and physiological conditions requiring frequent adaption to contingencies in order to maintain high levels of performance. Inflexible patterns of behavior in the immediate environment may distract from an athlete’s long-term goals. As a result, athletes who exhibit these inflexible behavior patterns may be likely to miss opportunities to engage in effective behavior relevant to long-term valued outcomes.

For better clarification, we will use the example of a runner using both inflexible and flexible verbal behavior. Suppose a runner generates the following statement during a performance task: “This is too hard; I am tired; I can’t do this.” If this statement is taken literally, a transformation of stimulus functions may decrease the athlete’s psychological flexibility. Instead of being simple events to observe, sensations will become events that are “too hard” and that need to be avoided or escaped because “I can’t do this.” Such repertoire-narrowing functions begin covertly, but the athlete may respond in overt ways
to change physiological sensations in ways that allow her to continue in a different manner (e.g., slowing down, walking, or even stopping her participation in the run).

An individual with greater psychological flexibility can recognize their automatic verbal interpretations of an event do not have to dictate the outcome of that event. A thought such as “This is too hard; I’m tired; I can’t do this” will be merely noted as a reaction rather than recognition of the qualities of a described event, reducing the transformation of functions. This process can be emphasized by changing the statement itself to reflect the more flexible approach: “I am having the thought that this is too hard, that I can’t do this.” The specifying statement “I am having the thought that” keeps the thought more purely descriptive. This descriptive nature may allow the athlete agility to respond to her description of the event in a way that fosters better athletic performance. This flexible perspective separates her verbal evaluations of a physiological occurrence from the direct qualities of those physiological events and her overt behavior in response to them. Such separation and specificity may allow her to take more precise action toward her performance goals such as continuing her current athletic behavior without altering it in an undesirable way, providing her with more strategic responses that fit the present demands of her run. These could include such things as persisting in a pace to see if the physiological reactions change, changing pace on hills, adjusting speed in order to finish strong, evaluating and adjusting performance to match a competitors, and so on.

Michael Phelps, the most decorated Olympic athlete to date, provides anecdotal evidence of the importance of language in training and competition by drawing the distinction between what one says about actions, and what one actually does. When asked about his performance and training approach, Phelps replied, “You can’t put a limit on anything; the more you dream the farther you get,” (2004) and “If you say you ‘can’t,’ you are restricting what you can do, or ever will do” (2009). It is this relationship
between the content of language and the overt action that is the heart of psychological flexibility research and that provides a possible link to mental toughness.

**Mental toughness.** Taking into consideration RFT and advancements in the science of complex human behavior, contextual sciences may now provide some insight on the phenomena of mental toughness and resiliency. Mental toughness and resiliency are not the repeated execution of a single behavior or trait but are, instead, better conceptualized as umbrella terms in which many responses (including relational responses) serve specified functions. Mental toughness and its conceptual counterparts appear to refer to psychological actions that achieve long-term goals (hardiness) while addressing immediate and pressing behavioral contingencies (grit) (Maddi, Matthews, Kelly, Villarreal, White, 2012). Mentally tough athletes act purposely, systematically, and constantly in the pursuit of desired outcomes. These outcomes motivate their performance and allow for the continued engagement in immediate, potentially aversive behaviors. It could be argued, then, mentally tough individuals are driven by their values, rather than their emotional or physiological experiences (Gardner & Moore, 2004).

From a psychological flexibility point of view, mental toughness and resiliency could be promoted by encouraging greater emotional and experiential willingness. The need for avoidance of difficult sensations and emotions narrows behavioral repertoires in the sense that only behaviors that immediately reduce or eliminate these sensations and emotions appear to be helpful. In contrast, methods that increase the willingness to experience difficult private events afford a much wider range of behavioral choices. In the previous example, the runner who recognized “I am having the thought that I am too tired” could include continuing with the actions that produce difficult sensations by saying “I am having the thought that I am too tired, and I’m willing to continue.” The impact of these approaches will be compared in the present study to the more traditional cognitive approach.
**CrossFit.** The present research study focuses on a training environment known as CrossFit. It is a good area to investigate mental toughness and the role of verbal behavior in sports for several reasons. The environmental dynamics that make CrossFit and the athletes who participate in the sport conducive for studying mental toughness and resiliency are numerous.

CrossFit is a fitness model that relies on exposing athletes to high-intensity, frequently varied, and brief-duration exercise. This training builds an individual’s fitness across 10 recognized physical skill competencies: cardiovascular/respiratory endurance, stamina, strength, flexibility, power, coordination, agility, balance, and accuracy (Glassman, 2002; Glassman, 2007). Distinctively, CrossFit is also fundamentally supported by a social context of sport, defining itself as the “sport of fitness.” Subsequently, CrossFit aims to treat all participants as athletes. While workouts are scaled varying on an individual’s abilities, the “athlete” identification approach is taken indiscriminately of age, experience, entering skill level, or physical ability. All participants are seen as athletes.

As “a sport of fitness,” CrossFit creators established a hierarchy of emphasis in training procedures. This hierarchy endorses the following components for the athletes to improve upon their individual fitness: diet, metabolic conditioning, gymnastics training, weightlifting and throwing, and competition. The components of this fitness model create a complex environment that exists both in and outside of a training facility. As such, CrossFit is commonly referred to as a lifestyle.

Case studies, reports, and increases in the number of certified affiliate gyms and instructors depict the growing and vast CrossFit population demographics. This population ranges from the historically non-athlete to the top performers in other sporting disciplines. Vast variation in demographics produces an equally large spectrum of entering knowledge, skills, and abilities among the individual athletes. Furthermore, top
competitors within CrossFit vary from individuals highly experienced with athletic competition to those who have a limited history within competitive sports. The variability in the CrossFit population produces as many differing psychological approaches to the sport as it has athletes.

Since an individual’s athletic behavior is a function of different learning histories that are influenced by the present environment, multiple variables influence and develop the “toughness” CrossFit athletes display. This learning environment offers an ideal context to observe the development of psychological approaches to situations identified as mentally challenging.

Fatigue. As fatigue is relevant to the measurement systems presented in this dissertation, a brief discussion of the phenomena will be discussed. In his 1944 book, “War As I Knew It,” General George Patton encapsulates the well-documented effects of fatigue on performance, “Fatigue makes cowards of us all. Men in condition do not tire.” As it is technically defined, fatigue is degradation in physical performance as a result of increased real or perceived task difficulty (Abd-Elfattah, Abdelazeim & Elshennawy, 2015). Said in another way, fatigue is a failure to apply required or expected force of voluntary muscle contraction and/or tension as a result of extended use (Edwards, 1981).

Fatigue is known to impact all dimensions of performance form, technique, strength, speed, heart rate, oxygen absorption, reaction time, and many, many others (Abd-Elfattah, Abdelazeim & Elshennawy, 2015; Edwards, 1981; Myers, Guskiewicz, Schneider & Prentice, 1999; Carpenter, Blasier, Gregory & Pellizzon, 1998). Athletes in all sporting disciplines strategically train in ways to minimize the effects of fatigue. In a very real sense it can be argued that athletes train to come in first by preparing to be the last to succumb to fatigue. In other words, the one who tires first is the first to lose.

Different types of athletes prepare for fatigue in different ways. Endurance athletes prepare in ways that allow individuals to maintain performance for as long as
possible (Hakkinen & Myllyla, 1990). As fatigue will always be present toward the end of endurance events, those least affected are more likely to win. For that reason, endurance athletes adopt a training protocol that tends to emphasize pacing and in-training exposure to the aversive effects of fatigue. Conversely, athletes who emphasize power or speed train in such a way that allows them to identify when they are least affected by fatigue. These training and competition distinctions may affect the ways CrossFit athletes approach task persistence.

**Purpose of Investigation**

Mental toughness is a key concept in athletic training and competition. Much of the work investigating psychological toughness has remained descriptive or correlational in nature rather than experimental. Functional investigations of influential factors on athletic toughness are needed in order to support the development of practical, reliable training programs.

The present research systematically evaluated the effects of verbal statements on the duration of athletic behaviors. It focused on three types of statements: a focus on sensation and form (Association Cues), distraction from sensation (Dissociation Cues), or willingness to experience sensation (Contextual Cues). These variations highlighted the distinction between sports psychology research drawn from a cognitive model and those derived from a psychological flexibility model. Association and dissociation approaches instruct athletes to control their attending to a specific goal or target to alter the impact of immediate-acting contingences. Conversely, contextual approaches promote using verbal behavior to produce more flexible responding even while experiencing aversive stimulation that would normally result in termination of responding.
Method

Design Analysis Overview

This study examined three psychological approaches, informed by performance and sports psychology literature. See Table 2.1 below for an abbreviated description and labeling system used to identify these three psychological approaches. These approaches were investigated across two experiments and utilized two separate experimental designs. These designs were used to accomplish two primary research goals 1\textsuperscript{st} to investigate athletic performance and 2\textsuperscript{nd} to evaluate the utility of two prominent methodological designs in a high performance population.

<table>
<thead>
<tr>
<th>Psychological approach</th>
<th>Reference label</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Association: Focus on task execution</td>
<td>90\textdegree</td>
<td>Independent variable condition prompting athletes to report how focused they are on the static hold task.</td>
</tr>
<tr>
<td>Contextual: Experiential acceptance</td>
<td>Willingness</td>
<td>Independent variable condition prompting athletes to report how willing to continue they are on the static hold task.</td>
</tr>
<tr>
<td>Dissociation: Distraction from task</td>
<td>Distraction</td>
<td>Independent variable condition prompting athletes to report how successfully they are distracting themselves from the static hold.</td>
</tr>
</tbody>
</table>

Table 2.1: Provides a key for the coding system used for the independent variable conditions along with a brief description of their meaning further elaborated in the introduction.

The first experiment, Experiment 1, utilized a within subject, alternating treatments (ATD) time series design. This specific design has been used successfully within athletic settings (Jackson, 2007) but has of yet been applied to highly competitive athletes. The advantage of within subject designs is that they allow visual inspection of changes in raw data as a function of an individual’s response to interventions. Uniquely, an ATD allows
for each participant to contact every treatment variable (Hayes, Barlow, & Nelson-Gray, 1999). In Experiment 1 each athlete systematically encountered each intervention condition multiple times, spread evenly over the experimental sessions.

Experiment 2 utilized a between group design. Group designs allow for analyses at the level of the population and avoid problems of multiple treatment interference when comparing multiple conditions. Because of the high degree of sophistication in statistical analysis used in-group designs, these methodologies can detect smaller effects than can be seen through visual analysis. This ability is of particular relevance to athletics in that small effects may mean the difference between winning, and losing, or between new personal records and stagnate performance.

Taken together these two designs worked in coordination to identify potentially subtle (but athletically significant) effects, identify variability in performance patterns, and control for carry over confounds. Using these two designs gave the researchers a unique lens by which high performance can be analyzed.

General Procedures

Participants

The participants for this study were recruited using in class presentations, fliers, and word of mouth from participants who recommending the study. Participants came from CrossFit affiliate training facilities in the Western United States and met the following criteria:

Inclusion Criterion. Individuals interested in the study were active participants in CrossFit activities and were actively competitive in sporting events. Athletes were screened by self-reports for participation in events, their performance outcomes, and description of their training programming. Participants were also screened for their availability to meet for data collection over a two-month period for Experiment 1 and a
two-week period for Experiment 2. Only individuals, who indicated valuing mental toughness, as it applied to their competition activities, were included.

**Exclusion Criterion.** Individuals who did not meet the above criterion were not allowed to participate in the study. All participants who were scheduled for initial meetings did so via a phone call. During this call individuals were pre-screened regarding their competitive history and for their availability to meet. No individual scheduled for either experiment failed to meet the above criteria. Individuals reporting a history with shoulder and/or back injuries were also excluded. Three potential participants who reported shoulder and back injuries did not participate. Individuals who used analgesics (for non-injury means, i.e., headaches, sore muscles) or alcohol within four hours of a session time were asked to reschedule as these substances affect pain sensation. Two participants in Experiment 1 and one participant in Experiment 2 rescheduled meeting times due to illness. These rescheduled times happened less than a week apart from their previous meeting time. Minors under the age of 18 and anyone from whom informed consent could not be collected did not participate. All participants were able to provide informed consent for the study.

**Demographic Data.** Demographic data was collected from all participants. Individuals provided information on their age, gender, profession, athletic history, injury history, and current perceived levels of fitness.

**Setting**

Experiment 1 and Experiment 2 were conducted on the University of Nevada, Reno campus (UNR). Data was collected in the psychology department located in the Mack Social Sciences (MSS) building. Experimental sessions were conducted in a small room designed for data collection only. This room contained the investigation equipment and was not designed for athletic training. The space also allowed participants to be
viewed through a one-way screen minimizing researcher and participant interaction. Isolation from the main training area helped insure the anonymity of the participants.

Participants met with members of the research team at regular intervals, across a two-week to two-month time period, dependent on Experiment 1 or 2, to collect session data. The research team for both experiments was composed of the primary investigator and two undergraduate psychology students. These individuals were selected for their high performance in advanced research methodology courses and for their interest and experience with behavior analysis and sports. All observations were calibrated using video recording, and all sessions were video recorded. Video allowed for accurate duration measures for the isometric hold.

