EXPLORING THE FOUR SOURCES OF SELF-EFFICACY

A Dissertation Presented to the Faculty
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Partial Fulfillment of the Requirements for the Degree of
Doctor of Philosophy in Business Administration

by

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ABSTRACT

Self-efficacy researchers have long theorized and commonly assumed that four distinct sources exist to instill people's beliefs about their efficacy: mastery experience, vicarious experience, verbal persuasion, and physiological arousal (Bandura, 1977, 1986, 1997). Despite this general assumption, there has surprisingly yet to be any empirical investigation to confirm the existence of the four distinct sources of self-efficacy. Moreover, no empirical investigation has been conducted to confirm the theory that strong efficacy antecedents will strengthen one's self-efficacy while adverse efficacy antecedents will weaken one's self-efficacy (Bandura, 1977, 1986, 1997; Chowdhury, Endres, & Lanis, 2002; Wood & Bandura, 1989). The objective of this research was to fill these gaps in the literature.

This study utilized a correlation design. A survey instrument comprised of scales designed to measure self-efficacy antecedents in relation to a particular task was used. The sample was an aircraft maintenance activity of the United States Navy. These organizations are subject to similar task, structural, and environmental conditions. Instruments were distributed to 434
potential respondents employed at an aircraft maintenance activity on the East Coast. There were 272 non-responses (N = 162).

An analysis of interdependence (i.e., a factor analysis) was utilized to ensure the homogeneity of the items for each scale as recommended by Bandura (2001). The items designed to measure vicarious experience and verbal persuasion failed to prove homogenous and, therefore, were not utilized. An analysis of dependence (i.e., multiple regression with effects-coded dummy variables) was utilized for hypotheses testing.

Although this research failed to confirm that four independent sources of self-efficacy exist for a given task, two considerable implications for theory were realized. This research empirically demonstrated that strong mastery experience and physiological arousal correlated to higher self-efficacy, while adverse mastery experience and physiological arousal correlated to lower self-efficacy for a specific task. Moreover, the first empirical evidence that adverse mastery experience would result in lower self-efficacy was obtained from this study.
DEDICATION

This work is dedicated to my wife, Cindy, and my daughter, Julia. Cindy’s steadfast support has enabled this and many other endeavors in years past. She has been amazing in her various roles as a wife, mother, manager, student, and friend. I look forward to our years to come. Julia is my “buddy” who always reminds me of the things that are truly important in life.
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In addition, I would like to acknowledge the men and women of the United States Army, Navy, Air Force, and Marine Corps. They voluntarily serve under difficult conditions, some of which would be inconceivable to most. Their service requires great sacrifice; in fact, some give all. It is their contribution to this nation that is the catalyst of our freedom and, therefore, our prosperity.
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CHAPTER 1: INTRODUCTION

1.1 Organizational Performance and the Human Factor

Many terms exist to describe the people of an organization. Examples include human resources (Gelade & Ivery, 2003), intellectual capital (Firer & Williams, 2003; Riahi-Belkaoui, 2003), and human capital (Cunningham, 2002). Accordingly, human performance is a factor when contemplating how to increase organizational performance (Cunningham, 2002; Firer & Williams, 2003; Gelade & Ivery, 2003; Riahi-Belkaoui, 2003) in most, if not all organizations. Perhaps this has never been more true than today.

To be effective, organizations must be able to adapt to a rapidly changing environment. Among the influences perpetuating this environment of widespread and rapid change are significant developments in technology and research, demographic and sociopolitical shifts, and the trend toward globalization. Moreover, these developments have brought the global economy to a crossroads between the industrial age and the postindustrial age (Senge, Carstedt, & Porter, 2001).

The supply of manual labor in developed nations such as the United States, Japan, and the West in general is
declining (Drucker, 1999; Sutherland, 1999).
Accordingly, intellectual capital is a critical element to organizations in developed countries because most labor is no longer prescribed and repetitive. Instead, qualified labor requires knowledge, the ability to apply that knowledge, and the ability to rapidly acquire new knowledge. Concisely, economic growth and survival in developed economies will depend on knowledge workers' productivity (Drucker, 1999).

Thus, it is clearly established that the human factor is significant to organizations (Cunningham, 2002; Firer & Williams, 2003; Gelade & Ivery, 2003; Riahi-Belkaoui, 2003) in all sectors and economies (Drucker, 1999). The trend toward automation and increased technological integration has not diminished this certainty. In fact, it may have magnified it. Human performance is a crucial factor in any organizational context.

1.2 Improving Human Performance

Once it is established that human performance is a significant factor to organizational performance, the challenge becomes improving human performance. When reduced to its simplest form, any measurement of human
performance will quantify a task. That task could range from manual to intellectual in nature, e.g., brick laying to book writing. Additionally, the task could require conscious thought or it could be routinized, i.e., recurrent tasks can be executed by either lower level sensory-motor systems or higher cognitive controls (Bandura, 1997).

In any case, a person needs two resources to successfully perform any task - the requisite skill (or knowledge) and self-efficacy (Bandura, 1982, 1986, 1997; Wood & Bandura, 1989). In many cases, a certain level of skill or knowledge is a requirement of employment. Moreover, knowledge acquisition and enhancement is routinely addressed in many organizations, e.g., employee training and development, tuition assistance, on the job training, apprenticeships, etc. Although many possess the requisite level of knowledge or skill to perform a given task, few perform at an optimum level. It is posited that this is reflective mostly of a variance in self-efficacy.

The implications for organizations are considerable. Much research has been conducted concerning employee training and development as well as human development in
general. Moreover, much of this research has been utilized in practice. Although self-efficacy could be the foremost method of increasing the performance of an organization's members, little research has been done to investigate methods of influencing self-efficacy in organizational settings.

Self-efficacy impacts human functioning through four psychological processes: cognitive, affective, motivation, and selection (Bandura, 1994). The relationships between self-efficacy and each of these processes will be discussed as well as any practical consequences. Concisely, this research will investigate the foundation of human agency - self-efficacy (Bandura, 1999).
CHAPTER 2: THEORETICAL BACKGROUND

2.1 Self-Efficacy

2.1.1 The Foundation of Self-Efficacy: Social Cognitive Theory

Self-efficacy is a major component of social cognitive theory (Bandura, 1986; Chowdhury et al., 2002; Malone, 2001). Social cognitive theory explains psychosocial functioning in terms of triadic reciprocal causation (Bandura, 1986). The triad consists of behavior, cognitive and other personal factors, and the

Figure 2.1

Reciprocal and bi-directional nature of personal (P), behavioral (B), and environmental (E) factors.
external environment (Bandura, 1986; Wood & Bandura, 1989). Figure 2.1 demonstrates that the elements of the triad work in a reciprocal and bi-directional fashion (Bandura, 1986; Gist & Mitchell, 1992; Wood & Bandura, 1989). Wood and Bandura (1989) assert that reciprocity does not indicate that reciprocal influences are of equal strength or occur simultaneously. Additionally, the bi-directional nature of the triad means that people are both products and producers of their environment (Wood & Bandura, 1989). Accordingly, self-regulation of motivation and performance attainments are governed by several self-regulatory mechanisms that operate together, one of which is a person’s belief in personal efficacy (Wood & Bandura, 1989).

2.1.2 Self-Efficacy Defined

Self-efficacy is the foundation of human agency (Bandura, 1999). “Perceived self-efficacy concerns people’s beliefs in their capabilities to mobilize the motivation, cognitive resources, and courses of action needed to exercise control over events in their lives” (Wood & Bandura, 1989, p. 364). Self-efficacy shouldn’t be confused with confidence. Self-efficacy isn’t merely a general belief in one’s ability. As mentioned, it is
much larger in scope because it is an assessment of one's capabilities in three complex and crucial areas: motivation, resources, and action. In addition, self-efficacy is not a generalized trait (Bandura, 1982, 1986), it is a person's belief in his or her ability to perform a specific task.

To be sure, one needs both skill and self-efficacy to successfully perform a task (Bandura, 1982, 1986; Wood & Bandura, 1989). Nevertheless, given the same level of skill, differences in self-efficacy could result in different performance outcomes (Gist & Mitchell, 1992; Wood & Bandura, 1989). For example, if two students with identical scores on college entrance examinations pursued the same curriculum, they would not likely graduate with identical grade point averages. This is not reflective of a variation in skill level, but a variation in self-efficacy. To be sure, the immediate basis of the lesser performance could be any number of factors such as illness or stress. The possibilities seem limitless; however, these immediate factors directly influence one's self-efficacy, which then impacts performance. In terms of illness, this could adversely affect performance by lowering one's efficacy after negatively influencing
his/her physiological state (i.e., one of the self-efficacy antecedents, which will be discussed in much detail later). On the other hand, if one was generally healthy and energetic, this could improve performance by raising one's efficacy after positively influencing his/her physiological state.

This is precisely why self-efficacy is one of the most powerful motives of behavior. At a given point in time, it determines the initial decision to perform a task, the amount of effort to be expended, and the level of persistence (Gardner & Pierce, 1998). Anyone concerned with impacting organizational or human performance should be interested.