Procedures-

Isometric hold test. After orientation to the equipment for the isometric hold test, and upon completing pre-session surveys, participants were equipped with the pulseoximeter placed on their non-dominant hand, and were instructed to engage in the isometric hold for as long as possible across a total of four rounds per session. They did this by placing their dominant hand through the ring pictured below at a straight 90-degree angle between their extended dominant arm (no bend at the elbow) and their body. See Image 2.1 below of experimental set up. Between these rounds they were given a 60-second rest.
Image 2.1 Experimental set up. Participants placed their arm through the ring with their elbow straight so that from their shoulder to wrist was at a 90-degree angle to their body.

The isometric hold required participants to hold a weight between 1.5% and 2% of their body weight at ninety degrees from their body for as long as possible. The participants were also required to stand, insert their arm through a ring six inches in diameter attached to an adjustable tripod. This set up ensured each participant held the weight with a fully extended arm at 90 degrees from their body.

The participants were asked to place their dominant arm inside the ring, and keep their arm as still as possible. Round timings began when the participant grasped the weight from the table and said the word “start”. The research team member would then begin the PowerPoint slideshow that prompted the athlete through each isometric
hold round of the session. Once the athlete rested their arm on any side of the ring for longer than 3 seconds, or vocally requested the round end, or by dropping the weight, the duration was documented, the round was completed, and the 60-second rest period began. Researchers would have stopped athletes if their heart rate reached the individual's predicted max heart rate (max heart Rate= 220- age) no participant in Experiment 1 reached this criterion. One participant in Experiment 2 met this max heart rate criterion. For this participant the research team stopped the round, began the 60-second rest interval in which time the participants heart rate recovered below the maximum rate and the session continued.

It was also explained to the participant that the study was evaluating mental toughness and performance. They were told that they would not be able to see a clock and the researchers would not prompt them to continue, or answer any questions asked during the task. Participants were told they could stop by telling the researcher they desired to stop, or by dropping the weight. They were also told that the round would be automatically terminated if the participant’s forearm rested on the boundary of the ring, or if the participant’s heart rate reached his/her maximum rate. Reaching any of these failure criteria triggered a 60-second rest period, at which point a new round commenced until all four rounds were completed. Participants were informed of their performance at the end of the study during the debriefing meeting.

The experimental conditions examined in this study were the three variations of instructions and prompting questions delivered throughout four timed rounds of an isometric-hold procedure. Appendix 2.1 through 2.4 provides the exact wording of the intervention instructions provided to the participants. Appendix 2.1 provides the exact wording of the baseline instructions provided to the participants. During intervention sessions, participants received instructions about how additional data were to be collected. The instructions describe the rounds, the static hold task they would engage in,
and how to respond to the audio recorded prompt questions (described in detail in the following paragraph). Participants then received cue cards via PowerPoint providing them with information regarding their focus task for that session. Cue cards prompted the participant to either “Focus on holding your arm at 90 degrees” for association, “Focus on how willing you are to continue” for contextual cues, or to “Focus on something else” for dissociation.

On an average of every 30 seconds (variable time VT schedule) a prerecorded audio prompt would ask the participants to rank on a scale of 1-5 the following per corresponding session condition:

- “Are you holding your arm at 90 degrees”?
- “Are you willing to continue”?
- “Are you thinking of something else”?

The VT schedule was used so athletes did not receive time-based feedback on their performance via the questions. These questions were asked to help insure that the initial cue was utilized throughout the session. Exploratory analysis was also collected using these answers to evaluate verbal behavior patterns and performance.

**Experimental Conditions.** Baseline condition (BL): During the baseline sessions, participants engaged in the isometric hold task. Task instructions, and a blank cue card were provided to the participants and no questions were asked via audio recording (See Appendix 2.1). During baseline, participants engaged in static hold procedures across four consecutive rounds with a 60-second rest interval between rounds. Data collectors did not verbally interact with the participant during session’s timed rounds. They observed the participant behind a one-way screen that allowed them to operate a semi-automated PowerPoint slideshow (for example of the PowerPoint’s used in this study see appendix 2.6) used that signaled and automatically controlled the 60-second rest intervals. Slides prompted participants to begin the next isometric hold round. At the end
of each session participants completed the Sports and Competition Monitor (Appendix 2.5).

During the intervention trials participants engaged in the isometric procedure across four consecutive rounds within the same condition, with a 60-second rest interval between rounds. Research team members did not verbally interact with participants during static hold sessions. The team members observed the participant behind a one-way screen, to record verbal behavior, and operate a semi-automated PowerPoint slideshow that signaled and automatically controlled the 60-second rest interval between rounds (see appendix 2.6 for example). The intervention PowerPoints were identical to the ones used in baseline phases except that each intervention PowerPoint was linked to an audio recording for cue questions, and also provide the participant with their focus statement during round timings.

$90^\circ$ Reports ($90^\circ$): This condition provided pre-session instructions and a cue card stating the participant’s task: “focus on holding your arm at $90^\circ$” (See Appendix 2.2). An audio recording asked participants to report on their performance: “Is your arm at $90^\circ$?” using a 1-5 scale. As the instructions indicated a response of “1” noted absolute focus on their arm; a response of “5” indicates no focus on their arm angle.

Willingness Reports (Willingness): This condition provided instructions on the isometric hold. Participants received a cue card stating their task was to: “focus on how willing you are to continue” (See Appendix 2.3). An audio recording asked participants to articulate via a Likert scale “Are you willing to continue?” As the instructions articulated, a response of “1” indicated they were fully willing to continue; a response of “5” indicated they were not willing to hold the weight any longer.

Distract Reports (Distraction): This condition provided instructions on the isometric hold. The participants also received a cue card articulating their task: “think of something else” (See Appendix 2.4). These sessions asked participants, via an audio recording, to
report, “Are you thinking of something else?” using a 1-5 scale. A response of “1” noted an absolute distraction from the task; a response of “5” indicated complete concentration on the static hold.

**Dependent Measures.** The primary dependent measure for this investigation was overall duration data, and duration fall off across the 4 rounds. Likert reporting scores were also tracked within and across sessions. Participant responses both within sessions, and on questionnaires were evaluated.

**Questionnaires.** Questionnaires were used throughout the study to further evaluate the athletes’ experiences and to assess specific questionnaire’s predictive validity regarding performance and sensitivity to the experimental manipulations. Copies of all questionnaires can be found in Appendices 2.5, 2.7, 2.8, 2.9, 2.10, 2.11. Questionnaires were used before, during, and at the conclusion of both experiments. Post-session questionnaires were also provided to the participants at the end of each isometric hold session. These session specific questionnaires asked about the participants’ experience in training and or competition events that might have impacted their performance in session. Each questionnaire used in this study is described in the Instruments section below.

**Instruments and Apparatuses**

1. **Acceptance and Action Questionnaire (AAQ-II)** – The AAQ-II questionnaire is the most frequently used measure of psychological flexibility (Bond, Hayes, Bear, Carpenter, Guenole, Orcutt & Walz & Zettle, 2011). It was used in this study as a pre and post evaluation tool. The AAQ-II works to assess the extent to which an individual’s rules function to control their overt behavior. The AAQ-II has shown empirical evidence for its validity across multiple domains, including but not limited to: depression, anxiety, job satisfaction, and job performance (Bond, Hayes, Bear, Carpenter, Guenole, Orcutt,
Walz & Zettle, 2011). In this study the AAQ-II had a Chronbach’s alpha of .818 See appendix 2.7.

2. Sport and Competition Questionnaire – The purpose of this questionnaire, designed by the researchers, was to collect information on each individual’s demographic background and athletic history relevant to the study. Additionally, this questionnaire was used to collect reports on the athlete’s self-descriptions of their athletic aptitude, perceived understanding of successful competition approaches, value of the mental aspects of competition, and self-generated rules towards mental toughness. This questionnaire was used as an exploratory tool to help the researchers understand and identify potential relationships between how participants describe their behavior and how they actually perform. This questionnaire was conducted at the beginning and closing of the study. The closing version differed from the initial version by removing demographic questions and adding questions regarding the social validity of study protocols and interventions. See Appendix 2.8 for the initial survey in Experiment 1, Appendix 2.9 for the initial survey in Experiment 2, Appendix 2.10 for the post survey in Experiment 2, and appendix 2.11 for the post survey for Experiment 2.

3. Sport and competition monitor. This questionnaire was also developed by the researchers and was collected at the conclusion of every session. This questionnaire collected information from participants regarding events relevant to training, and/or competition that may have occurred between sessions. It was also designed to probe self-generated rules regarding discomfort and corresponding tolerance during the static hold. The questions asked participants about their perceived performance. The repeated implementation of this questionnaire was used to assess how verbal behavior might have changed throughout the study, and whether this has an impact on performance outcomes. Learning how athletes generate and follow rules while engaging in specific
tasks may have critical implications for a better understanding of performance under aversive stimulation. See Appendix 2.5.

4. **Pulse oximeter**: Model number CM50SD+ by Contec and available for purchases at http://www.contecmed.com/, was used to track athletes’ heart rate over session rounds. In Experiment 1, it was used only for safety reasons providing a round termination point if athletes reached their maximum heart rate. In Experiment 2, heart and oxygen rates were recorded.

5. **Timer**: A CDN TM 30 Direct Entry 2-Alarm Timer available for purchase at http://www.amazon.com/CDN-TM30-Direct-Entry-2-Alarm/dp/B004S0SO9M/ref=sr_1_50?ie=UTF8&qid=1457993772&sr=8-50&keywords=timer+digital, was used to track the duration of each isometric hold round. In both experiments time was recorded to the nearest second. Upon completion or each round the timer was stopped, and duration was recorded on the data sheet. The PowerPoint slide show was calibrated such that a 60 second rest interval was controlled by the automated nature of the slides and not the timer. All sessions were video recorded to insure accuracy of duration.

6. **In session verbal behavior**: In session likard scaling verbal behavior was recorded by the research team member behind the session viewing screen. Responses 1-5 were written down on the data sheet used for duration measures. All sessions were recorded with audio to insure accuracy of data collection.

**Data Collection and Integrity.** Sessions were conducted in a room with a one-way screen such that minimized contact between research staff and participants. Research assistants noted the start and stop times for each round of every session. All sessions were videotaped and the lead researcher reviewed tapes to ensure that start and stop times, and verbal statements were recorded accurately and that rest intervals were of the correct length. To insure that instructions were consistent between and
within participants, a PowerPoint slide show was used to prompt athletes (See appendix 2.6 for an example).

Inter-observer agreement (IOA) between research assistants and the lead researcher was calculated for 30% of all sessions for both Experiment 1 and 2. Variables assessed for agreement were the duration of static hold sessions and recorded verbal statements during round timings. If IOA rates fell below 80% calculated by the formula number of intervals agreed divide by the number of intervals agreed plus the number of intervals disagreed all multiplied by 100 researcher team members would have been retrained to 100% agreement criterion, but this trigger point was not reached in either of the Experiments.

**Experiment 1 – Within Subject Alternating Treatments Design**

**Alternating Treatments Design.** Experiment 1 utilized a within-subject time-series design (Alternating Treatments Design). Within subjects designs generally rely upon visual inspection of data. The advantage of such designs is in the ability to track a single individual over time using raw data, and descriptive statistics to visually display behavior change and or improvement. In athletics this can provide a unique opportunity to see how ones behavior changes over time and track individuals improvement. (Hayes, Barlow et al., 1999).

The ATD was used to systematically evaluate the effects of associative (90 degree), dissociative (Distraction), and contextual (Willingness) cueing statements on performance post baseline assessment (BL) on an isometric hold task for an individual participant. All participants in this experiment were exposed to all three statements. A total of six participants evenly divided by gender experienced all three conditions, in a semi-random counterbalanced fashion (See Table 2.2, Below).
Table 2.2: Depicts the counter balanced conditions for participants, as well as their gender and ages. 90° represents arm placement conditions, WR represents Willingness conditions, DR represents Distraction conditions.

After an initial baseline condition, conditions were introduced to participants in an alternating fashion. All participants in the ATD were exposed to the three conditions. Each session introduced a different condition than the session preceding it. Nine sessions in total were conducted for each participant. Rapidly switching of conditions was done to quickly isolate the most effective independent variables, and to minimize the risk of maturation effects (Cooper, Herron & Heward, 2007; Hayes, Barlow et al., 1999).

Participants

The participants for this Experiment 1 were recruited following the procedures outlined above. A total of 3 male and 3 female participants who actively participated in CrossFit activities and who competed in sporting events with no history of back and shoulder injuries participated for a total of nine experimental sessions. These participants were also able to meet for data collection over a two-month period of time.
**Demographic Data.** Demographic data was collected from all participants. Individuals provided information on their age, gender, profession, athletic history, injury history, and current perceived levels of fitness.

**Data Collection and Integrity**

Sessions were conducted in a room with a one-way screen such that minimized contact between research staff and participants. Research assistants noted the start and stop times for each round of every session, All sessions were videotaped and the lead researcher reviewed tapes to ensure that start and stop times, and verbal statements were recorded accurately and that rest intervals were of the correct length. To insure that instructions were consistent between and within participants, a PowerPoint slide show was used to prompt athletes (See appendix 2.6 for an example).

Inter-observer agreement (IOA) between research assistants and the lead researcher was calculated for 30% of all number of intervals agreed divide by the number of intervals agreed plus the number of intervals disagreed all multiplied by 100. The research team was trained scoring videos of model participants to 100% agreement. In vivo data collection agreement criterion was held at 80% if agreement rates fell below 80% research members would be retrained to 100% criterion. 80% was selected in that research assistants were collecting time data to tenths of a second. Variables assessed for agreement were the duration of static hold sessions (percentage agreement equaled 83.33 %), and recorded verbal statements during round timings (actual percentage of agreement equaled 100%).

**Assessments.** All 6 participants completed a full battery of self-report data pre and post study. This full battery was administered at session 1st and 9th session of Experiment 1. The packet included The AAQ-II, the Sport and competition questionnaire, and sports and competition monitor (See appendices 2.5, 2.7, 2.8 & 2.9). Upon completion of each session the Sport and Competition Monitor (appendix 2.5).
Instructions for the beginning of the sessions prompted to answer questions regarding their level of nervousness and desire to delay the start of the session prior to the isometric hold (Appendix 2.1-24). Upon completion of the isometric task the athletes again answered questions regarding their perceived pain (see Appendix 2.5). Athletes were then prompted to answer open-ended questions that asked about their perceived performance, what if anything had extraneously influenced their performance, how they perceived their performance, and how they could improve in the next session. (see Appendix 2.5).

**Results: Experiment 1**

Results of the Sport and Competition Questionnaire show that all participants reported participating in competitive sporting events within the last year, and all reported a long and diverse history, outside of CrossFit (i.e., college football, ski team, cross county, wrestling etc…). All 6 athletes had participated in at least two different types of competitive athletic disciplines before participating in CrossFit. Each participant reported varying average frequency of training sessions each week, and reported that fluctuations in the frequencies of training depended on competition seasons, and rest/recovery day cycles. Frequency of training sessions resulted in a mean of 5 times per week and a range of 5-6 times each week. All participants reported valuing mental toughness as an important factor in their performance. The AAQ-II scores for the participants in this study were consistently low at both pre to post study with an average score of 14.16 and a range of 7-20. Values did not change significantly from pre to post. Table 2.3 below depicts values for each participant.
Table 2.3 represents demographic data for participants. The frequency of training days did not change as a function of the study. Nor did the participants value of Mental of toughness, a scale of 1-4, 4 being the highest value. Participants scores on the AAQ-II were the most variable.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Age</th>
<th>Pre-Training Frequency</th>
<th>Post Training Frequency</th>
<th>Pre Value of Mental Toughness</th>
<th>Post Value of Mental</th>
<th>Pre AAQ-II</th>
<th>Post AAQ-II</th>
</tr>
</thead>
<tbody>
<tr>
<td>FP1.1</td>
<td>22</td>
<td>6 days</td>
<td>6 days</td>
<td>4</td>
<td>4</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>MP1.2</td>
<td>45</td>
<td>7 days</td>
<td>7 days</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>MP1.3</td>
<td>64</td>
<td>5 days</td>
<td>5 days</td>
<td>4</td>
<td>4</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>MP1.4</td>
<td>31</td>
<td>5 days</td>
<td>5 days</td>
<td>3</td>
<td>4</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>FP.15</td>
<td>33</td>
<td>5 days</td>
<td>5 days</td>
<td>4</td>
<td>4</td>
<td>13</td>
<td>9</td>
</tr>
<tr>
<td>FP1.6</td>
<td>20</td>
<td>2 days</td>
<td>5 days</td>
<td>3</td>
<td>3</td>
<td>17</td>
<td>11</td>
</tr>
</tbody>
</table>
Sports and Competition Monitor data indicate that participants remained fairly consistent, if participants changed their score they changed only a point across a 5 delay, 10 anxiety, and 8 pain point scale, in their reports of perceived anxiety, desire to delay the session, and pain across the three conditions (See Table 2.4). Open-ended questions revealed that without any performance feedback athletes were unable to identify accurately if their performance was better or worse than previous sessions. No formal coding of answers were undertaken.
<table>
<thead>
<tr>
<th>Participants</th>
<th>90 degree</th>
<th>Willingness</th>
<th>Distraction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Anxiety</td>
<td>Delay</td>
<td>Pain</td>
</tr>
<tr>
<td>FP1.1</td>
<td>5.5</td>
<td>No Delay</td>
<td>5.5</td>
</tr>
<tr>
<td>MP1.2</td>
<td>6.33</td>
<td>No Delay</td>
<td>7.66</td>
</tr>
<tr>
<td>MP1.3</td>
<td>2.33</td>
<td>1 min</td>
<td>3</td>
</tr>
<tr>
<td>MP1.4</td>
<td>2</td>
<td>No Delay</td>
<td>4</td>
</tr>
<tr>
<td>FP1.5</td>
<td>1</td>
<td>No Delay</td>
<td>1.66</td>
</tr>
<tr>
<td>FP1.6</td>
<td>2.66</td>
<td>No Delay</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 2.4 Depicts the average Anxiety, Desire to delay or wait to start the isometric hold task, and participants perceived pain. Consistently participants would rather start the task immediately than wait any length of time. Anxiety and perceived pain differs across participants but is fairly consistent within participants. Anxiety was ranked on a 1-10 scale with 1 being the lowest and 10 the high. Pain was ranked on a 1-8 scale 1 as the low and 8 as the high.
Isometric hold test. Data from the isometric hold tests were collected and analyzed across two primary domains of analysis; total duration and fatigue fall off. These data and the subsequent patterns are displayed and described participant by participant below.

Total duration data showed no consistent difference or patterns between conditions. At this level of visual analysis participants’ data show high levels of variability and little to no distinction among conditions. Figures 2.1 – 2.6 show total time data for all 6 participants. Times varied greatly across sessions and times for conditions overlapped in all cases.

Figure 2.1: depicts data for participant FP1.1. Participant FP1.1 shows a decrease in session 2 as a result of feeling ill. This participant had rescheduled this session upon feeling better and initial timing shows comparable duration to other sessions, however fall off data for this session was significant. All other session data are consistent with other participants in which variability makes determine a functional relation difficult to detect.
Figure 2.2: Participant MP1.2 shows the most variable data pattern when viewed at total time. This participant also had the longest durations across all 6 participants. No distinctions could be made across the 9 timings of what intervention would be most advantageous using this type of analysis.
Figure 2.3: Participant MP1.3 shows improvement over baseline with all three independent variable conditions. However, distinction within independent variable conditions cannot be determined.

Figure 2.4: Participant MP1.4 shows no distinction across IV conditions and baseline session performance is better than all other sessions.
Figure 2.5: Participant FP1.5 shows improvement over baseline with all three independent variable conditions. However, distinction within independent variable conditions cannot be determined.
Figure 2.6: Participant FP1.6 shows improvement over baseline with all three independent variable conditions. However, distinction within independent variable conditions cannot be determined.

*Fatigue fall off:* Fatigue fall off data were evaluated to identify two potential sources of variation. Data were graphed in such a way as to identify if fatigue trends across the four timed rounds. Data show constancy in fatigue patterns within participants and across sessions. Visual inspection suggests that the shape of the fatigue trends for each participant is unique to their individual performance, but the pattern did not change as a result of intervention conditions. Round 1 was consistently the longest round, with each round progressively decreasing.

Data were also visually inspected to evaluate potential changes in slope across rounds and between conditions. In other words, while overall shape did not change, the graphic convention used here was used to investigate whether the slope between timings was distinctive based on intervention condition. Visual inspection of data indicates that if effects are occurring they are too subtle to be detected through visual analysis. See figures 2.7-2.12 for each participant's fatigue data.
Figure 2.7: Participant FP1.1 data shows a sharp decrease in time from the initial round of a session to the subsequent timings, additionally the participant tends to show recovery after the second round. Visual inspection alone cannot determine a difference in fatigue slopes across round times. Session 2 for this participant shows the effects of illness on fatigue.
Figure 2.8: Participant MP1.2 Data shows a sharp decrease in time from the initial round of a session with a sharp recovery on the fourth round. This participant also showed the most extreme variability in round timings, and reported the most extreme amount of pain perceived out of all the other participants. Visual inspection alone cannot determine a difference in fatigue slopes across round times.
Figure 2.9: Fatigue fall off data from Participant MP1.3 are shown in this figure. Data produced a fairly predictable trend.
Figure 2.10: Fatigue fall off data from participant MP1.4 are shown in this figure. Data produced a fairly predictable shape of fatigue however variability across session round duration is also seen.

Figure 2.11: Fatigue fall off data from participant FP1.5 is shown in this figure. Data produce a fairly predictable shape with possible study fatigue seen in sessions 7, 8, and 9.
Figure 2.12: Fatigue fall of data for participant FP1.6 are shown here. Fatigue patterns remain fairly consistent while the slope of fatigue appears to change however visual inspection may not be the best means of identifying this potential change.

**Summary.** Data from Experiment 1 were graphed for visual inspection to identify potential changes in duration as a function of intervention conditions. At the more molar level, total time suggested that for three of the participants any of three interventions improved performance over baseline. For the other participants the high level of variability did not allow for any statement to be made.

When data on fatigue fall off were evaluated as a function of experimental condition, no consistent pattern was seen. Background variability was notable and visual inspection did not suggest effects of one experimental condition over another. However there does seem to be a difference between baseline and the experimental conditions when taken as a whole.

Within subjects designs require fairly robust and distinctive differences relative to background variability within subject in order to detect differences. In the context of high
session to session variability, an ATD is not well suited to detect changes. ATD designs can account for background trends, treatment carryover and multiple treatment interaction effects, but only when additional extraneous sources of variability are small enough, and experimental effects are large enough, as to show separation in data trends. That did not happen in the present study. It appeared that the variability seen in this study would only allow a very large effect from experimental conditions to be detected in an ATD. An ATD is especially difficult when comparing multiple instructional conditions within subject, because instructions cannot be fully withdrawn (Hayes, 1994).

Between subject designs can identify small but significant changes that may not be revealed within subject via visual analysis. Experiment 2 was planned originally because of that issue, but in the original design of Experiment 2, the condition that Experiment 1 suggested was the best would have been compared to a wait list. Because all conditions appeared to be superior to baseline but equivalent in Experiment 1, instead all three were compared in Experiment 2. No wait list was included since there was some evidence that these conditions were superior to baseline, both from previous research and from Experiment 1.

**Experiment 2 – Between Subjects Pre/Post comparisons**

**Pre/Post Group Design Comparison.** Experiment 2 was a systematic replication of Experiment 1. The participants for this study met the same requirements of those in Experiment 1, and were recruited by identical means. There are, however, several notable differences in this experiment.

Experiment 2 utilized a group pre/post group design. All three experimental conditions were examined in this study, but each participant was only exposed to one of the three conditions. Pre/post group designs also require a larger N-size in order to model between subject sources of variability, and to determine statistical significance.
The N selected for this study was 45, 15 in each arm based on a power analysis which is discussed below.

Participants in Experiment 2 were exposed to one baseline session in which informed consent was collected, initial surveys were administered, and experimental baseline session instructions were provided. The baseline isometric hold data was collected in the same manner as Experiment 1, participants held a light weight at 90 degrees from their body for as long as possible for four rounds with a 60-second rest in between rounds. Participants for study two concluded the study with a single, second session in which independent variable instructions were provided, experimental session data was collected, closing surveys were administered and participants were debriefed. The isometric hold protocol during the experimental data session was collected like that of Experiment 1, participants held a light weight at 90 degrees from their body for as long as possible four rounds with a 60 second rest in-between rounds. Like Experiment 1 participants were prompted to give Likard scale responses to questions directly related to their cuing statement.

This second study was employed to further investigate the research question posed in Experiment 1. The ability to use inferential statistics to identify potentially subtle effects within the context of many sources of variability were of desired for this programmatic investigation.

Participants

The participants for this Experiment 1 were recruited following the procedures outlined above. Forty-five male and female participants who actively participated in CrossFit activities and competed in sporting events with no history of back and shoulder injuries participated for a total of two experimental sessions. Participants were scheduled and based on availability to meet over a two-week period of time.
Demographic Data. Demographic data was collected from all participants. Individuals provide information on their age, gender, profession, athletic history, injury history, and current perceived levels of fitness.

Data Collection and Integrity.

Sessions were conducted in a room with a one-way screen such that minimized contact between research staff and participants. Research assistants noted the start and stop times for each round of every session. All sessions were videotaped and the lead researcher reviewed tapes to ensure that start and stop times, and verbal statements were recorded accurately and that rest intervals were of the correct length. To insure that instructions were consistent between and within participants, a PowerPoint slide show was used to prompt athletes (See appendix 2.6 for an example).