2.1.3 The Dynamics of Self-Efficacy

Self-efficacy has three dimensions: magnitude, strength, and generality (Gist, 1987). First, magnitude describes the level of task difficulty; e.g., lifting an object that weighs 10 pounds versus 100. Second, strength describes whether the conviction regarding magnitude is strong or weak; e.g., some people could believe much more strongly in their ability to lift a 100-pound object than others. Finally, generality describes the degree to which the expectation is
generalized across situations; e.g., a person's efficacy for lifting a 100-pound object may or may not vary with fatigue.

Another premise of self-efficacy is that it changes over time with new information and experience, i.e., it is dynamic (Gardner & Pierce, 1998; Gist & Mitchell, 1992). This is true for both conscious and routinized tasks. "When routinized behavior repeatedly fails to produce expected results, the cognitive control system again comes into play. Both the behavior and the changing environmental circumstances are monitored to identify the source of the problem. New modes are considered and tested. Control reverts to the lower control system after an adequate mode is found and becomes the habitual way of doing things" (Bandura, 1997, p. 34).

2.2 The Impact of Self-Efficacy on Human Functioning

Bandura (1994) tells us that self-efficacy affects human functioning through the four major psychological processes. These are the cognitive, motivational, affective, and selection processes. Each process is described below with respect to its association with self-efficacy.
2.2.1 Self-Efficacy and Cognitive Processes

Self-efficacy impacts the cognitive process by influencing the anticipatory scenarios humans construct and rehearse (Bandura, 1994). For instance, those with high self-efficacy beliefs tend to anticipate success scenarios while those with low self-efficacy beliefs tend to dwell on pitfalls and anticipate failure. In short, self-efficacy impacts analytic thinking (Bandura, 1994).

2.2.2 Self-Efficacy and Motivation Processes

Self-efficacy impacts motivation by determining goal level, perseverance, and resilience to failures (Bandura, 1994). Those with a high sense of self-efficacy tend to set higher goal levels than those with low self-efficacy and, consequently, tend to exert more effort. Additionally, those with low self-efficacy tend to attribute failures to a lack of ability while those with high self-efficacy tend to attribute failures as a lack of effort. Accordingly, those with low self-efficacy tend to give up in difficult situations and limit their future involvement in similar endeavors (Bandura, 1997; Weiner, 1985). Conversely, those with high self-efficacy persevere in difficult circumstances and are resilient in light of failure (Bandura, 1997; Weiner, 1985).
2.2.3 Self-Efficacy and Affective Processes

Affective processes, which regulate emotional states and the elicitation of emotional or physiological reactions, are influenced by self-efficacy on several fronts. Bandura (1994) offers the following example; a weak sense of efficacy to exercise control over stressors activates autonomic reactions, catecholamine secretion, and release of endogenous opioids. Conversely, those with a greater sense of self-regulatory efficacy tend to be more successful in reducing health impairing habits and incorporating health-promoting habits into their lifestyle (Bandura, 1994).

2.2.4 Self-Efficacy and Selection Processes

Self-efficacy influences selection processes. That is, self-efficacy influences the types of activities and environments people choose. Bandura (1994) tells us that people avoid situations that they believe are beyond their capabilities, but readily undertake challenges that they perceive themselves to be capable of handling. Higher self-efficacy beliefs will lead to more challenging undertakings (Bandura, 1997).

2.3 The Practical Consequences of Self-Efficacy
Several practical consequences of self-efficacy exist. These consequences will be discussed categorically as cognitive, affective, negative, and performance consequences. Additionally, the implications from an organizational standpoint will be discussed.

2.3.1 Cognitive Consequences

An abundance of literature exists that describes the impact of self-efficacy on an individual's approach to learning. Self-efficacy for memory functioning is an important element of metamemory (Bandura, 1989). Stevens and Gist (1997) assert that matching post-training interventions to trainees' self-efficacy yields improved skill maintenance. In addition, Brown (2001, p. 279) tells us, "individuals with high learning self-efficacy are hypothesized to practice more and spend more time learning than individuals with low self-efficacy. In addition, high self-efficacy individuals are likely to experience less off-task attention, generated by anxiety, than individuals with low self-efficacy."

From an organizational standpoint, self-efficacy is a crucial element to the intellectual capital of the firm. It is commonly speculated that people will need to be continuously retrained throughout their careers.
Additionally, intellectual capital has become a critical component to most organizations in developed nations because economic growth can only occur if their knowledge workers are productive (Drucker, 1999). This productivity is not only based upon acquired knowledge and the ability to apply it, but also the ability to rapidly acquire new knowledge. These are challenging attributes to achieve when considering the magnitude, velocity, and unpredictability of change in recent years. It is imperative that firms understand the practical ramifications of self-efficacy in the cognitive domain in order to best improve and maintain their intellectual capital.

2.3.2 Affective Consequences

In the affective domain, self-efficacy is thought to be negatively related to anxiety among newcomers to organizations (Saks, 1994). Self-efficacy could be a moderating variable that determines whether job control contributes positively or negatively to coping with work stressors (Schaubroeck & Merritt, 1997). Jex and Bliese (1999) continue that self-efficacy could moderate the relationship between stressors and strains.

2.3.3 Negative Consequences
Although most effects of self-efficacy are positive, some potentially negative relationships exist. For instance, the motivation decreasing effects of initial negative self-efficacy perceptions are more robust than the motivational effects of initial positive self-efficacy perceptions (Stone, 1994). In addition, people with high self-efficacy perceptions tend to make self-serving attributions for poor performance while people with low self-efficacy perceptions tend to make self-effacing attributions for poor performance (Silver, Mitchell, & Gist, 1995). High self-efficacy perceptions could also exacerbate the economically irrational escalation bias whereas low self-efficacy perceptions would diminish it (Whyte, Saks, & Hook, 1997).

Nevertheless, some problems are helpful if not necessary. According to Wood and Bandura (1989, p. 364), "...if people experience only easy successes, they come to expect quick results and are easily discouraged by failure. To gain a resilient sense of efficacy, people must have experience in overcoming obstacles through perseverant effort."

Both individuals and the organizations that employ them should be aware of the potentially negative
consequences of self-efficacy. As mentioned, one needs both skill and self-efficacy to perform a task. Great care should be taken, especially in organizational settings, to ensure both are present. Although the expected negative scenario involves the possession of skills with a deficiency of self-efficacy, the reverse is possible.

2.3.4 Performance Consequences

In a series of three experimental studies, Cole and Hopkins (1995) reported a strong, significant correlation between individual self-efficacy and performance. Several other researchers have, in one fashion or another, supported the notion that self-efficacy is a correlate of performance (Bandura, 1991; Gibson, 2001; Malone, 2001; Prussia, Anderson, & Manz, 1998; Renn & Fedor, 2001; Stajkovic & Luthans 1998). In a meta-analysis of two decades of research, Stajkovic and Luthans (1998) report that self-efficacy explains a 28% increase in performance as compared to organizational behavior modification (17%), feedback interventions (13.6%), and goal setting (10.9%). Additionally, self-efficacy is thought to play a critical role in influencing effectiveness, perceived productivity, job
satisfaction, and ability to cope in remote workers
(Staples, Hulland, & Higgins, 1999), which is significant
given the trend toward telecommuting.

2.4 Self-Efficacy in an Organizational Context

Given the aforementioned performance consequences of
self-efficacy, the possibilities in an organizational
context are countless. All organizations exist to serve
some purpose or perform some function. Self-efficacy has
been clearly demonstrated to impact performance. If not
for the aforementioned practical consequences, anyone in
a leadership or managerial capacity should take an active
interest in the self-efficacy of everyone under his or
her cognizance on this account. Some investigation has
occurred in this realm.

Gist (1987) tells us that the following motivational
concepts, which are within a leader’s control, are
related to self-efficacy: goal setting, feedback, and the
Pygmalion Effect (positive expectations of others).
Others have supported the importance of feedback from
those in leadership (Chowdhury, Endres, & Lanis, 2002;
Wood & Bandura, 1989). Wood and Bandura (1989) state
that follower efficacy can be built by assigning tasks
that will bring success, avoiding situations in which
failure is likely, and measuring success by self-improvement versus triumphs over others.

In addition to echoing the importance of successful work experiences, Pearlmutter (1998) tells us that management has a responsibility to promote staff self-efficacy by creating a culture and environment that increases self-confidence and organizes around teamwork. Luthans and Peterson (2002) demonstrate that managers' self-efficacy is a partial mediator of employee engagement and rated manager effectiveness. Finally, leadership climate at a higher level in the organization affects self-efficacy by enhancing role clarity, while leadership climate at the lower organizational levels impacts self-efficacy by moderating psychological strain (Chen & Bliese, 2002).