Inter-observer agreement (IOA) between research assistants and the lead researcher was calculated for 30% of all sessions using the formula number of intervals agreed divide by the number of intervals agreed plus the number of intervals disagreed all multiplied by 100. The research team was trained scoring videos of model participants to 100% agreement. In vivo data collection agreement criterion was held at 90% if agreement rates fell below 80% research members would be retrained to 100% criterion. 80% was selected in that research assistants were collecting time data to tenths of a second. Variables assessed for agreement were the duration of static hold sessions (percentage agreement equaled 90.06 %), and recorded verbal statements during round timings (actual percentage of agreement equaled 100%). Remedial training protocols were not required given the level of agreement between the lead researcher and research team members.

Assessments. All 45 participants completed a full battery of self-report data pre and post study. This full Battery was administered at session 1st and 2nd session of Experiment 2. The packet included The AAQ-II, the Sport and competition questionnaire,
and sports and competition monitor (See appendices 2.5, 2.7, 2.8 & 2.9). Upon completion of both session the Sport and Competition Monitor (appendix 2.5). Instructions for the beginning of the sessions prompted to answer questions regarding their level of nervousness and desire to delay the start of the session prior to the isometric hold (Appendix 2.1-24). Upon completion of the isometric task the athletes again answered questions regarding their perceived pain (see Appendix 2.5). Athletes were then prompted to answer open ended questions that asked about their perceived performance, what if anything had extraneously influenced their performance, how they perceived their performance, and how they could improve in the next session. (see Appendix 2.5).

**Results Experiment 2 – Between Subject Pre/Post Design**

The demographic characteristics of the participants for Experiment 2 are described below. Participants in the three conditions were compared using appropriate statistical tests (one-way analyses of variance for parametric data; Chi Square for binary data) on age, gender, years of military experience as well as pretreatment levels of competition history, and psychological flexibility as measured by the AAQ-II. No significant differences were found between groups on any of these variables. Notably however the average score on the AAQ-II for all athletes in Experiment 2 was again low, with a mean score of 14.6. The average age of participants was 30 years, 62% of the group was represented by males, and 38% were female. 9% had military experience while the remaining 91% were civilian.

**Analytic Approach**

Power calculations were made using the approach discussed in Rosenthal, Rosnow, & Rubin (2000) using the program G*Power (Faul, Erdfelder, Lang, & Buchner, 2007). No data exist to estimate expected effect size, thus the study was powered on the basis of applied interest, reasoning that a very large effect would be of most interest to
sports psychologists and athletic trainers. A total N of 45 was targeted because a sample size of 15 per group would have at least a power of .75 to detect an effect size of $d = 1.0$ between any two conditions. Effect size labels (small, medium, large) were used following the convention established by Cohen (1988). The term "significant" was used for inferential analyses with $p \leq .05$, and the term "marginally significant" was used for inferential analyses with $p > .05$ and $\leq .10$. Particularly in view of the relatively small sample size, marginally significant findings were interpreted. P values less than .0009 are reported as " .000" regardless of specific values.

The main analysis focused on time to exhaustion values, in a three (condition) by four (trials) within two (phases) design. In this design the first factor is between subjects, and the last two are within subjects (four trials each nested within the baseline and post intervention phases). A treatment impact would be revealed either in a condition by phase two way interaction (e.g., if after intervention, greater or lesser times to exhaustion occurred for some conditions and not others), or by a condition by phase by trials three way interaction (if after intervention, greater or lesser changes in times to exhaustion occurred for some conditions and not others but did so differentially for some of the four trials and not others). In line with the experimental expectations, the willingness condition might be expected to produce longer times to exhaustion than the other conditions after intervention. If that was a global effect it would be revealed in a significant two way interaction of condition and phase; if it was a resistance to exhaustion within the four trial set, it might be revealed in a significant three way interaction. If a two-way interaction was found, that interaction would be further explored in a analysis of covariance, collapsing across trials and using baseline time to exhaustion as the covariate.

There were no missing data. In all analyses, data were checked for skewness and kurtosis before analysis and needed corrections were applied. Because time to
exhaustion data were right skewed (with skewness values per time period ranging from .082 for timing 1 to 2.213 for timing 8) logarithmic transformations were applied, resulting in more acceptable skewness values (range: -1.097 for log timing 1 to .957 for log timing 3). Three multivariate extreme outliers were identified across all eight timing periods, one in each treatment condition. After log transformation these were still outliers but no longer extreme. All main outcome analyses were the same with the outliers removed as when they were included (albeit with stronger results for treatment condition if they were removed). Given that pattern, the more conservative approach appeared to be to leave them in, and thus the primary results reported below include all participants and are based on the logarithmic data. When removal of outliers lead to changes in how the results are described in terms of significance, supplementary analyses with outliers included are also reported. When means in actual seconds are reported (these are used to help picture the results, since logarithmic values are uncommon for most readers), these are values in seconds and also include the three outliers.

**Checks on the Independent Variable**

Before proceeding to analysis of outcomes we needed to see if participants actually followed the directions in the conditions. Prior to the isometric hold session, all participants were given instructions describing the isometric task, and the research focus on mental toughness. During intervention sessions the instructions included information on the statements participants would be asked to focus on, as well as instructions for how to answer the audio recorded questions that would occur during the test specifically related to that statement. At the end of the instructions participants were asked to answer comprehension questions about their content (Appendix 2.1-2.4). If participants answered these questions incorrectly researchers would have corrected the participants before beginning the session but all participants answered the questions correctly.

**Primary Outcome: Time to Exhaustion**
The results of the three (condition) by four (trials) by two (phases) repeated measures analysis of variance are presented in Table 2.5.

Table 2.5

<table>
<thead>
<tr>
<th>Variable</th>
<th>df</th>
<th>F</th>
<th>p</th>
<th>Partial eta sq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditions</td>
<td>2, 42</td>
<td>.53</td>
<td>.60</td>
<td>.024</td>
</tr>
<tr>
<td>Trials</td>
<td>3, 126</td>
<td>199.30</td>
<td>.000</td>
<td>.826</td>
</tr>
<tr>
<td>Trials by Condition</td>
<td>6, 126</td>
<td>1.19</td>
<td>.32</td>
<td>.054</td>
</tr>
<tr>
<td>Phases</td>
<td>1, 42</td>
<td>.005</td>
<td>.94</td>
<td>.000</td>
</tr>
<tr>
<td>Phases by Condition</td>
<td>2, 42</td>
<td>3.82</td>
<td>.03</td>
<td>.154</td>
</tr>
<tr>
<td>Trials by Phases</td>
<td>3, 126</td>
<td>.90</td>
<td>.45</td>
<td>.021</td>
</tr>
<tr>
<td>Trials by phases by condition</td>
<td>6, 126</td>
<td>.58</td>
<td>.75</td>
<td>.027</td>
</tr>
</tbody>
</table>

The analysis revealed a large and significant effect for trials, due to the fall off of times to exhaustion from the first to the fourth trial both phases \( (F(3, 126) = 199.30, \ p = .000, \ \text{partial eta squared} = .826) \) and a large and significant condition by phase interaction \( (F(2, 42) = 3.82 , \ p = .03, \ \text{partial eta squared} = .154) \). No other effects were significant. These effects are shown in Figure 2.13, 2.14 and 2.15. As can be seen, in both the 90-degree condition and the distraction condition all times to exhaustion values were similar or worse after intervention across the four trials as compared to baseline, while in the willingness condition all post intervention times to exhaustion improved. Additional analyses were conducted using a variety of demographic baseline covariates (age, gender, competition history, baseline psychological flexibility, baseline pain or anxiety) but the results were the same and thus these analyses are not reported here.
Figure 2.13 depicts fatigue across the log transformed means times for participants in the 90 degree condition. Results show that initial timing rounds are comparable in both phases however performance on subsequent rounds are lower than that of baseline log transformed means.
Figure 2.14 depicts fatigue across log transformed mean times for participants in the willingness condition. Results show that all timing rounds during the willingness intervention phase improves performance above baseline log transformed means.
Figure 2.15 depicts fatigue across the log transformed means for participants in the distraction condition. Results show that all timing rounds during the distraction intervention phase decreases performance below baseline means.

The statistically significant interaction of phase and condition was further explored in an analysis of covariance of the log average time to exhaustion values after intervention for the three conditions, using the average log baseline time to exhaustion as a covariate. The adjusted means for each condition are shown in Table 2.6.
Table 2.6

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 degree</td>
<td>2.1599</td>
<td>.17035</td>
<td>15</td>
</tr>
<tr>
<td>Willing</td>
<td>2.1702</td>
<td>.15753</td>
<td>15</td>
</tr>
<tr>
<td>Distraction</td>
<td>2.0981</td>
<td>.12690</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>2.1427</td>
<td>.15261</td>
<td>45</td>
</tr>
</tbody>
</table>

This analysis showed a large and significant effect for the covariate ($F(1, 41) = 95.96, p = .000$, partial eta squared = .701), and a large and significant effect for condition ($F(2,41) = 3.62, p = .036$, partial eta squared = .15). Post hoc analyses revealed that the willingness condition produced significantly longer times to exhaustion than did the distraction condition (adjusted mean differences = .081, SE = .031, $p = .013$) and marginally significantly longer times that the 90 degree condition (adjusted mean differences = .058, SE = .031, $p = .069$). The distraction and 90 degree conditions did not differ from each other (adjusted mean differences = .022, SE = .031, $p = .48$). When the log outliers were removed the results were replicated except that the willingness condition was now significantly different from both the distraction (adjusted mean differences = .06, SE = .024, $p = .017$ and the 90 degree (adjusted mean differences = .089, SE = .024, $p = .001$) conditions.

The effect is shown in the bar graph of the estimated marginal means in Figure 2.16. Although the statistical analysis was calculated using log values, for clarity of presentation the data in the figure are presented in seconds (outliers are included).
Figure 2.16 depicts differences across time in seconds for ease of interpretation. This data is not depicted in log-transformed data. Range bars represent estimated standard error.

**Process variables:**

Analysis of Covariance (ANCOVA) statistics were run on all pre and post survey data. These statistics were run order to in order to identify process relevant variables. None of the process changes were significantly different from pre to post, nor did any of the conditions significantly impact processes of change. None of the process changes related significantly to time to exhaustion, either in baseline or at post. For example, the baseline AAQ-II scores correlated $r (45) = -.16 (p = .29)$ with the total time to exhaustion in baseline. There was an interesting pattern across the four baseline trials however with
the AAQII correlating with baseline time to exhaustion $r(45) = .04$, $p = .77$ in trial 1, $r(45) = -.17$, $p = .26$ in trial 2, $r(45) = -.24$, $p = .11$ in trial 3, and $r(45) = -.27$, $p = .074$ in trial 4. The marginally significant correlation in the fourth trial suggests that psychological flexibility may be more linked to persistence over time than it is to initial levels of persistence.

**Mediators and Moderators:**

Key moderators were explored by adding them as covariates to the main analysis. Key possible mediators were explored using a non-parametric cross product of the coefficients approach (Preacher & Hayes, 2008). None of the analyses indicated significant moderation or mediation.

**In Session Verbal Behavior Trends and Descriptors:**

Exploratory data analysis was conducted on the in session verbal behavior regarding the prompted focusing cue questions. Repeated audio questions were asked on a variable interval (VI) schedule of 30 seconds. These questions were ranked by the participants on a 1-5 scale across conditions and rounds. For each condition a response of “1” indicated the participant was completely able to focus on the prompted cue, a response of “5” indicated the participant was no longer able to focus on the statement cue. Questions per condition were condition specific. Thus the association condition asked “Are you focusing on holding your arm at 90-degrees?.” The contextual condition asked “Are you willing to continue?” and the disassociation question asked, “are you thinking of something else?” But the Likert responses remained the same across conditions and participants.

Based on these different question types data was analyzed within condition. Trends were also evaluated across the four rounds. Data trends for all participants in each of these conditions ($n=15$ per condition) were analyzed. Across the three condition types data reveals similar trends.
Raw data is presented for all conditions and categories in the appendix (appendix 2.12-2.21). This data is sub-categorized in by “high,” “mid,” and “low” performers. This was initially done, as the first analysis were conducted such that if differences among the top performers for this investigation would be different from lower performers these trends would be easily identified. Such distinctions were not found. Within experimental condition data patterns remain similar so analysis across top high performs, mid high performers and low mid performers, are not present as a matter of presenting findings with clarity.

**90-degree verbal behavior trends:** Participants in the 90-degree condition were instructed to rank their ability to “are focusing on holding your are at 90-degrees?” a response of “1” indicated participants were completely able to accomplish this focusing task, a response of “5” indicated participants could no longer focus on the prompted statement. Participants Likert responses were analyzed by those who reporting trends remained consistent (i.e., “1, 1, 1, 1 …”) or who increased reporting trends all increased (i.e., “1, 1, 3, 5…”) were grouped together participants whose response rates varied (i.e., “1, 4, 2, 3…”) were group differently. For this IV condition participants remained consistent or increased their responses at 100% for both rounds 1 and 2. In rounds 3 and 4, two of the 15 participants varied their responses dropping the percentage to 87%.

**Willingness verbal behavior trends:** Participants in the Willingness condition were instructed to rank their ability to “are you focusing on being willing to continue” a response of “1” indicated participants were completely able to accomplish this focusing task, a response of “5” indicated participants could no longer focus on the prompted statement. Participants Likert responses were analyzed by those who reporting trends remained consistent (i.e., “1, 1, 1, 1 …”) or who increased reporting trends all increased (i.e., “1, 1, 3, 5…”) were grouped together participants whose response rates varied (i.e., “1, 4, 2, 3…”) were group differently. For this IV condition participants remained
consistent or increased their responses at 100% for both rounds 1 and 2. In round 3 one participant varied their responses dropping the percentage to 93%. In round 4 all participants again remained consistent or increased their responses generating a percentage of 100%.

**Distraction verbal behavior trends:** Participants in the Distract condition were instructed to rank their ability to “are you thinking of something else” a response of “1” indicated participants were completely able to accomplish this focusing task, a response of “5” indicated participants could no longer focus on the prompted statement. Participants Likert responses were analyzed by those who reporting trends remained consistent (i.e., “1, 1, 1, 1…”) or who increased reporting trends all increased (i.e., “1, 1, 3, 5…”) were grouped together participants whose response rates varied (i.e., “1, 4, 2, 3…”) were group differently. For this IV condition, unlike the previous condition, participants were highly varied in responses. Only 53% of participants remained consistent or increased their responses across the round. 73% of participants remained consistent or increased their responses across round 2. 66% of participants remained constant or increased their responses across round 3. And 93% of participants remained consistent or increased their responses across round 4. It is important to note that in round 4 durations became so short that most participants were only presented with 2 or 3 verbal response opportunities which could have resulted in the higher agreement for within this round over the other previous rounds.

Across the three conditions, these verbal reports showed little in the way of a consistent relationship to termination except that in all conditions, if the strategy was reported lost, termination was likely. Distraction had far more ebb and flow that the other strategies.

**Social Validity and Credibility of the Interventions**
At the conclusion of Experiment 2 each participant was asked three additional questions regarding the perceived validity of the study. These questions are as follows and can be found in Appendix 2.10:

- Do you feel this study has changed how you approach workouts and competitions from a mental standpoint? If yes, how so?
- Did you find this study helpful to your competition performance and or training?
- Would you recommend this study to others?

Across all participants’ data 44.4% of participants felt that the study changed how they approached their workouts and competitions from a mental standpoint. Exploratory qualitative explanations regarding those who reported a change revealed a new awareness or a new appreciation for the effects of their psychology on performance outcomes. 73.3% of participants reported finding this study helpful when it came in their competition and training performance. 95.5% of participants said they would recommend this study to other athletes. Out of the 45 participants only 2 said they would not recommend the study.

Validity and creditability questions evaluated by conditions suggest distinctions across groups. The willingness condition group rated the study most positivity and found it the most useful in comparison to the other 2 conditions. These reports also concur with findings in actually performance differences. Participants in the 90-degree focus condition report 40% found that the study changed how they approach training and competitions settings from a mental standpoint. 66.6% found the study helpful with regards to their performance in training and competition and 93.3% percent of those in this condition would recommend the study to others. Comparable to those in the 90-degree condition the Distraction focus group indicated that 46.6% Found the study changed how they approach training competition settings psychologically. 66.6% percent
found the study helpful with regards to their training and competition performance, and 93.3% of the individuals in this group would recommend the study.

Willingness condition indicates that 46.6% of participants from this condition state that the study changed how they approach training and competitions for a mental standpoint. 86.6% report that the study was helpful with regards to their training and competition performance, and 100% of the participants from this group would recommend the study to others.

**Summary:** Data from Experiment 2 were analyzed using inferential statistics to detect potential changes in duration as a function of intervention conditions. This design provided an examination of each intervention condition without contamination of the other conditions, and was able to detect differences that the design used in Experiment 1 was unable to accomplish.

When data on fatigue fall off were evaluated as a function of experimental condition, no consistent change in pattern was seen across conditions. This indicates that verbal statements in general do not impact the form or shape of fatigue. When each condition is compared by phase in relation to baseline performance overall duration improved across rounds only in the willingness condition. Willingness significantly increased performance over distraction; it was marginally significant when compared to the 90 degree focus condition. The 90 degree condition did not differ from the distraction condition.

Between subject designs can identify small but significant changes that may not be revealed when using within subject designs and visual analysis if extraneous variables impact session-to-session performance. Experiment 2 was planned originally because of that issue, and the results of this experiment show that a between group design was able to delineate effects where there is a high degree of natural variability and a subtle intervention effect.
Supplementary Study:

Follow Up Demographic Assessment

In Experiment 1 and 2 it was observed that participants scored significantly lower than the average respondent on the AAQ-II. On this assessment a higher scores indicates more inflexible psychological responses while a lower scores tend to be more psychologically flexible. In the original validation study on the AAQ-II the average score was 20.69; across the two Experiments in the present study the average AAQ-II score was 14.59 (Sd 5.72), which is approximately .8 of a standard deviation away from the validation study mean. In Experiment II AAQ-II scores did not correlate significantly baseline with time to exhaustion except marginally in trial 4, even though the flexibility-focused statement (i.e., the willingness statement) was most helpful. It seems possible that the correlational failure could have been due to a floor effect in this population, or to the need for a more performance focused version of the AAQ.

To assess if these low scores were consistent and significant in CrossFit populations we conducted a supplementary study to Experiment 1 and 2 that was not originally planned in the dissertation. The AAQ-II was administered and data was collected in 30 CrossFit classes from the UNR affiliate gym Individuals in the classes were offered the option to fill out the AAQ-II prior to exercising. Additional information on the athlete’s gender, age, competition history and duration in CrossFit specific activities were also collected. A total of 164 participants volunteered.

There was no missing data for the AAQ-II assessment: each of the 164 participants answered all 7 items. However the specific demographic data on age, gender, competition history and duration in CrossFit activity resulted in several missing data points. Of the 164 participants, 16 did not identify their age, 11 did not identity their gender, 17 did not identify their competition history, and 17 did not identify the duration of their participation in CrossFit.
AAQ-II data collected in Experiments 1 and 2 were administered as a part of the pre and post study questionnaire battery. For this follow-up assessment on the AAQ-II only the pre study AAQ-II score was used for analysis so as to avoid possible contamination due to experimental procedures.

Data collection CrossFit classes at the University of Nevada, Reno’s took place at the Lombardi Recreation and Wellness (Lombardi Rec), a campus recreation and wellness center. Lombardi Rec. provides a full service gym to students, faculty, staff, and alumni of the university, and includes a CrossFit-approved affiliate gym. During this evaluation Lombardi Rec. offered 30 CrossFit Classes a week. Class size during the time in which data was collected ranged from 7-25 participants. Participants answered the AAQ-II questionnaire independently but within the training facility and in the open prior to the start of the class. So as to protect the individual’s anonymity of participation, if participants did not want to participate they could also turn in a blank AAQ-II.

For one week during the Spring 2015 semester a member from the research team attended the first 5 minutes of the CrossFit classes offered at Lombardi Rec. At the start of the class the instructor introduced the research team member, who then instructed the athletes how to fill out the survey, which was then completed and collected. Because many of the Lombardi athletes take more than one class a week, athletes were instructed to only fill out the survey if they had not yet done so.

The CrossFit athletes were compared to a cross-cultural AAQ-II sample from several European countries (Monestes, Karekla et al., in press). This data set was used as a comparison sample because of its large N and vast sampling demographic. The comparison data set sampled 2,507 individuals utilizing seven different AAQ-II translations (Dutch, English, French, Greek, Italian, Japanese, and Spanish) across eight different countries. Because the results showed highly similar psychometric properties across these countries data from the entire comparison study were used. The
overall mean was 20.69 (SD 7.97), which was quite similar to the original validation
study.

Independent samples T-tests were run between the CrossFit and the cross-
cultural AAQ-II comparison groups. An additional test between male, female, and
competitive versus noncompetitive CrossFitters were also compared to the cross-cultural
data. Significant findings and post hoc analyses are presented below.

There was a significant difference between the total AAQ-II scores of CrossFit
athletes (M=14.46, SD=5.72) and the cross-cultural comparison group (M=20.69,
SD=7.97) that fell on the borderline between a medium and large effect size: $t(2669) =
9.85, p = 0.0001, d = .79$). The patterns were nearly identical for males and females with
male CrossFit athletes (M=13.97, SD=5.55) and female CrossFit athletes (M=14.82,
SD=5.66) showing highly similar scores; as was the case for males (M=21.38, SD=9.13)
and females (M=22.13, SD=9.09) in the cross-cultural sample. As would be expected
given these numbers, the CrossFit athletes differed from the cross-cultural sample both
with males, $t(714) = 6.34, p = .0001$, and females $t(1896) = 7.56, p = .0001$.

Within the CrossFit sample, the AAQ-II scores of actively competitive CrossFit
athletes AAQ-II scores and cross-cultural AAQ-II scores collected by Monestes and
colleagues. Results showed a significant difference in scores the actively competitive
CrossFit Athletes (M=13.17, SD=4.64) and cross-cultural AAQ-II scores (M=20.69,
SD=7.97) conditions; $t(2575) = 7.85, p = 0.0001$.

A two-way independent samples T-test was conducted examining the differences
between the actively competitive male CrossFit AAQ-II scores and cross-cultural male
AAQ-II scores collected by Monestes and colleagues. Results showed a significant
difference in scores for actively competitive male CrossFit Athletes (M=13.33, SD=5.52)
and cross-cultural AAQ-II scores (M=21.39, SD=9.13) conditions; $t(690) = 5.4588, p =
0.0001$. Additional planned comparisons showed that the AAQ-II scores for the
Competitive CrossFit scores was significantly lower than the Monestes and colleagues cross-cultural male AAQ-II scores (SE=1.48, p = 8.06, 95% CI: 5.16-10.96).

A two-way independent samples T-test was conducted examining the differences between the activity competitive Female CrossFit AAQ-II scores and cross-cultural female AAQ-II scores collected by Monestes and colleagues. Results showed a significant difference in scores for actively competitive female CrossFit athletes (M=13.33, SD=3.17) and cross-cultural female AAQ-II scores (M=22.13, SD=9.09) conditions; $T(1833) = 5.03, p = 0.0001$. Additional planned comparisons showed that the AAQ-II scores for the actively competitive Female CrossFit scores was significantly lower than the Monestes and colleagues cross-cultural female AAQ-II scores (SE=1.75, p = 8.80, 95% CI: 5.36-12.24).

A two-way independent samples T-test was conducted examining the differences between the noncompetitive CrossFit athletes AAQ-II scores and cross-cultural AAQ-II scores collected by Monestes and colleagues. Results showed a significant difference in scores for Noncompetitive CrossFit Athletes (M=15.12, SD=5.99) and cross-cultural AAQ-II scores (M=20.69, SD=7.97) conditions; $t(2582) = 6.08, p = 0.0001$. Additional planned comparisons showed that the AAQ-II scores for the noncompetitive CrossFit athletes scores was significantly lower than the Monestes and colleagues cross-cultural AAQ-II scores (SE=.92, p = 5.57, 95% CI: 3.77-7.37).

A two-way independent samples T-test was conducted examining the differences between the noncompetitive male athlete’s CrossFit AAQ-II scores and cross-cultural male AAQ-II scores collected by Monestes and colleagues. Results showed a significant difference in scores for noncompetitive male CrossFit athletes (M=14.09, SD= 4.173) and cross-cultural male AQ-II scores (M=21.39, SD=9.12) conditions; $t(673) = 3.73, p = 0.0002$. Additional planned comparisons showed that the AAQ-II scores for the noncompetitive male CrossFit athletes scores was significantly lower than the Monestes
and colleagues cross-cultural male AAQ-II scores (SE=1.95, p = 7.29, 95% CI: 3.46-11.14).

A two-way independent samples T-test was conducted examining the differences between the noncompetitive female CrossFit athletes AAQ-II scores and cross-cultural female AAQ-II scores collected by Monestes and colleagues. Results showed a significant difference in scores for noncompetitive female CrossFit athletes (M=15.54, SD= 6.5600) and cross-cultural female AAQ-II scores (M=22.13, SD=9.09) conditions; t(1861) = 5.33, p = 0.0001. Additional planned comparisons showed that the AAQ-II scores for the noncompetitive female CrossFit athletes scores was significantly lower than the Monestes and colleagues cross-cultural female AAQ-II scores (SE=1.235, p = 6.587245000, 95% CI: 4.16-9.01).

Within group comparisons. Another way to examine the possibility that the non-significant relation of the AAQ-II to time to exhaustion was a floor effect related to better AAQ-II scores for competitive athletes, was to compare the AAQ-II scores for competitive versus non-competitive CrossFit athletes in this larger and more diverse population. Independent-samples t-tests were run within this CrossFit group to evaluate potential differences between competitors and non-competitors. Results showed that Competitive CrossFit athletes had significantly more flexible AAQ-II scores (M=13.17, SD= 4.46) than did Noncompetitive CrossFit scores (M=15.13, SD=5.99) conditions, although the difference was small t (145) = 2.20, p = 0.03, d = .34.

There were no significant differences between competitive and non-competitive female athletes, competitive and noncompetitive male athletes.