2.5 Nature of the Problem

Clearly, some valuable investigation has occurred. The consequences and implications of self-efficacy are well established. Nevertheless, much work remains in the realm of investigating self-efficacy in an organizational context. Specifically, it must be understood how to enhance performance by influencing self-efficacy.
As mentioned, we know that people need two things to successfully perform any task - the requisite skill(s) and self-efficacy (Bandura, 1977, 1986, 1997). Moreover, we also know that self-efficacy positively correlates to performance (Bandura, 1991; Cole & Hopkins, 1995; Gibson, 2001; Malone, 2001; Prussia, Anderson, & Manz, 1998; Renn & Fedor, 2001; Stajkovic & Luthans 1998; Staples, Hulland, & Higgins, 1999). All that is seemingly needed to achieve optimum performance is a system to ensure that employees either possess or acquire requisite skills and then strengthen and maintain their self-efficacy in each task that they must perform. Nevertheless, optimum performance is rarely achieved, if ever.

It is theorized and commonly assumed that people's beliefs about their efficacy can be instilled and strengthened in four principle ways: mastery experiences, vicarious experience, verbal persuasion, and physiological arousal (Bandura, 1977, 1986, 1997; Wood & Bandura, 1989). It is posited that these sources are the nexus between the leadership of an organization and the self-efficacy of its members. Nevertheless, little empirical analysis has occurred with respect to Bandura's (1977, 1986, 1997) theory. Moreover, no empirical
analysis has been conducted to confirm that four distinct sources of self-efficacy exist for a given task. Accordingly, before any research is conducted to exploit this nexus, it must be certain that the four commonly held sources of self-efficacy are, in fact, sources of self-efficacy.

2.5.1 Statement of the Problem

There is no empirical basis confirming Bandura's (1977, 1986, 1997) theory that four distinct sources of self-efficacy exist for a given task. An exhaustive review of self-efficacy antecedent literature was conducted and subsequently documented. Each antecedent was examined independently. Afterward, a framework was presented to measure each self-efficacy antecedent in relation to a specific task.
CHAPTER 3: LITERATURE REVIEW AND HYPOTHESES

3.1 Sources of Self-Efficacy

People's beliefs about their efficacy can be instilled and strengthened in four principle ways: mastery experiences, modeling, social persuasion, and judgments of their physiological states (Bandura, 1977, 1986, 1997; Wood & Bandura, 1989). Moreover, strong efficacy antecedents will strengthen one's self-efficacy while adverse efficacy antecedents will weaken one's self-efficacy (Bandura, 1977, 1986, 1997; Chowdhury et al., 2002; Wood & Bandura, 1989). Hereafter, each source of self-efficacy is discussed individually.

3.1.1 Mastery Experience

Mastery experience, also called enactive mastery, enactive attainment, or performance attainment, is the most powerful source of self-efficacy (Bandura, 1977, 1986, 1997; Chowdhury et al., 2002; Dawes, Horan, & Hackett, 2000; Wise & Trunnell, 2001; Wood & Bandura, 1989). Smith (2002) states two reasons for this. First, enactive mastery is based on experiences that are direct and personal. Second, mastery is usually attributed to one's own effort and skill. Although enactive mastery is
described as the greatest source of self-efficacy, little empirical information exists in this realm.

Direct experience is thought to increase self-efficacy in mathematics students (Lopez, Lent, Brown, & Gore, 1997); however, this finding that supports the notion of enactive mastery as a source of self-efficacy was based upon assumption, not direct empirical investigation. Reading scores were found to predict self-efficacy in inner city, Hispanic-American adolescents (Chin & Kameoka, 2002); however, Bandura’s notion was again assumed, not investigated. Enactive mastery, as well as the other three sources of self-efficacy, was tested in relation to computer (information technology) interest with significant findings; however, the four sources of self-efficacy are implied and based upon Bandura (1986). Debowski, Wood, and Bandura (2001) have gone a step further under this assumption by investigating, albeit with significant findings, the impact of guided exploration (a hybrid of both mastery and vicarious experiences) on self-efficacy. Finally, Wise and Trunnell (2001) demonstrated in a six-group, single-factor with repeated measures experimental design that bench press efficacy increased when mastery
experience was followed by vicarious experience and/or verbal persuasion.

In contrast, Dawes et al. (2000) reported inconsistent findings with the aforementioned studies. The impact of mastery experiences on self-efficacy in middle school technology students was investigated with no significant findings (Dawes et al., 2000). Although the evidence that mastery experience is a source of self-efficacy far outweighs this inconsistency, this finding detracts from Bandura’s (1977, 1986, 1997) theory nonetheless.

More importantly, the aforementioned empirical findings were based only on strong efficacy antecedents. As discussed previously, strong mastery experiences are believed to strengthen self-efficacy while adverse mastery experiences (failures) are believed to weaken self-efficacy (Bandura, 1977, 1986, 1997; Chowdhury et al., 2002; Wood & Bandura, 1989). Nevertheless, no empirical analysis has been conducted that specifically tests whether strong mastery experience correlates to higher self-efficacy while adverse mastery experience correlates to lower self-efficacy for a given task.
H1a: A strong mastery experience will correlate to higher self-efficacy.

H1b: An adverse mastery experience will correlate to lower self-efficacy.

3.1.2 Vicarious Experience

Vicarious experience, known also as modeling, affects self-efficacy through a social comparison process where people judge their capabilities in relation to the capability of others (Bandura, 1977, 1986, 1997; Wood & Bandura, 1989). Vicarious experience is believed to be the second most effective way to develop self-efficacy (Chowdhury et al., 2002; Wise & Trunnell, 2001). "Proficient models build self-beliefs of capability by conveying to observers effective strategies for managing different situations" (Wood & Bandura, 1989, p. 364).

Gorrell and Capron (1990) demonstrated that cognitive modeling, where the model narrates the thought process behind the behavior, increased the self-efficacy of pre-service teachers. In addition to verbal persuasion, vicarious experience has also been demonstrated to increase the self-efficacy of pre-service teachers (Hagen, Gutkin, Wilson, & Oats, 1998). In a field experiment, Israeli soldiers' self-efficacy for
assignment to Special Forces was increased through vicarious experience and verbal persuasion (Eden & Kinnar, 1991). Lopez et al. (1997) tells us in a non-empirical fashion that vicarious experience and performance attainment (i.e., mastery experience) increases mathematics self-efficacy. Guided exploration, a hybrid of both enactive mastery and vicarious experience, was also found to increase self-efficacy (Debowski et al., 2002).

Several empirical studies have demonstrated that vicarious experience is a source of self-efficacy. However, these studies have not investigated vicarious experience itself while controlling for mastery experiences, verbal persuasion, and physiological arousal. In addition to vicarious experience, verbal persuasion was also present in three studies (Eden & Kinnar, 1991; Gorrell & Capron, 1990; Hagen et al., 1998). Enactive mastery supplemented vicarious experience in two additional studies (Debowski et al., 2002; Lopez et al., 1997). Moreover, it is theorized that observing similar people succeed with sustained effort raises one’s efficacy beliefs, while observing similar people fail despite high effort lowers one’s
efficacy beliefs and undermines their efforts (Chowdhury et al., 2002; Wood & Bandura, 1989). Nevertheless, no empirical analysis has been conducted that specifically tests whether strong vicarious experience correlates to higher self-efficacy while adverse vicarious experience correlates to lower self-efficacy for a given task.

*H2a:* A strong vicarious experience will correlate to higher self-efficacy in the absence of mastery experience and verbal persuasion.

*H2b:* An adverse vicarious experience will correlate to lower self-efficacy in the absence of mastery experience and verbal persuasion.

3.1.3 Verbal Persuasion

Verbal persuasion, also known as social persuasion, is another way to increase people's beliefs in their efficacy (Bandura, 1977, 1986, 1997; Wood & Bandura, 1989). Verbal persuasion is thought to be the third most effective way to develop self-efficacy (Chowdhury et al., 2002; Wise & Trunnell, 2001). Wise and Trunnell (2001) also demonstrate that verbal persuasion is most effective when following a performance accomplishment (i.e., a
mastery experience). "If people receive realistic encouragement, they will be more likely to exert greater effort and to become successful than if they are troubled by self-doubts" (Wood & Bandura, 1989, p. 365).

In Eden and Kinnar's (1991) field experiment with a non-equivalent groups design, Israeli soldiers' self-efficacy for assignment to Special Forces was increased in the treated group through verbal persuasion and a subsequent, substantial increase in volunteerism occurred. Verbal persuasion, along with vicarious experience, has been found to increase the self-efficacy of pre-service teachers (Hagen et al., 1998). Social persuasion predicts educational and occupation self-efficacy in inner city, Hispanic-American adolescents (Chin & Kameoka, 2002).