Summary: Results indicated that participants within this CrossFit demographic grouping show significantly lower AAQ-II scores than peers in the general population. Competitive CrossFit athletes were more flexible than non-competitive CrossFitters, however, suggesting that better psychological flexibility did correlate with overt
performance. This pattern of results suggests that as traditionally measured psychological flexibility may indeed be relevant to performance in this population, but the very low scores also suggest that there may need to be additional measure development.

**General Discussion**

The experiments in this series of evaluations sought to explore the effects of verbal statements on persistence when athletes are pushed to their perceived limit. The data collected in both experiments offers some insight for empirically approaching mental toughness and resiliency as psychological phenomena within high performance domains.

Competitive athletes succeed or fail based on very small effects. The results from Experiment 1 showed no differential effects among conditions based on visual inspection of data. Within subject designs carry a greater risk of Type II errors however (Cooper, Heron & Heward, 2007), especially in situations that require detection of subtle effects.

Results from Experiment 2 indicate that when a group design and inferential statistics were employed reliable differences among independent variables could be identified. The results from this second evaluation provide some insight to suggest that common sport psychology approaches may not be as effective as approaches pulled from contextual behavior science. Taken together these two experiments offer directions for future research regarding language in high performance populations and athletics in particular.

**CrossFit as a high performance research population**

The competitive CrossFit population was selected for this programmatic research for several reasons. It is well documented that the participation in and notoriety of CrossFit has grown in the last several years. This growth has affected the number of CrossFit athletes. Also well noted is its diversity in its athletic composition.
Each CrossFit athlete enters the community with a unique sport and athletic background. These individual histories range from athletes with no experience in any sport, let alone exercise, to athletes who have transitioned into CrossFit at the peak of other sporting disciplines. The demographic backgrounds represented in the current study support this notion; participants reported histories with team, and single sports, power and endurance sports, and performance and atheistic sports. With its emphases on overall fitness CrossFit has made a concerted effort to include numerous age demographics as well, thus competitive participants range in age from early teens into their eighties. The participants in this study represented ages between 18 and mid-sixties. Taken together the CrossFit population provides a vast research pool not limited to specialists or techniques of one individual activity or discipline. The diversity allows wide generality and a unique opportunity to evaluate the psychological aspects of sport not constrained by potential technical aspects.

Culturally, CrossFit is also noted for its emphasis on toughness and resiliency within the training and competition community. The nature of high intensity interval training is inherently painful. Thus individuals are not only training for physical gains and competition, but are frequently exposed to high levels of fatigue and pain. Athletes and their coaches work just as hard to prepare for the mental and painful demands of CrossFit as they do the physical components. This nature provided a social community who highly values the improvement and awareness of mental toughness and resiliency.

**Experimental components**

**Setting.** The setting for this investigation, the research area within Mack Social Sciences on the UNR campus, was specifically chosen away from campus recreation. The area provided anonymity for the participants while operating within convenient walking distance for most athletes. The Mack Social Science building houses academic faculty, research space, and provides traditional lecture classrooms, this space offers
little to no social cues for athletics and fitness. Removing the athletes from their traditional training and competition areas provides a control over potential social and historical cues for tough and resilient behaviors. Such removal allowed the researchers the ability to account for environmental cues such that the effects of language on performance could be best investigated.

**Independent variables.** The focusing cue statements used in these experiments are drawn from traditional sports psychology literature and contextual behavior science. The specific statements were designed to address the task athletes engaged in, but were general and simple enough to be easily modified to other settings both athletic and experimental.

The Association (“focus on holding your arm at 90 degrees”) and Dissociation (Distraction or “think of something else”) focus types are frequently discussed within the sport psychology literature. While it is known that athletes uses both of these focusing strategies, the effectiveness of one over the other is unknown and seems to be depended to sporting type (Silva & Appelbaum, 1989). Even less is known regarding the training and implementation outcomes of these statements.

The contextual cuing statement (“focus on how willing you are to continue”) is not well known in sports psychology, although there is evidence for its effectiveness within clinical and organizational areas (i.e., business and safety industries; for example Levin & Hildebrant & Lillis & Hayes, 2012). Highly competitive athletes are a different population and it was not known if this approach would be helpful. Findings suggest that competitive athletes have extraordinarily high levels of willingness as reflected in their very low AAQ-II scores. Nevertheless the data showed that their performance can still be impacted positively from directed contextually based statements.

**Dependent Variables:** This specific isometric hold protocol was selected for its ability to produce discomfort, simulating situations requiring mental toughness.
(distressing, painful, and fatiguing), and the ability to account for potential influencing performance variables. This procedure isolated a single behavior of interest from other confounding factors such as those found in competitive sports where technique, body type, scores, other athletes, coaches, and spectators might affect behavior.

**Experiment 1**

Experiment 1 utilized a small sample size (N=6) and a within subject alternating treatments design (ATD). In this experiment all participants were systematically exposed to each of the independent variable conditions across a total of nine sessions. Data from this evaluation show high rates of variability across all conditions for all participants. For three of the six participants data indicated that any of the three independent variables improves performance over baseline. However delineation between the independent variable conditions cannot be concluded with visual inspection alone.

The undifferentiated results from Experiment 1 can be evaluated from both methodological and theoretical vantage points. To best discuss the implications for method and theory in high performance populations knowledge of the well-documented and naturally occurring variability in athletics will be explained below. While the ATD design is typically a well suited design for situations involving somewhat variable data, maturation trends, and even potential carry over, the design is only able to detect functional relations if independent variable effects are significantly larger than variability that occurs naturally. When this is not the case the design and the visual analysis therein becomes inadequate.

In athletics performance variation is a given. With this knowledge athletes train accordingly. Sources of variability are well researched and documented, sleep, hydration, caloric intake, stress, and recovery are a few of many performance factors athletes work to account for in both training and competition environments (Flora, 2010; Glassman, 2002). In many ways athletes train to produce improving trends in performance while at
the same time minimizing their own variability. Athletes track, plan, and predict training and competition outcomes as a factor of accounting for sources of variability. As athletes become more precise in their training, seconds of variability have powerful impacts on competition outcomes. This is particularly true today given advances in technology and knowledge of body mechanics. Those working with highly trained and competitive athletes are often looking for technologies that produce changes across fractional units of change (i.e., fractions of a second). Precise analytic and data display tools are therefore needed when working with these demographics.

Given the expected variability in athletic performance the ATD design was selected for its ability to account for some sources of variability, maturation, and carry over effects (Cooper et al., 2007, Hayes, Barlow, & Nelson-Gray, 1999). The ATD design has been used in situations with factors of variability similar to athletics. However, this design has not been rigorously tested in settings that require precise detection among inherent extraneous variability. Under most circumstances, the rapidly alternating nature of the ATD makes it ideal for dependent measures that are susceptible to maturation or slight carry over effects. The ATD design can determine an effect if the outcome of the independent variable is larger than the effects of maturation, natural variability, or carryover alone. When IV effects can be seen in one condition over others, even in variable data, a functional relation can be concluded. The problem in this case was that the effects of note in Experiment 1 were likely to be only a matter of seconds. These effects are not detectable using the ATD given the current conventions of implementation and data analysis, especially in the presence of background variation.

As with all within subject designs carry over and maturation effects can distort or mask the identification of functional relations between variables of interest. The researchers looked for these potential confounds. For three of the six participants (MP1.3, FP1.5, FP1.6) later sessions became more consistent across round timings,
which could suggest potential confounding effects as a result of multiple IV exposures and/or carry over. If carry over is assumed well known principles of verbal behavior could explain this data pattern. Verbal networks are dynamic and can be added too, but not subtracted from (Hayes, 1994). So while each session was differentiated from previous sessions in the instructions and the prompt cue questions, once exposed to all three interventions there would be no way to completely isolate the subsequent sessions from previous ones.

If maturation is assumed, the rate of maturation on the isometric hold could affect the ability to interpret the impact of focus statements on performance. In post study disclosure meetings several participants anecdotally noted that the general length of study affected their interest in the study. This fact alone could impact their performance. To remedy these potential concerns Experiment 2 was developed. While the results of Experiment 1 concluded little in regards to the specific research question on athletic performance, much information regarding how behavior analytic methods work or fail to work in high performance settings were brought to light.

Behavior science has only recently begun to investigate high performance populations, and so methodological challenges are just being identified. As shown in Experiment 1 analyses solely reliant on visual inspection of raw data are presented with unique challenges when socially significant effects are small. Behavior analytics sole reliance on visual inspection may quickly become a limiting factor for the field’s adoption among high performance groups if way of interpreting small effects cannot be identified.

Traditionally applied behavior analysis has made its mark through large and socially significant effects among populations of profoundly and deficient performance. Examples might include teaching verbal responses in nonverbal learners, teaching alternative responses for aggression and/or self injurious behavior, activities of daily living in the developmentally delayed (tying shoes, brushing teeth), or improving
academic skills in delayed learners (Cooper et al., 2007). However these types of effects are not what is call for in high performance groups. It is important to identify subtle changes across the spectrum of human performance. Quantitatively graphics that can detect not just large effects but small ones will need to be identified and refined in the time series designed favored by behavior analysts.

High performers can produce a unique challenge to research designs that rely only on graphic depiction. In these populations the target behavior already occurs “proficiently” within the behavioral repertoire—researchers in these cases are pursuing an improvement in a component of that response class (i.e., speed, strength, duration). Desired changes maybe remarkably subtle but highly significant. The development of methodologies and data analytic tools to identify these changes in single subject methodology is warranted if behavior science strives towards a comprehensive understanding human behavior.

The results of Experiment 1 do not indicate that within subject designs have little to offer high or complex levels of human performance; on the contrary they have much to offer. The principles of behavior apply across the continuum of human performance, and behavior analysis has spent much time researching the conditions under which these principles can be optimized. This notion of optimization aligns well with sport. Athletes who optimize their behavior above other competitors win.

In general athletes are interested in two general outcomes of their behavior. First they work to surpass their own historic performance (i.e., new personal records) and second they work to beat their competition. The ability to look at a single performer over time and track his/her performance changes is highly desired. This ability to track individual performance is especially needed as an individual becomes a more and more proficient performer. At a larger scale athletes naturally use within subject designs, especially as they become more elite. Statistically the best athletes are outliers, which
creates an inherently very small population by which one can run statistical analyses. Therein the precision by which data changes can be detected in populations already proficient would be a massive contribution to both fields.

The data and the analysis from this Experiment illuminated potential areas by which researchers can work to advance the field of behavior science. Both in terms of aiding the performance of challenging populations and ways that allow behavior analysts to refining the data analytic tools of their own field.

**Experiment 2**

Experiment 2 employed a group design with a larger sample size (N=45). Unlike Experiment 1 these participants were only exposed to one of the three independent variable conditions after an initial baseline session. This design allowed for a larger number of participants to volunteer and complete the study due to the shorter time commitment. Experiment 2 also allowed researchers to control for potential carryover and maturation effects.

This experiment utilized inferential statistics. Inferential statistics evaluate variable effects as applied to a group rather than an individual per say. This focus on group trends has resulted in the almost complete rejection of statistical procedures among applied behavior analysis (Hopkins & Mason, 1998). The concern is understandable but group designs can also be of value to the behavioral sciences and the individual.

It seems helpful for both methodologies to be applied to experimental investigations. The findings of Experiment 1 and Experiment 2 are not in contradiction. Experiment 1 suggested that intervention could be helpful to a degree. In terms of overall means, the willingness condition was slightly better in Experiment 1, but that the ATD design permitted no way to analyze those effects. The methodology and the
mathematical precision of Experiment 2 was needed to identify which of the three intervention conditions best served the tested group of athletes.

The results of Experiment 2 suggest performance benefits in the willingness condition. In particular the willingness condition improved performance above baseline whereas the 90-degree condition remains comparable to baseline. Distraction showed a decrease in performance outcomes when compared to its baseline performance. Comparisons across conditions in the main analysis indicated that in terms of time to exhaustion, willingness was clearly and significantly different than distraction and was marginally significantly different from the 90-degree condition.

The use of language and cuing statements had a differential affect on overt performance trends in a pain tolerance task. Interestingly, to achieve this affect athletes didn’t have to engage in overtly different verbal responses to achieve differences in duration. Each participant, read the script, held the weight, and answered questions, using the same Likard scaling across conditions, regarding their focus. Cueing statements that never required their utterance from the participant predictably affected the overt quality of the target behavior.

Behavior analysis has often focused exclusively on overt behavior and environmental manipulation as a means by which to argue its validity as a scientific field. But not all behavior is overt, especially when it comes to complex human behavior. As it relates to these evaluations covert and overt language can impact dimension of other overt responses. Behavior occurs in a context that includes language-based influences. Individual athletes respond to what they are currently experiencing, what they are currently doing, and how what they are doing fits with valued outcomes. Language processes affect all of these actions.

There were differences among the instructions on these dimensions. The willingness instruction focused less on the form of the targeted behavior and more on the
functional relation the person had to it. In contrast, the 90-degree instruction specified what to do in a formal sense; the distraction specified what not to do. It seems possible that these differences helped to explain the results – specifically the last two interventions contain formal response restrictions that could restrict the repertoire and make access to fewer responses acceptable.

For this population in particular providing numerous means by which one can address current experiences maybe more beneficial than directly limiting psychological events toward experiences. This is especially true when the context and sensations (i.e., when something becomes painful) that involve those actions may radically change during an event. The ability to access the a broader range of useful response options could have large-scale implications, and could provide additional guidance for teaching athletes how to talk about their performance and experience that go beyond the specifics of the present study.

**Demographic Follow Up**

Evidence supports the idea that psychological flexibility plays a role in one’s ability to respond adaptively to dynamically changing contingencies (Haas & Hayes, 2006). The AAQ-II was implemented to test the applicability of tools used to identify psychological flexibility in other demographics to competitive athletic populations.

In the CrossFit population tested, the AAQ-II resulted in very low scores. In fact these scores on average were so low that further questions arose regarding a potential floor effect. The significantly lower AAQ-II scores raises questions about psychological flexibility as it relates to this assessment tool and this population. As a measure of psychological inflexibility this tool as currently designed may not have provided the most helpful assessment of these individual athletes psychological state as it relates to athletic performance.
There are many specific versions of the AAQ and related measures of psychological flexibility (e.g., physical pain Mcracken & Velleman, 2010; diabetes Gregg et al., 2007) and in general these specific instruments work better in targeted domains. Psychological flexibility as a construct is best viewed as a context-bound set of response tendencies. The problem is that athletes constant exposure to pain while training may lead to verbal opinions that change the functional properties of instruments such as the AAQ-II which are focused on emotional pain, but ask about these issues in ways that could overlap this high levels of tolerance of physical pain as part of athletic training, Culturally, athletes are well acquainted with the centrality of pain and discomfort. Pain and in particular pain tolerance is a fundamental aspect of athletic training. Athletes frequently discuss the benefits of engaging in painful activities, as well as frequently training to the point of experiencing pain and failure such that they can push the boundaries of this experience for competition sake. 

Research regarding the working used in AAQ assessments for athletes may be beneficial. These results raise some concerns about the use of the AAQ with highly competitive athletes until the reasons for the lower scores and its implications are better understood. The fact that the AAQ-II levels varied with the level of competitiveness, however, provides some support for the relevance of the concept in this population as traditionally measured despite the low overall scores.

Implications

In 1881 the Olympic committee adopted as its motto the Latin words, Citius, Altius, Fortius: In English these words mean “faster, higher, stronger.” Over the last 120 years professional athletics have taken the motto to heart. Performance outcomes across all sports have improved. To a great extent technology, advances in the fields of physiology, biology, and body mechanics have helped create great strides in athletic
efficiency, and in turn world records. However while recognized as important, the “mindset” and psychology of athletics has remained mostly unchanged and arguably few research based advancements have been made (Epstein, 2014).

While all athletic trainers admit that there are functional relations between environment, biology, and athletic mindset or verbal processes the psychological component has struggled to be subjected to the same level of empirical, systematic, and progressive influence. This study needs to be seen in that light. Taken together these two experiments have provided evidence for the influence of language on athletic performance when athletes are pushed to their own limits.

Together these two experiments offer a clear general implication: Language matters. Statements provided to the athlete’s impacted performance in relation to baseline trends. The effect was specific since Willingness focus statements improved persistence in the isometric performance task.

The literature has long discussed and identified the relevance of language on performance (Dugdale & Eklund, 2002; Hass & Hayes, 2006; Hayes, 1994; Hayes, Luoma, Bond, Masuda & Lillis, 2006). The two experiments presented here agree with these findings. Talk does matter, and talking either out loud or covertly does impact dimensions of overt behavior. For behavior analysis, the notion that language impacts complex human behavior challenges the assumptions that the principles identified in nonhuman organism will transfer in whole cloth to complex human performance in the same way.

Among high performers it is rare for interventions to be used for skill acquisition or refinement to proficiency. High performers are so named because of the skill and proficiency they already exhibit. In their own right high performers are outliers to the right of the performance distribution. Yet there is still benefit to improving and moving these performers ever further from the mean. For example, Michael Phelps desires to swim
faster; a NASA engineer peruses better precision; solders work such that high-risk
operations result in maximal benefit. Targeting and measuring the quality of high
performance is fundamental to work within this specific population. The results of these
two experiments provide some insight regarding how the quality of an action can be
impacted as a function of language. Of the three variables tested, duration (a quality
dimension of behavior) was influenced in different ways by simply using different
wording in a challenging task. It then can be derived that the quality of performance is
influenced in both positive and negative directions as a function of words. Knowing that
language can be used to facilitate performance can impact how athletes and those who
work with them (coaches) use language to achieve performance goals.

**Future Research**

In general athletes are interested in two primary outcomes of their performance.
They want to know that they are improving beyond their own historic performance
records, i.e., are they beating themselves. Secondly, they want to know how they are
doing in competition, i.e., are they beating their competitors. These driving factors
promote an environment that is both hungry for data and results. Such factors make the
world of high performance athletics ripe with low hanging fruit for psychological research.
Given the preliminary findings of this study many systematic research lines could be
developed. Below are several such directions.

Given the subtle and yet significant impact of willingness, future research should
expand upon this process and statements that engage it. Expanding the statement to
more relevant factors such as those related to specific sports or to different aspects of
psychological flexibility may help their generalizability as well as provide fundamental
information on how high performing populations operate within psychologically
demanding and stressful contexts.
Furthermore as research builds these statements to become more complex research designs should look to delineate and identify the potential for rule following behavior. Types of rules suggested by RFT, in particular pliancy. Such designs could contribute to knowledge regarding the roles and impact of rule following on psychological flexibility in populations identified for their high rates flexible responding.

As more information regarding language and high performance is understood, there needs to be more effort to integrate effective language components to more real world settings. The kinds of interventions that work need to be integrated into competition and training environments. Research that incorporates performance feedback, social interaction, competition, and performance-based goals needs to be linked to the effects of language on athletic performance, so that mental toughness can be studied further.

Contextual behavior scientists has long wondered if psychological flexibility and rigidity can be measured at the level of physiology. The area sport provides an ideal avenue by which this area can be investigated. Athletes are highly familiarized with biometrics and interrogate them into their training frequently. Additionally given the levels of physiological stress athletes place themselves under subtle changes in performance maybe best detected in these extreme performers. As there should be no finding in behavior science that contradicts biology such research could benefit sports psychology by providing the ability to detect the effects psychological interventions in competition settings and further argue the validity of psychology as a hard science (Vilardage, Hayes, Levin, Muto, 2009).

The overall low scores on the AAQ-II scores within this CrossFit population is an interesting finding. A research line looking to developing a more precise and empirically validated tool that avoids the floor like finding in athletes is needed. Furthermore how these types of scores translate across different types of athletic settings maybe relevant.
The environmental context within aesthetic sports is vastly different than those in performance based sports, as is team versus individual sports.

**Conclusion**

Psychological flexibility, relational frame theory and acceptance and commitment therapy provide a wide array of information regarding the functional use of language to improve performance. RFT has much to say about how language works to facilitate and inhibit athletic performance. This is an empirical fact. For example, verbal prompts that are related to the individual’s goals for exercise, as vetted by the Implicit Relational Assessment Procedure, an RFT tool, lead to higher intensity athletic workouts (Jackson et al., 2016). The use of ACT in promoting exercise significantly increases maintenance of exercise habits (Butryn, Forman, Hoffman, Shaw, & Juarascio, 2011; Ivanova, Jensen, Cassoff, Gu, & Knauper, 2015). ACT for dieting leads not only to greater weight loss, but also to improved levels of exercise (Tapper, Shaw, Ilsley, Hill, Bond, & Moore, 2009). Data from this study adds to the growing body of evidence that psychological flexibility interventions can be of benefit to athletic performance, and extends that knowledge to highly competitive athletes. The information gleaned from these high performance populations could offer a mutually beneficial outcome by providing further information on the continuous nature of psychological flexibility while simultaneously improving performance.

Together these experiments provide an example of how language impacts athletic performance and persistence. Importantly, these two investigations provide evidence that mental toughness and resiliency are malleable rather than inherent and unchangeable character traits. These traits are teachable. It is time to learn how.
References


Appendix 2.1

Baseline phases

Instructions:

During this exercise you will be holding a weight that closely approximates 1.5% of your body weight. This weight is selected to assess pain tolerance. It is not a measure of strength or technique. As a result, this task is not likely to produce any long lasting effects, or produce residual soreness that will impact later exercise performance. The pain, is only momentary, however, the longer you continue to hold the weight the more uncomfortable it will become. You will hold this weight for four rounds, but will have a 60 second rest period between each round.

Cue Card:

During Baseline phase cue card is blank

Please answer the following questions as they relate to the narrative above:

1. What percentage of your body weight will you be holding?
2. What character trait is this study aiming to evaluate?
3. If you could delay the start of the session how long would you do so?
   - 0 seconds
   - 30 seconds
   - 60 seconds
   - 5 minutes
   - 10 minutes
4. On a scale of 1 to 10 (1 not nervous/anxious: 10 extremely nervous/anxious) how nervous/anxious are you about starting this session?
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10
Appendix 2.2

90 Degree Reports:

Instructions:

We are studying mental toughness. During this exercise you will be holding a weight that closely approximates 1.5% of your body weight. This weight is selected to assess pain tolerance. As a result, this task is not likely to produce any long lasting effects, or produce residual soreness that will impact later exercise performance. The pain is only momentary, however, the longer you continue to hold the weight the more uncomfortable it will become. You will hold this weight for four rounds, but will have a 60 second rest period between each round. When you are holding the weight an audio recording will ask you “Are you holding your arm at 90 degrees?” A response of “1” indicates that you are holding your arm at 90 degrees. A response of “5” indicates that you are not holding your arm at 90 degrees.

Cue Card:

Your Task:

Focus on holding your arm at 90 degrees

Please answer the following questions as they relate to the narrative above:

1. What percentage of your body weight will you be holding?

2. What character trait is this study aiming to evaluate?

3. What question will the audio recording ask you?

4. If you could delay the start of the session how long would you do so?

   0 seconds   30 seconds   60 seconds   5 minutes   10 minutes

5. On a scale of 1 to 10 (1 not nervous/anxious: 10 extremely nervous/anxious) how nervous/anxious are you about starting this session?

   1   2   3   4   5   6   7   8   9   10
Appendix 2.3

Willingness Reports:

Instructions:

We are studying mental toughness. During this exercise you will be holding a weight that closely approximates 1.5% of your body weight. This weight is selected to assess pain tolerance. It is not a measure of strength or technique. As a result, this task is not likely to produce any long lasting effects, or produce residual soreness that will impact later exercise performance. The pain is only momentary, however, the longer you continue to hold the weight the more uncomfortable it will become. You will hold this weight for four rounds, but will have a 60 second rest period between each round. When you are holding the weight an audio recording will ask you “Are you willing to continue?” A response of “1” indicates that you willing to continue. A response of “5” indicates that you are not willing.

Cue Card:

Your Task:

Focus on how willing you are to continue

Please answer the following questions as they relate to the narrative above:

1. What percentage of your body weight will you be holding?

2. What character trait is this study aiming to evaluate?

3. What question will the audio recording ask you?

4. If you could delay the start of the session how long would you do so?

   0 seconds   30 seconds   60 seconds   5 minutes   10 minutes

5. On a scale of 1 to 10 (1 not nervous/anxious: 10 extremely nervous/anxious) how nervous/anxious are you about starting this session?

   1   2   3   4   5   6   7   8   9   10
Appendix 2.4

Dissociation Reports:

Instructions:
During this exercise you will be holding a weight that closely approximates 1.5% of your body weight. This weight is selected to assess pain tolerance. It is not a measure of strength or technique. As a result, this task is not likely to produce any long lasting effects, or produce residual soreness that will impact later exercise performance. The pain is only momentary, however, the longer you continue to hold the weight the more uncomfortable it will become. You will hold this weight for four rounds, but will have a 60 second rest between each round. When you are holding the weight an audio recording will ask you “Are you thinking of something else” A response of “1” indicates that you thinking of something unrelated to what your are presently doing. A response of “5” indicates that you are can only think of holding the weight.

Cue Card:

Your Task:

Focus on something else.

Please answer the following questions as they relate to the narrative above:

1. What percentage of your body weight will you be holding?
2. What character trait is this study aiming to evaluate?
3. What question will the audio recording ask you?
4. If you could delay the start of the session how long would you do so?
   - 0 seconds
   - 30 seconds
   - 60 seconds
   - 5 minutes
   - 10 minutes
5. On a scale of 1 to 10 (1 not nervous/anxious: 10 extremely nervous/anxious) how nervous/anxious are you about starting this session?
   - 1
   - 2
   - 3
   - 4
   - 5
   - 6
   - 7
   - 8
   - 9
   - 10
Appendix 2.5

Sport and Competition Monitor (Administered after every session)

Date: ___________  Participant # ___________

1. Did you notice or encounter any unique or unusual events that may have impacted your performance in competition or training, since the last meeting?

   Yes/No

   If yes, Please describe:


2. Were there any times since the last meeting that you can remember feeling stressed, frustrated, or emotional during training or competition?