Empirical analysis has confirmed that verbal persuasion is a source of self-efficacy. Research specifically testing whether social or verbal persuasion is a source of self-efficacy also had elements from the other sources of self-efficacy therein. Two studies had elements of vicarious experience (Eden & Kinnar, 1991; Hagen et al., 1998). Chin and Kameoka's (2002) study also tested the impact of mastery experiences on self-
efficacy. In addition, no empirical investigation has occurred that specifically tests whether strong verbal persuasion correlates to higher self-efficacy while adverse verbal persuasion correlates to lower self-efficacy for a given task.

\[ H3a: \quad \text{Strong verbal persuasion will correlate to higher self-efficacy in the absence of mastery experience and vicarious experience.} \]

\[ H3b: \quad \text{Adverse verbal persuasion will correlate to lower self-efficacy in the absence of mastery experience and vicarious experience.} \]

3.1.4 Physiological Arousal

People's judgments concerning their physiological states, i.e., physiological arousal, are the fourth determinant of self-efficacy (Bandura, 1986; Wood & Bandura, 1989). Physiological arousal is also called affective arousal (Smith, 2002) and emotional arousal (Conger & Kanungo, 1988; Hagen et al., 1998). Generally, people attribute a physiological condition to an efficacy perception; e.g., fatigue is attributed to physical
incapability (Wood & Bandura, 1989). Conger and Kanungo (1988) further describe this phenomenon as follows:

Emotional arousal states that result from stress, fear, anxiety, depression, and so forth, both on and off the job, can lower self-efficacy expectations. Individuals are more likely to feel competent when they are not experiencing strong aversive arousal. Empowerment techniques and strategies that provide emotional support for subordinates and that create a supportive and trusting group atmosphere can be more effective in strengthening self-efficacy beliefs (p. 479).

Chowdhury, Endres, and Lanis (2002) assert that this is the least most important determinant of the four.

Hill and Ward (1989) demonstrated that two different versions of the same mood manipulation are capable of producing comparable mood states that have significantly different effects on perceived self-efficacy. Lower levels of perceived stress (i.e., a strong efficacy antecedent) before and during a climb correlate to higher self-efficacy in one's ability to execute the correct climbing technique (Jones, Mace, Bray, & MacRae, 2002). In a study examining the social conventions of tennis,
the adverse impact of negative mood was found to be greater among low-efficacy players than high-efficacy players (Ryska, 2002). To be sure, the Ryska (2002) study supports the theory; however, negative mood and self-efficacy were assessed prior to the intervention (i.e., the tennis match) in order to examine another outcome.

The aforementioned studies support Bandura’s (1977, 1986, 1997) theory that four distinct sources of self-efficacy exist. Moreover and unlike the other antecedents, researchers have examined physiological arousal with both strong and adverse antecedents as variables. Nevertheless, no empirical investigation has occurred that specifically tests whether strong physiological arousal correlates to higher self-efficacy while adverse physiological arousal correlates to lower self-efficacy for a given task.

H4a: **Strong physiological arousal will correlate to higher self-efficacy.**

H4b: **Adverse physiological arousal will correlate to lower self-efficacy.**
CHAPTER 4: METHODOLOGY

This study utilized a non-experimental design. Initially, scales which measure self-efficacy antecedents vis-a-vis two specific tasks common to the sample used in this research were developed. The corresponding items were incorporated into a survey instrument. These scales were largely based upon commonly held principles of self-efficacy theory and self-efficacy scale construction in appraisal-based scenarios. Once the instrument was constructed, a sample was surveyed. An analysis of interdependence (i.e., a factor analysis) was utilized to ensure the homogeneity of the scales as recommended by Bandura (2001). An analysis of dependence (i.e., multiple regression with effects-coded variables) was utilized for hypotheses testing.

This research was intended to establish an empirical basis for Bandura's (1977, 1986, 1997) theory that four distinct sources of self-efficacy exist for a particular task. Strong efficacy antecedents are believed to correlate to higher self-efficacy while adverse antecedents are believed to correlate to lower self-efficacy for a given task (Bandura, 1977, 1986, 1997; Chowdhury et al., 2002; Wood & Bandura, 1989).
Accordingly, it is posited that one must examine efficacy antecedents from both a strong and an adverse perspective. Explicitly, each distinct efficacy antecedent should correlate to higher self-efficacy if it is strong in nature; conversely, each distinct efficacy antecedent should correlate to lower self-efficacy if it is adverse in nature.

4.1 Sample Population

Theoretically, the four sources of self-efficacy are universal; i.e., these sources apply to every task. Nevertheless, one’s efficacy will vary from task to task. Consequently, when attempting to measure self-efficacy antecedents, a particular task must be chosen. When choosing such a task, it is desirable to identify a specific population because specific populations will routinely engage in tasks that are generic among the members. For example, it can be reasonably assumed that a generic task among law enforcement officers is using firearms when necessary. Identifying a task that is either generic within or peculiar to a specific population or organization also allows for increased validity by controlling for significant structural and, at times, environmental disparities.
Accordingly, the overall population of this study was comprised of the field-based aircraft maintenance organizations of the United States Navy. Over 200 of these organizations exist ranging in size from approximately 200 members to over 1,700 members. One of these organizations served as the sample. Such breadth and depth was desirable because it allows for a high rate of unwilling participation among samples while providing a sufficient number of participants from a statistical standpoint.

Additionally, these activities are subject to virtually identical structural and environmental conditions, with the exception of geographic location. This ensures homogeneity and therefore validity should multiple samples be desired. These structural and environmental conditions are detailed in a five-volume policy document that governs all of naval aviation maintenance (NAMP, 2001). The policy and procedures are mandatory unless permission is granted by the staff of the top Admiral in the U. S. Navy (NAMP, 2001). Permission is rarely sought or granted. Most importantly, though, the vast majority of individuals
within these organizations perform a series of generic tasks.

4.2 Measures

As demonstrated in Table 4.1, the independent variables are a specific task, the four efficacy antecedents, and the strength of the antecedent. The task must be specific and apply to all of the other variables in order to test the hypotheses. As mentioned earlier, the four sources of self-efficacy are thought to exist universally; however, the strength and magnitude of each source will vary from task to task (Bandura, 1986, 1997). Accordingly, a specific task was utilized. Each antecedent (i.e., source of self-efficacy) was investigated independently in relation to the given task and varying antecedent strength levels. Three levels of antecedent strength were included: strong, moderate, and adverse. The strong and adverse measures were used for hypotheses testing. The moderate measures served as the reference group, which is necessary for statistical analysis. Finally, control variables were utilized for testing vicarious experience and verbal persuasion, which is discussed in detail later.
### 4.2.1 Dependent Variable

The dependent variable is self-efficacy. The measure is a self-efficacy appraisal, which is the response to an item of a self-efficacy scale on the instrument. Self-efficacy is a belief in one’s capabilities to mobilize the motivation, cognitive resources, and courses of action needed to exercise control over a specific event (Bandura, 1977, 1986, 1997). A self-efficacy appraisal is an expression of that belief. It is posited that one’s self-efficacy appraisal is likely the best measure of self-efficacy because threats to validity are born only to flawed designs provided that certain conditions are met, such as privacy, anonymity, etc. (Bandura, 2001).

The response scale format was largely identical to the format endorsed by Bandura (1997, 2001). It was
unipolar, ranging from 0 to 10. Self-efficacy scales should not be bipolar because a rating of zero is equivalent to complete incapability to perform a task (Bandura, 2001). Additionally, self-efficacy scales with few response points are to be avoided because they are less sensitive and, therefore, reliable (Pajares, Hartley, & Valiante, 2001). Respondents were asked to rate their confidence ranges from 0, "cannot do at all"; to 5, "moderately certain can do"; to 10, "certain can do", which is the standard methodology for measuring efficacy beliefs (Bandura, 1997, 2001). The word "can" is used versus "will" because "can" is a judgement of capability, "will" is a statement of intention, and the two constructs are conceptually and empirically separable (Bandura, 1997, 2001).

4.2.2 Independent Variables

The three independent variables (efficacy antecedent, strength level, and the generic tasks pertinent to the target population) were operationally defined for the purposes of this research. Tasks must be defined operationally because self-efficacy varies for each person, task, and could change over time for both a given person and task. Additionally, the target
population must be able to understand the sources of self-efficacy and the corresponding strength levels in order to participate in this research; i.e., most respondents would not understand the term physiological arousal in this context.

The operational definitions of the first independent variable, a generic task, are discussed first. In any aircraft maintenance activity, two tasks are generic. All technicians or mechanics in these organizations both repair a component and use support equipment. These terms, although generic, have very specific meanings that are understood by members of aircraft maintenance activities worldwide.

The keyword in the phrase “repair a component” is the word component. Any aircraft is comprised of several subassemblies; e.g., an aircraft engine, an aileron, a radar system, etc. Moreover, some of these subassemblies have their own subassemblies; e.g., a jet engine could have an afterburner, compressor, turbine, etc. In the daily terminology of these technicians, whether they are electronics technicians, airframe mechanics, engine mechanics, etc., these subassemblies are all generically referred to as components. The basic mission of these
organizations is to restore aeronautical material (i.e. aircraft components) to good working order. How components are repaired brings us to the next generic task.