   Yes/No

   If yes, how many times: ______________

   Do you feel this had an impact on your performance?

   Yes/No

   If yes, was this impact positive or negative? ___________

3. How painful was this session?

   
<table>
<thead>
<tr>
<th>Not painful</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>Extremely painful</th>
</tr>
</thead>
</table>


4. Do you feel like the way you approach the mental aspects of training and competition have changed since the last meeting?

   Yes/No

   If yes, Please describe:

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

5. Explain what you might do to increase your ability to hold the weight longer?

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________

6. Do you think you beat your best time during this session? What make you think you did or did not accomplish this?

   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
   __________________________________________________________
Appendix 2.6

To begin round 1 say "start" for the research assistant to give you a 5 second count down

5

4

3

2

1

11/7/15
Your Task:
Focus on how willing you are to continue.

A 60 second break will now begin (you will be given a 5 second count down)

Begin Round 2 in...

5

4

3
Your Task:
Focus on How willing you are to continue

A 60 second break will now begin
(you will be given a 5 second count down)

Round 3 will begin in... 5
Your Task:
Focus on how willing you are to continue.

A 60 second break will now begin (You will be given a 5 second count down)
Begin Round 4 in...

5

4

3

2

1

5
Your Task:

Focus on how willing you are to continue.

You have completed this session. Please complete the questionnaires the research team member has for you.

Thank you for your participation.
# Appendix 2.7

## AAQ-II

Below you will find a list of statements. Please rate how true each statement is for you by circling a number next to it. Use the scale below to make your choice.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>never true</td>
<td>very seldom true</td>
<td>seldom true</td>
<td>sometimes true</td>
<td>frequently true</td>
<td>almost always true</td>
<td>always true</td>
</tr>
</tbody>
</table>

1. My painful experiences and memories make it difficult for me to live a life that I would value.  
   1  2  3  4  5  6  7

2. I’m afraid of my feelings.  
   1  2  3  4  5  6  7

3. I worry about not being able to control my worries and feelings.  
   1  2  3  4  5  6  7

4. My painful memories prevent me from having a fulfilling life.  
   1  2  3  4  5  6  7

5. Emotions cause problems in my life.  
   1  2  3  4  5  6  7

6. It seems like most people are handling their lives better than I am.  
   1  2  3  4  5  6  7

7. Worries get in the way of my success.  
   1  2  3  4  5  6  7
Appendix 2.8

Sport and Competition Questionnaire (Initial Experiment 1)

Date:________  Participant #____________ (Research Team will complete)

Demographic Information

Sex: M/F  Dominant Hand: R/L  Age:________

Approximate Weight:________  How long have you done Crossfit:____

How many times a week do you train/work out:____________

Do you have a history with other sports or athletic activities? Yes/No

If yes please describe

_________________________________________________________________________________________________

_________________________________________________________________________________________________

Crossfit Questions

Please provide and rating for the following questions.

<table>
<thead>
<tr>
<th></th>
<th>I consider myself to be a mentally tough competitor.</th>
<th>Never True</th>
<th>Rarely True</th>
<th>Often True</th>
<th>Always True</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>I set goals to improve my performance.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>I follow a training program to meet my goals</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>I value mental toughness</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>I believe I am capable of performing better than I usually do.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>I get distracted when I think about how I feel</td>
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<table>
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<tr>
<th></th>
<th>during competitions.</th>
<th></th>
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<tbody>
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<td>I get discouraged if I don’t meet my goals.</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<tr>
<td>8</td>
<td>I must control my emotions in order to be a successful competitor.</td>
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<td>2</td>
<td>3</td>
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<tr>
<td>9</td>
<td>I meet, or satisfactorily approximate, the performance expiations I set for competitions.</td>
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<td>2</td>
<td>3</td>
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10. Do you use a specific training program for competition? __________
If yes what? Or do you develop your own? ______________

11. How often do you incorporate a rest/recovery day into your training? _____

12. Do you compete or train for events other than Crossfit competitions? Yes/No
If yes, please describe?
_________________________________________________________________________________________________

13. About how many competitions do you participate in each year? __________

14. How long have you been competing in Crossfit events? ________________

15. Explain what type of mental strategies you might use to increase your completion performance:
_________________________________________________________________________________________________
_________________________________________________________________________________________________
_________________________________________________________________________________________________
_________________________________________________________________________________________________
16. To you, what does a successful athlete do to insure their success?

17. Do you use your training data to inform subsequent training sessions? If so, please provide an example of how a new PR would inform subsequent training sessions. If you do not use training data in this manner, what does a new PR mean to you?
## Appendix 2.9

### Sports and Competition Behavior Questionnaire (Post Experiment 1)

#### Crossfit Questions

Please provide a rating for the following questions.

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<th>Rarely True</th>
<th>Often True</th>
<th>Always True</th>
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<td>1</td>
<td>I consider myself to be a mentally tough competitor.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>I set goals to improve my performance.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>I follow a training program to meet my goals</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>I value mental toughness</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>I believe I am capable of performing better than I usually do.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>I get distracted when I think about how I feel during competitions.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>I get discouraged if I don’t meet my goals.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>I must control my emotions in order to be a successful competitor.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>I meet, or satisfactorily approximate, the performance expectations I set for competitions.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

10. Do you use a specific training program for competition? ________
    If yes what? Or do you develop your own? __________

11. How often do you incorporate a rest/recovery day into your training? _____
12. Do you compete or train for events other than Crossfit competitions? Yes/No
   If yes, please describe?

_________________________________________________________________________________________________

13. About how many competitions do you participate in each year? _________

14. How long have you been competing in Crossfit events? ________________

15. Explain what type of mental strategies you might use to increase your completion performance:

_________________________________________________________________________________________________

_________________________________________________________________________________________________

_________________________________________________________________________________________________

_________________________________________________________________________________________________

16. To you, what does a successful athlete do to insure their success?

_________________________________________________________________________________________________

_________________________________________________________________________________________________

_________________________________________________________________________________________________

_________________________________________________________________________________________________

_________________________________________________________________________________________________
17. Do you use your training data to inform subsequent training sessions? If so, please provide an example of how a new PR would inform subsequent training sessions. If you do not use training data in this manner, what does a new PR mean to you?

18. Do you feel this study has changed how you approach workouts and competition from a metal standpoint? If yes, how so?

19. Did you find this study helpful to your competition performance and or athletic training?
20. Would you recommend this study to others?
Appendix 2.10

Sport and Competition Questionnaire (Initial Experiment 2)

Date:______ Participant #__________ (Research Team will complete)

Demographic Information

Sex: M/F Dominant Hand: R/L Age:__________

Approximate Weight:__________ How long have you done Crossfit:__________

How many times a week do you train/work out:__________

Do you have a history with other sports or athletic activities? Yes/No

If yes please describe

_________________________________________________________________________________________________

_________________________________________________________________________________________________

Crossfit Questions

Please provide and rating for the following questions.

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<thead>
<tr>
<th></th>
<th></th>
<th>Never True</th>
<th>Rarely True</th>
<th>Often True</th>
<th>Always True</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>I consider myself to be a mentally tough competitor.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>I set goals to improve my performance.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>I follow a training program to meet my goals</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>I value mental toughness</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>I believe I am capable of performing better than I usually do.</td>
<td>1</td>
<td>2</td>
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<td>4</td>
</tr>
<tr>
<td>6</td>
<td>I get distracted when I think about how I feel during competitions.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
7. I get discouraged if I don’t meet my goals.  

8. I must control my emotions in order to be a successful competitor.  

9. I meet, or satisfactorily approximate, the performance expectations I set for competitions.  

10. Do you use a specific training program for competition? __________  
    If yes what? Or do you develop your own? ______________  

11. How often do you incorporate a rest/recovery day into your training? ______  

12. Do you compete or train for events other than Crossfit competitions? Yes/No  
    If yes, please describe?  

13. About how many competitions do you participate in each year? __________  

14. How long have you been competing in Crossfit events? ______________  

15. Explain what type of mental strategies you might use to increase your completion performance:  

________________________________________  

________________________________________  

________________________________________  

________________________________________  

________________________________________  

________________________________________
16. When a training exercise becomes, painful, frustrating, or hard do you try to control those thoughts and feelings by focusing on what you're doing? How helpful is this to you?

17. When competing in an event becomes, painful frustrating, or hard do you try to control those thoughts and feelings by focusing on what you're doing? How helpful is this to you?

18. When a training exercise becomes, painful, frustrating, or hard do you try to control those thoughts and feelings distracting yourself from those events? How helpful is this to you?

19. When competing in an event becomes, painful frustrating, or hard do you try to control those thoughts and feelings distracting yourself from those events? How helpful is this to you?
Appendix 2.11

Sports and Competition Behavior Questionnaire (Post Experiment 2)

**Crossfit Questions**

Please provide and rating for the following questions.

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</thead>
<tbody>
<tr>
<td>1</td>
<td>I consider myself to be a mentally tough competitor.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>I set goals to improve my performance.</td>
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<td>4</td>
</tr>
<tr>
<td>3</td>
<td>I follow a training program to meet my goals</td>
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<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>I value mental toughness</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>I believe I am capable of performing better than I usually do.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>I get distracted when I think about how I feel during competitions.</td>
<td>1</td>
<td>2</td>
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<tr>
<td>7</td>
<td>I get discouraged if I don’t meet my goals.</td>
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<tr>
<td>8</td>
<td>I must control my emotions in order to be a successful competitor.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>I meet, or satisfactorily approximate, the performance expectations I set for competitions.</td>
<td>1</td>
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<td>4</td>
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</table>

10. Do you use a specific training program for competition? _________
    If yes what? Or do you develop your own? _________

11. How often do you incorporate a rest/recovery day into your training? ______
12. Do you compete or train for events other than Crossfit competitions? Yes/No

If yes, please describe?

_________________________________________________________________________________________________

13. About how many competitions do you participate in each year? __________

14. How long have you been competing in Crossfit events? ______________

15. Explain what type of mental strategies you might use to increase your completion performance:

_________________________________________________________________________________________________

_________________________________________________________________________________________________

_________________________________________________________________________________________________

_________________________________________________________________________________________________

16. When a training exercise becomes, painful, frustrating, or hard do you try to control those thoughts and feelings by focusing on what your doing? How helpful is this to you?

_________________________________________________________________________________________________

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_________________________________________________________________________________________________

17. When competing in an event becomes, painful frustrating, or hard do you try to control those thoughts and feelings by focusing on what your doing? How Helpful is this to you?

_________________________________________________________________________________________________

_________________________________________________________________________________________________

_________________________________________________________________________________________________

18. When a training exercise becomes, painful, frustrating, or hard do you try to control those thoughts and feelings distracting yourself from those events? How Helpful is this to you?
19. When competing in an event becomes, painful frustrating, or hard do you try to control those thoughts and feelings by distracting yourself from those events? How helpful is this to you?

20. Do you feel this study has changed how you approach workouts and competition from a mental standpoint? If yes, how so?

21. Did you find this study helpful to your competition performance and/or athletic training?

22. Would you recommend this study to others?
Appendix 2.12
“90-Degree” top 5 performers likert scale verbal responses

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Appendix 2.12 displays the verbal responses for the highest level post intervention total time performers in the 90-degree condition. Each round is noted and likert responses are presented in descending order.
### Appendix 2.13

“90-Degree” mid 5 performers likert scale verbal responses

<table>
<thead>
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<td>1 1 1 1</td>
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</table>

Appendix 2.13 displays the verbal responses for the mid level, post intervention total time performers in the 90-degree condition. Each round is noted and likert responses are presented in descending order.
Appendix 2.14

“90-Degree” low 5 performers likert scale verbal responses

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<td>5</td>
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</table>

Appendix 2.14 displays the verbal responses for the lowest level, post intervention total time performers in the 90-degree condition. Each round is noted and likert responses are presented in descending order.
Appendix 2.15
“Willingness” top 5 performers likert scale verbal responses

<table>
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<th>Round</th>
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Appendix 2.16

"Willingness" mid 5 performers likert scale verbal responses

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Appendix 2.16 displays the verbal responses for the middle level, post intervention total time performers in the Willingness condition. Each round is noted and likert responses are presented in descending order.
### Appendix 2.17

“Willingness” low 5 performers likert scale verbal responses

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Appendix 2.17 displays the verbal responses for the lowest level, post intervention total time, performers in the Willingness condition. Each round is noted and likert responses are presented in descending order.
**Appendix 2.18**

"Distract" top 5 performers likert scale verbal responses

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Appendix 2.18 displays the verbal responses for the highest level, post intervention total time, performers in the Distract condition. Each round is noted and likert responses are presented in descending order.
Appendix 2.19
“Distract” mid 5 performers likert scale verbal responses

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Appendix 2.19 displays the verbal responses for the middle level, post intervention total time, performers in the Distract condition. Each round is noted and likert responses are presented in descending order.
Appendix 2.20
“Distract” low 5 performers likert scale verbal responses

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Appendix 2.20 displays the verbal responses for the lowest level, post intervention total time, performers in the Distract condition. Each round is noted and likert responses are presented in descending order.