Support equipment is the essential term in the phrase "using support equipment". Support equipment is officially defined by the Department of the Navy as, "equipment required to make an aeronautical system, command and control system, support system, subsystem, or end item of equipment operational in its intended environment. This includes all equipment required to launch, arrest, guide, control, direct, inspect, test, adjust, calibrate, gauge, measure, assemble, disassemble, handle, transport, safeguard, store, actuate, service, repair, overhaul, maintain, or operate the system, subsystem, end item, or component" (NAMP, 2001, pg. C-53). In short, support equipment is something a technician in an aircraft maintenance activity uses to repair a component so an aircraft is operational. Examples of using support equipment include: inspecting the inside of a jet engine with an instrument called a boroscope; testing a wiring harness for the proper amount of ohms, amps, and volts with an instrument called a
multimeter; etc. Although items of support equipment vary by trade, component, and situation, they are all generically understood to be support equipment.

Operationally defining the second independent variable, the sources of self-efficacy, was largely accomplished by converting esoteric nomenclatures to action verbs. Mastery experience was operationally defined by describing the respondent previously performing the task; e.g., "...I have repaired the component". Modeling or vicarious experience was operationally defined by describing the respondent’s previous observation of task performance; e.g., "...I have watched someone repair the component". Verbal persuasion was operationally defined as the respondent having been verbally appraised of his or her ability to perform the task; e.g., "...I have been told that I can repair the component". Finally, physiological arousal or affective states was operationally defined as a respondents judging their ability to perform a task given a physiological state; e.g., "repair a component when I am feeling energized and cheerful". These operational definitions are further discussed in conjunction with survey item construction.
The third independent variable, antecedent strength, was incorporated by providing gradations of challenge. Bandura (2001, p. 3) tells us, "Perceived self-efficacy should be measured against levels of task demands that represent gradations of challenge or impediments to successful task performance. Self-efficacy appraisals reflect the level of difficulty individuals believe they can surmount. If there are no obstacles to overcome, the activity is easily performable and everyone has uniformly high self-efficacy for it."

Such a gradation must also exist when measuring the effects of self-efficacy sources; however, these will be gradations of success or failure versus challenge. Strong antecedents (i.e., successes) strengthen self-efficacy while adverse antecedents (i.e., failures) are believed to decrease self-efficacy (Bandura, 1977, 1986, 1997; Chowdhury et al., 2002; Wood & Bandura, 1989). Accordingly, an arrangement of items ranging from complete success to complete failure must be provided for each antecedent and task.

Operationally defining strong self-efficacy antecedents was accomplished by describing a complete success with no obstacles; e.g. "successfully ... with no
difficulty". Conversely, an adverse antecedent was described as a complete failure; e.g., "...unsuccessful in all previous attempts". In addition to measuring strong and adverse antecedents, a middle ground was needed for statistical analysis purposes, which is discussed later. This moderate strength level was described as a success with some inherent obstacles; e.g., "successfully ... with some difficulty".

4.2.3 Control Variables

In addition to the independent and dependent variables, control variables were utilized for testing hypotheses 2 and 3. Vicarious experience has been demonstrated to be a self-efficacy antecedent given the presence of mastery experience (Debowksi et al., 2002; Lopez et al., 1997), and verbal persuasion (Eden & Kinnar, 1991; Gorrell & Capron, 1990; Hagen et al., 1998). Verbal persuasion has been demonstrated to be a self-efficacy antecedent given the presence of mastery experience (Chin & Kameoka, 2002) and vicarious experience (Eden & Kinnar, 1991; Hagen et al., 1998). No research has investigated either theoretical source of self-efficacy independently.

For example, the Eden and Kinnar (1991) study tested Israeli soldiers' likelihood to volunteer for special
forces duty after the control group had both watched special forces soldiers training and were simultaneously told that they were capable of such training. Certainly, both efficacy antecedents were present; however, they were measured in the aggregate. Controlling for the other sources of self-efficacy when measuring vicarious experience and verbal persuasion was believed to allow original investigation that would confirm their distinct existence.

Accordingly, the items designed to measure vicarious experience and verbal persuasion were modified in order to isolate these antecedents from other self-efficacy antecedents. This was done by adding a phrase to the applicable items that controlled for the other sources, e.g., "...but have never attempted to repair the component myself or watched anyone attempt to repair the component." To be sure, self-efficacy antecedents are believed to work in conjunction to influence self-efficacy appraisals. Nevertheless, an investigation that isolates each antecedent is needed to empirically establish that four distinct sources of self-efficacy exist.

4.3 Scales
Scales were developed for each specific antecedent and strength level grouping. Two items were constructed for each scale, one for each of the generic tasks discussed previously. These scales were developed specifically for this research to provide an initial empirical investigation of the four sources of self-efficacy. These two-item scales were believed to be the minimum essential requirement for such an investigation. A general description of the scale construction framework and operational definitions were presented previously. A specific description for each scale and the corresponding items are subsequently presented.

4.3.1 Strong Mastery Experience

An item for each task was constructed to be reflective of a strong mastery experience. A mastery experience was operationally defined by describing the respondent previously performing the task; e.g., "...I have repaired the component". Operationally defining a strong strength level was accomplished by describing a complete success with no obstacles; e.g. "successfully ... with no difficulty". The corresponding items are presented below.
(1.) Repair a component when I’ve successfully repaired the component before with no difficulty
(13.) Use an item of support equipment when I’ve successfully used the support equipment before with no difficulty

4.3.2 Moderate Mastery Experience

An item for each task was constructed to be reflective of a moderate mastery experience. A mastery experience was again operationally defined by describing the respondent previously performing the task; e.g., "...I have repaired the component". A moderate strength level was described as a success with some inherent obstacles; e.g., "successfully ... with some difficulty". The corresponding items are presented below.

(2.) Repair a component when I’ve successfully repaired the component before with some difficulty
(14.) Use an item of support equipment when I’ve successfully used the support equipment before with some difficulty

4.3.3 Adverse Mastery Experience

An item for each task was constructed to be reflective of an adverse mastery experience. A mastery experience was again operationally defined by describing
the respondent previously performing the task; e.g., "...I have repaired the component". An adverse strength level was described as a complete failure; e.g., "...unsuccessful in all previous attempts". The corresponding items are presented below.

(3.) Repair a component when I’ve been unsuccessful in all previous attempts to repair the component
(15.) Use an item of support equipment when I’ve been unsuccessful in all previous attempts to use the support equipment

4.3.4 Strong Vicarious Experience

An item for each task was constructed to be reflective of a strong vicarious experience. A vicarious experience was operationally defined by describing the respondent’s previous observation of task performance; e.g., "...I have watched someone repair the component". Operationally defining strong strength level was accomplished by describing a complete success with no obstacles; e.g. "successfully ... with no difficulty". A phrase was added to vicarious experience scales to control for the other antecedents, e.g., "...but have never attempted to repair the component myself or been told
that I was capable of repairing the component." The corresponding items are presented below.

(4.) Repair a component when I’ve watched someone repair the component with no difficulty, but have never attempted to repair the component myself or been told that I was capable of repairing the component

(16.) Use an item of support equipment when I’ve watched someone use the support equipment with no difficulty, but have never attempted to use the support equipment myself or been told that I was capable of using the support equipment

4.3.5 Moderate Vicarious Experience

An item for each task was constructed to be reflective of a moderate vicarious experience. A vicarious experience was again operationally defined by describing the respondent’s previous observation of task performance; e.g., "...I have watched someone repair the component". A moderate strength level was described as a success with some inherent obstacles; e.g., "successfully ... with some difficulty". As mentioned previously, a phrase was added to vicarious experience scales to control for the other antecedents, e.g., "...but have never
attempted to repair the component myself or been told that I was capable of repairing the component." The corresponding items are presented below.

(5.) Repair a component when I’ve watched someone repair the component with some difficulty, but have never attempted to repair the component myself or been told that I was capable of repairing the component.

(17.) Use an item of support equipment when I’ve watched someone use the support equipment with some difficulty, but have never attempted to use the support equipment myself or been told that I was capable of using the support equipment.

4.3.6 Adverse Vicarious Experience

An item for each task was constructed to be reflective of an adverse vicarious experience. A vicarious experience was again operationally defined by describing the respondent’s previous observation of task performance; e.g., “...I have watched someone repair the component”. An adverse strength level was described as a failure; e.g., “...unsuccessfully”. As mentioned previously, a phrase was added to vicarious experience scales to control for the other antecedents, e.g., “...but
have never attempted to repair the component myself or been told that I was capable of repairing the component." The corresponding items are presented below.

(6.) Repair a component when I’ve watched someone attempt to repair a component unsuccessfully and have never attempted to repair the component myself or been told that I was capable of repairing the component

(18.) Use an item of support equipment when I’ve watched someone attempt to use an item of support equipment unsuccessfully and have never attempted to use the support equipment myself or been told that I was capable of using the support equipment

4.3.7 Strong Verbal Persuasion

An item for each task was constructed to be reflective of strong verbal persuasion. Verbal persuasion was operationally defined as the respondent having been verbally appraised of his or her ability to perform the task; e.g., "Repair a component when I have been told". Operationally defining strong strength level was accomplished by describing a complete capability for success with no obstacles; e.g. "... that I am capable and would have no difficulty". A phrase was added to verbal
persuasion scales to control for the other antecedents, e.g., "...but have never attempted to repair the component myself or watched anyone attempt to repair the component." The corresponding items are presented below.

(7.) Repair a component when I've been told that I am capable and would have no difficulty, but have never attempted to repair the component myself or watched anyone attempt to repair the component

(19.) Use an item of support equipment when I've been told that I am capable of using it with no difficulties, but have never attempted to use the support equipment myself or watched anyone attempt to use the support equipment

4.3.8 Moderate Verbal Persuasion

An item for each task was constructed to be reflective of moderate verbal persuasion. Verbal persuasion was again operationally defined as the respondent having been verbally appraised of his or her ability to perform the task; e.g., "Repair a component when I have been told". A moderate strength level was described as a capability for success with some inherent obstacles; e.g., "...that I am capable even though it would be difficult". As mentioned previously, a phrase was
added to verbal persuasion scales to control for the other antecedents, e.g., "...but have never attempted to repair the component myself or watched anyone attempt to repair the component." The corresponding items are presented below.

(8.) Repair a component when I’ve been told that I am capable even though it would be difficult, but have never attempted to repair the component myself or watched anyone attempt to repair the component
(20.) Use an item of support equipment when I’ve been told that I am capable of using it even though it would be difficult, but have never attempted to use the support equipment myself or watched anyone attempt to use the support equipment

4.3.9 Adverse Verbal Persuasion

An item for each task was constructed to be reflective of adverse verbal persuasion. Verbal persuasion was again operationally defined as the respondent having been verbally appraised of his or her ability to perform the task; e.g., "...I have been told". An adverse strength level was described as a complete incapability; e.g., "...that I am not capable". As mentioned previously, a phrase was added to verbal
persuasion scales to control for the other antecedents, e.g., "...but have never attempted to repair the component myself or watched anyone attempt to repair the component." The corresponding items are presented below.

(9.) Repair a component when I’ve been told that I am not capable of repairing the component and have never attempted to repair the component myself or watched anyone attempt to repair the component.

(21.) Use an item of support equipment when I’ve been told that I am not capable of using it and have never attempted to use the support equipment myself or watched anyone attempt to use the support equipment.

4.3.10 Strong Physiological Arousal

An item for each task was constructed to be reflective of strong physiological arousal. Strong physiological arousal was operationally defined as respondents judging their ability to perform a task given a positive physiological state; e.g., "repair a component when I am feeling energized and cheerful". The corresponding items are presented below.

(10.) Repair a component when I’m feeling energized and cheerful
(22.) Use an item of support equipment when I’m feeling energized and cheerful

4.3.11 Moderate Physiological Arousal

An item for each task was constructed to be reflective of a moderate physiological arousal. Moderate physiological arousal was operationally defined as respondents judging their ability to perform a task given a moderate physiological state; e.g., "repair a component when I am feeling physically and emotionally normal". The corresponding items are presented below.

(11.) Repair a component when I’m feeling physically and emotionally normal

(23.) Use an item of support equipment when I’m feeling physically and emotionally normal

4.3.12 Adverse Physiological Arousal

An item for each task was constructed to be reflective of adverse physiological arousal. Adverse physiological arousal was operationally defined as respondents judging their ability to perform a task given a moderate physiological state; e.g., "repair a component when I am feeling fatigued and stressed". The corresponding items are presented below.
(12.) Repair a component when I'm feeling fatigued and stressed
(24.) Use an item of support equipment when I'm feeling fatigued and stressed

4.4 The Instrument

The items and response scale for research involving self-efficacy sources bear many similarities to those involving self-efficacy appraisal in relation to a particular task. To be sure, this focus on self-efficacy antecedents did cause some differences in instrument design and item construction; however, every possible effort was made to keep this research uniform with the commonly held methods of self-efficacy scale construction in domain based (i.e., task based) scenarios. This was not only thought to allow for the possibility of future research involving both domain based and antecedent based research, but also afford some proven safeguards to validity.

The items included on the instrument also integrated original material with the standard methodology for measuring self-efficacy beliefs where possible. The major purpose of this research was to empirically determine if four independent sources of self-efficacy
exist for a particular task. Consequently, it would be impossible to fully employ measures that are targeted at measuring self-efficacy itself in domain based scenarios, e.g., math efficacy, computer self-efficacy, etc. Nevertheless, much valuable insight has been gleaned from years of self-efficacy research and it was utilized inasmuch as it was compatible with the objectives of this research. For instance, the items must cover a range of difficulty levels, albeit in a different context as discussed previously.

It is posited that one must measure efficacy in order to measure the effect of efficacy antecedents; therefore, the response scale is unipolar (0-10) to conform to the accepted means of self-efficacy appraisal. To confirm the theory that four distinct sources of self-efficacy exist, efficacy appraisals should correlate directly to the strength of the efficacy source. Explicitly, strong antecedents should correlate to higher efficacy appraisals, adverse antecedents should correlate to lower efficacy appraisals, and moderate antecedents should produce efficacy appraisals that fall between the appraisals reflecting strong and adverse antecedents. Concisely, for any instrument to effectively measure the
effect of self-efficacy antecedents, the items must be
task based, demonstrate a bipolar range of antecedent
strength (success to failure) for each task, and solicit
a response for an efficacy appraisal.

The instrument used in this research was designed to
empirically confirm the theory that four distinct sources
of self-efficacy exist for a particular task (Bandura,
1977, 1986). In doing so, it was necessary to
empirically demonstrate that strong efficacy antecedents
correlate to higher self-efficacy while adverse efficacy
antecedents correlate to lower self-efficacy (Bandura,
1977, 1986, 1997; Chowdhury et al., 2002; Wood & Bandura,
1989). In the interests of establishing this empirical
basis, only the most essential parameters were defined
for the instrument: the four self-efficacy sources, three
levels of antecedent strength, and two tasks.

Including all four sources of self-efficacy is
necessary given the hypotheses. Limiting the gradation
of antecedent strength to three levels (complete success,
moderate success, and total failure) was intended to keep
the design simple and, therefore, measurable. At a
minimum, two tasks were required to perform a factor
analysis to ensure instrument validity (Bandura, 2001).
Additionally, including two dissimilar tasks would increase reliability if the results are repeated (Trochim, 2000); i.e., regardless if appraisals differ between tasks, all efficacy appraisals should correlate directly to a range of given antecedent strengths (Bandura, 1977, 1986, 1997). This framework requires 24 items, i.e., two tasks, four sources, and three levels of antecedent strength (2 x 4 x 3).

The instrument itself (Appendix A) is a one page, two-sided document when printed. Each task encompasses one side of the document, along with the response scale, instructions, and one item from each scale that corresponds to the appropriate task. The items on each side were listed according to self-efficacy source and antecedent strength, respectively. The items were not scrambled on the instrument as they are intended to measure one's belief in his/her self-efficacy for a particular task given obvious gradations in challenge (Bandura, 2001). Appendix B depicts the arrangement of the items according to the various variables.

4.5 Study Procedures

4.5.1 Institutional Review Board Approval
The Institutional Review Board (IRB) of Touro University International must be consulted prior to any data collection involving human subjects. The Chairperson of the IRB reviewed the materials and determined that this research qualified for an expedited review, i.e., a review carried out by the IRB Chairperson alone. The purely anonymous nature of the instrument was noted. Accordingly, the Chairperson deemed the research acceptable and stated that the only further action was the inclusion of a cover letter (Appendix C) that explained the nature of the research to potential respondents and informed them of its voluntary and anonymous nature.

4.5.2 Data Collection Procedures

The researcher arrived on site on a Monday. Upon arrival, the researcher met with the executives that agreed to participate in order to restate the objectives of this research and give an overview of the data collection procedures. The executives' questions were answered and a briefing was held with the organization's middle managers. Afterward, based upon previous arrangement, the researcher visited each work center in the organization.
A work center is the next higher level of analysis beyond the individual in such an organization. That is, aircraft maintenance activities are organized by division, i.e., airframes division, electronics division, etc. Divisions are organized by groups referred to as work centers; e.g., the airframes division is comprised a paint work center, a hydraulics work center, a machinery repair work center, etc. Each of these work centers was visited to distribute instruments, provide instructions, and answer questions.

The various work center supervisors had received direction to cease production and convene a work center meeting when the researcher arrives. Respondents were assured by the researcher of their anonymity. The researcher pointed out the instructions on the instrument that state, "You are not identifiable by these responses. Please don’t write your name on this form."

Additionally, the respondents were informed that access would not be granted to the completed instruments in raw form. The respondents were also informed of the importance of their participation in this research. Instructions were given to complete the instrument privately during the course of the week and deposit the
instrument at a predetermined collection point. In closing, respondents were thanked for their cooperation. The researcher collected the completed instruments at the aforementioned collection point at close of business on Friday of that week.

The timeline of one workweek was arrived at after consulting a focus group comprised of four individuals. These individuals are either managers or former managers of an aircraft maintenance activity. A consensus was reached immediately. The group believed that anything less that one workweek would be viewed as an infringement on the stressful, deadline-driven schedules of the respondents and that they would intentionally decline to participate. A timeline that exceeded one workweek could lead to participation being delayed and then forgotten, an unintentional failure to participate. Consequently, one workweek was determined to be the allowable time for completion.

4.6 Analysis

4.6.1 Data Input and Organization

After collecting the instruments, the data was initially transferred into a Microsoft Excel spreadsheet. Responses were input according to task and antecedent
strength. Each was representative of respondent. Each of 24 columns was reflective of an item from the instrument, i.e., one response for each task, self-efficacy antecedent, and antecedent strength. From here, data could easily be managed for statistical analysis within the current application or be transferred to another statistical analysis program.

4.6.2 Analysis of Interdependence for Instrument Validity: Factor Analysis

A factor analysis should be performed to ensure that the items of a self-efficacy scale are homogenous (Bandura, 2001). Normally, this is done when only one domain of efficacy is present in a study or performed separately for each domain in a multiple domain study (Bandura, 2001). The results of a domain based self-efficacy study would be factor analyzed to ensure gradations of challenge are provided for (Bandura, 1997, 2001); i.e., each level of challenge should demonstrate a high correlation or factor loading. If this proved to be the case, the researcher could be confident that the instrument would measure what it was designed to measure - self-efficacy appraisals at varying levels of challenge within a domain (task).
Given that this research is unique in being antecedent based versus domain based, the primary focus was to ensure that the items designed to measure a specific antecedent and strength level are homogenous, irrespective of the task. Zikmund (2000, p. 544) tells us,

The general purpose of a factor analysis is to summarize the information contained in a large number of variables into a smaller number of factors. ...If a researcher has a set of variables and suspects that these variables are interrelated in a complex fashion, then factor analysis may be used to untangle the linear relationships into their separate patterns.

A factor analysis in antecedent based research should demonstrate that items representing the same scale load the same factor, regardless of task or domain. Each scale is representative of a specific antecedent and strength level and contains two items, one representative of each task. Concisely, the 24 items should yield 12 pairs of homogeneous factor loadings that form an interpretable factor structure.
Minitab statistical software was used to perform the factor analysis. As initially proposed by Cattell (1966), a scree test was used to determine the proper amount of factors to retain. Afterward, a factor analysis was conducted. If deemed necessary, one of the orthogonal factor rotation strategies was to be employed, i.e., varimax or quartimax. The objective of orthogonal rotation is to obtain loading values that are interpretable, which is a viable option given that rotation does not change the original contribution of the variables (Cooley & Lohnes, 1971). Varimax rotation squares the factor loadings to maximize variance, while quartimax rotation simplifies factor loadings by using the fourth power versus the second (Cooley & Lohnes, 1971). If the factor loadings proved the items for each scale homogenous, then regression analysis would be performed. In order to test each hypothesis, the three corresponding scales representative of the specific antecedent must have proved valid.

4.6.3 Analysis of Dependence for Hypothesis Testing:

Multiple Regression with Effects-Coded Dummy Variables

Multiple regression with effects-coded dummy variables was used to test the hypotheses. Multiple
regression is appropriate in studies with two or more independent variables, one dependent variable, and a level of analysis of interval or ratio for all variables (Zikmund, 2000). Moreover, regression is the common method of data analysis for self-efficacy research. An obstacle is encountered given that the independent variables in this study (task, antecedent, and antecedent strength) are not quantitative in nature. Explicitly, the varying degrees or categorizations (e.g., strong versus adverse, difficulty versus simple, etc.) can not be accurately expressed by arbitrarily assigning numeric values. Assigning such a value would impose an unrealistic measurement assumption. This was easily rectified with effects coded dummy variables. Hardy (1993) describes the method as follows:

When independent variables of interest are qualitative, we require a technique that allows us to represent this information in quantitative terms without imposing unrealistic measurement assumptions on the categorical variables. ...Defining a set of dummy variables allows us to capture the information contained in a categorization scheme and then to use this information in standard regression estimation.
In fact, the set of independent variables specified in a regression equation can include any combination of qualitative and quantitative predictors (p. 2).

The traditional coding scheme for dummy variables is binary. Each variable would be coded with either a 0 or 1. Hardy (1993) likens it to a light switch where 0 represents "off" and 1 represents "on". In such a coding scheme, a reference group must be identified to measure from and this group is usually at an extreme end of the possibilities, e.g., strongest or weakest, wealthiest or poorest, etc. (Hardy, 1993). This technique would not be useful given that the hypotheses in this study measure polar opposites from the middle; i.e., efficacy appraisals representative of strong and adverse antecedents must be measured from efficacy appraisals representative of moderate antecedents.

Thankfully, an alternative coding scheme exists for precisely such situations. Hardy (1993, p. 64) tells us that effects-coded dummy variables "define a middle category as reference group rather than one of the extreme categories of an ordinal distribution. The choice is often defended as a means of constructing group comparisons that mimic a contrast of designated
categories to an 'average' value for the overall sample.'"

Effects-coded dummy variables are coded in one of

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<th>Source</th>
<th>Antecedent</th>
<th>H1a</th>
<th>H1b</th>
<th>H2a</th>
<th>H2b</th>
<th>H3a</th>
<th>H3b</th>
<th>H4a</th>
<th>H4b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastery</td>
<td>Strong</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mastery</td>
<td>Moderate</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mastery</td>
<td>Adverse</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vicarious</td>
<td>Strong</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vicarious</td>
<td>Moderate</td>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vicarious</td>
<td>Adverse</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Verbal</td>
<td>Strong</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Verbal</td>
<td>Moderate</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Verbal</td>
<td>Adverse</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Physiological</td>
<td>Strong</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Physiological</td>
<td>Moderate</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-1</td>
<td>-1</td>
<td>0</td>
</tr>
<tr>
<td>Physiological</td>
<td>Adverse</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

The self-efficacy appraisal (DV) for each corresponding grouping and response.

three ways: 0, 1, or -1 (Hardy, 1993). The reference group (moderate efficacy antecedents) was coded as -1.
The group contrasted by the reference group (-1) was coded with 1.
Groups not being contrasted were coded with 0. Table 4.2 represents the coding scheme that was intended for use in performing the regression analyses in Microsoft Excel.

As previously mentioned, if the factor analysis failed to demonstrate that a scale is valid, all corresponding scales for that particular antecedent would have been useless for hypothesis testing; i.e., measurement from a moderate position toward (hypothesized) polar opposites would not be possible. In such a case, each row that is reflective of the responses to the items corresponding to these scales would have
been removed. In addition, the columns that are reflective of the corresponding hypotheses and dummy variables would have also been removed.

A separate regression analysis was performed for each of the generic tasks using the coding scheme above. In order to support the hypotheses, regression results should have been $R^2 > .28$ and $p < .001$ in both cases. The requirement for significant results in two separate tasks was based upon theory that sources of self-efficacy are applicable to all tasks in all domains (Bandura, 1977, 1986, 1997) and the traditional quantitative assumption of repeatability (Trochim, 2000).
CHAPTER 5: RESULTS

Instruments were distributed to 434 potential respondents employed at an aircraft maintenance activity on the East Coast. There were 272 non-responses (N = 162). The initially desired number of respondents (N = 200) was not achieved; however, a sample size of 162 is more than adequate for this research.

With respect to hypothesis testing with multiple regression, the recommended number of cases per independent variable normally varies from 5 to 20 cases per independent variable. Green (1991) recommends using one of two general formulas: $N > or = 50 + 8m$ (where $m$ = the number of independent variables), or $N > or = 104 + m$. Zizzi (2004) recommends calculating both formulas and using the higher number. This would further ensure that the sample size is reliable and maximize the power of the analysis. Given the three independent variables in this study, these calculations result in required sample sizes of $N = 84$ and $N = 107$ respectively. Accordingly, the sample size of $N = 162$ is considered adequate.

5.1 Factor Analysis for Instrument Validity

The data was input into a Microsoft Excel spreadsheet. It was arranged in columns by items or
independent variable sets; i.e., each column represented an antecedent, task, and antecedent strength grouping. Each row was reflective of the responses given by an individual respondent. The data was then transferred to Minitab statistical software.

A scree test was performed to determine the number of factors to retain. As suggested by Cattell (1966), all factors should be retained until an obvious leveling of eigenvalues occurs. As depicted below in Figure 5.1, the leveling in eigenvalues occurred after five factors; therefore, five factors were retained, accounting for 77.9% of the variance.

![Figure 5.1](image)

Ideally, the greatest factor loadings would have been homogenous when comparing similar antecedents and
antecedent strength levels between tasks; i.e., the 24 items should yield 12 pairs of homogeneous factor loadings. In addition, these pairs should have formed an interpretable factor structure. Explicitly, the homogenous factor pairings should have demonstrated a clear structure that would allow interpretation.

The data proved to be homogenous in all twelve variations with the unrotated factor loadings; however, an interpretable factor structure was not apparent. All of the variable pairings loaded one of two factors. Consequently, a rotation strategy was employed.

Varimax rotation was utilized in order to improve the fit by maximizing the variance of squared loadings for each factor (Kaiser, 1958). This rotational strategy is frequently employed in the domains of sociology and psychology (Jackson & Borgatta, 1981). In instances where the factor structure is overly compressed, varimax rotation will spread the factor loadings in order to provide an interpretable factor structure.

Such a factor structure was apparent in this case as evidenced in Table 5.1. Specifically, Factor 1 is representative of adverse antecedents that are directly related to task performance (i.e., mastery experience,
Table 5.1 Varimax Rotated Factor Loadings and Communalities

<table>
<thead>
<tr>
<th></th>
<th>Factor1</th>
<th>Factor2</th>
<th>Factor3</th>
<th>Factor4</th>
<th>Factor5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strong Mastery Experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>0.024</td>
<td>0.373</td>
<td>-0.023</td>
<td>1.078*</td>
<td>0.124</td>
</tr>
<tr>
<td>Use support equipment</td>
<td>-0.023</td>
<td>0.050</td>
<td>0.342</td>
<td>1.221*</td>
<td>-0.056</td>
</tr>
<tr>
<td><strong>Moderate Mastery Experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>0.656</td>
<td>0.489</td>
<td>-0.095</td>
<td>1.157*</td>
<td>0.003</td>
</tr>
<tr>
<td>Use support equipment</td>
<td>0.525</td>
<td>0.163</td>
<td>0.413</td>
<td>1.254*</td>
<td>-0.224</td>
</tr>
<tr>
<td><strong>Adverse Mastery Experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>2.028*</td>
<td>0.907</td>
<td>-0.310</td>
<td>0.705</td>
<td>-0.122</td>
</tr>
<tr>
<td>Use support equipment</td>
<td>2.160*</td>
<td>0.271</td>
<td>0.301</td>
<td>0.421</td>
<td>-0.318</td>
</tr>
<tr>
<td><strong>Strong Vicarious Experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>0.458</td>
<td>1.446*</td>
<td>0.548</td>
<td>0.693</td>
<td>-0.120</td>
</tr>
<tr>
<td>Use support equipment</td>
<td>0.330</td>
<td>0.582</td>
<td>1.417*</td>
<td>0.750</td>
<td>-0.249</td>
</tr>
<tr>
<td><strong>Moderate Vicarious Experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>0.816</td>
<td>1.568*</td>
<td>0.454</td>
<td>0.485</td>
<td>-0.194</td>
</tr>
<tr>
<td>Use support equipment</td>
<td>0.945</td>
<td>0.770</td>
<td>1.310*</td>
<td>0.558</td>
<td>-0.325</td>
</tr>
<tr>
<td><strong>Adverse Vicarious Experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>1.519</td>
<td>1.770*</td>
<td>0.402</td>
<td>0.257</td>
<td>-0.228</td>
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<tr>
<td>Use support equipment</td>
<td>1.690*</td>
<td>0.633</td>
<td>1.264</td>
<td>0.026</td>
<td>-0.289</td>
</tr>
<tr>
<td><strong>Strong Verbal Persuasion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>0.125</td>
<td>1.706*</td>
<td>0.842</td>
<td>0.709</td>
<td>-0.350</td>
</tr>
<tr>
<td>Use support equipment</td>
<td>0.241</td>
<td>0.771</td>
<td>1.741*</td>
<td>0.541</td>
<td>-0.196</td>
</tr>
<tr>
<td><strong>Moderate Verbal Persuasion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>0.593</td>
<td>1.647*</td>
<td>0.815</td>
<td>0.340</td>
<td>-0.277</td>
</tr>
<tr>
<td>Use support equipment</td>
<td>0.968</td>
<td>0.666</td>
<td>1.484*</td>
<td>0.427</td>
<td>-0.174</td>
</tr>
<tr>
<td><strong>Adverse Verbal Persuasion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>1.907*</td>
<td>1.308</td>
<td>1.106</td>
<td>-0.300</td>
<td>-0.370</td>
</tr>
<tr>
<td>Use support equipment</td>
<td>2.227*</td>
<td>0.208</td>
<td>1.279</td>
<td>-0.228</td>
<td>-0.308</td>
</tr>
<tr>
<td><strong>Strong Physiological Arousal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>0.062</td>
<td>0.439</td>
<td>0.160</td>
<td>1.139*</td>
<td>-0.333</td>
</tr>
<tr>
<td>Use support equipment</td>
<td>-0.042</td>
<td>0.065</td>
<td>0.578</td>
<td>1.392*</td>
<td>-0.417</td>
</tr>
<tr>
<td><strong>Moderate Physiological Arousal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>0.163</td>
<td>0.505</td>
<td>0.144</td>
<td>1.201*</td>
<td>-0.713</td>
</tr>
<tr>
<td>Use support equipment</td>
<td>-0.002</td>
<td>-0.074</td>
<td>0.421</td>
<td>1.384*</td>
<td>-1.119</td>
</tr>
<tr>
<td><strong>Adverse Physiological Arousal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repair a component</td>
<td>0.380</td>
<td>0.894</td>
<td>0.193</td>
<td>0.287</td>
<td>-1.742*</td>
</tr>
<tr>
<td>Use support equipment</td>
<td>0.420</td>
<td>-0.022</td>
<td>0.290</td>
<td>0.604</td>
<td>-2.239*</td>
</tr>
<tr>
<td>Variance explained</td>
<td>0.230</td>
<td>0.172</td>
<td>0.143</td>
<td>0.139</td>
<td>0.096</td>
</tr>
</tbody>
</table>

vicarious experience, and verbal persuasion). Factors 2 and 3 are representative of strong and moderate antecedents that involve external stimuli (i.e., vicarious experience and verbal persuasion). It should be noted these antecedents do not qualify for hypothesis
testing, which accounts for a limitation of this research that will be discussed later. Factor 4 is representative of strong and moderate antecedents that involve internal stimuli (i.e., mastery experience and physiological arousal). Factor 5 is representative of an adverse antecedent that is indirectly related to task performance (i.e., physiological arousal).

Strong and moderate antecedents are believed to load the same factor because both are strong antecedents in the absolute sense. Explicitly, successfully performing a task with no difficulty and successfully performing a task with some difficulty are both measures of success, notwithstanding the gradation of challenge recommended by Bandura (2001). Conversely, failing to perform a task is definitely a measure of failure, hence the different factor loading.

With respect to adverse efficacy antecedents, adverse mastery items load a different factor (Factor 1) than adverse physiological arousal items (Factor 5). This is interpreted to be a reflection of the relationship between the applicable efficacy antecedent and the task. Specifically, physiological arousal is indirectly related to task performance; i.e., fatigue and
stress could have been brought about by any number of reasons, but it is thought to affect one's efficacy for performing the tasks nonetheless. Conversely, mastery experience is directly related to task performance; i.e., a previous failure to perform a given task is direct involvement with the task that affects one's efficacy in successive attempts.

This interpretation of adverse efficacy antecedents that are directly related to task performance is further supported by the items reflective of adverse vicarious experience and verbal persuasion. In both of these cases, the relationship between the task and the antecedent is direct and, consequently, three of the four corresponding items loaded Factor 1. In the case of the item that failed to load highest on Factor 1, the next highest factor loading was present (1.519). It should be noted that a loading greater than .3 is considered "high" while a loading greater than .6 is considered "very high" and the relevant variables help to describe that factor quite well (Burgess, 2001).

In reference to vicarious experience and verbal persuasion with both strong and moderate strength levels, the structure is identifiable and supports the
interpretation with high factor loadings. Nevertheless, it is not homogenous as three of the remaining pairings failed to load the same factor along the lines of the task variable. Explicitly, these items load the same factor for each antecedent (i.e., vicarious experience and verbal persuasion) and strength level for external stimuli (i.e., strong and moderate). Nevertheless, the items that were intended to measure the task of "repairing a component" loaded Factor 2, while the items that were intended to measure the task of "using support equipment" loaded Factor 3. This renders all but two of the items invalid as self-efficacy antecedents are believed to be universal. Given that the items reflective of the reference group (moderate efficacy antecedents) are considered invalid, hypothesis testing of vicarious experience (H2) and verbal persuasion (H3) is not practicable.

5.2 Testing H1 and H4 with Multiple Regression

Multiple regression with effects-coded dummy variables was carried out in Microsoft Excel as recommended by Hardy (1993). Four columns contained the dummy variables with the coding scheme mentioned previously for H1 and H4. An additional column contained
the corresponding response (DV). Each row was reflective of a response for a given independent variable grouping. A separate regression analysis was carried out for each task. Appendix E contains the Microsoft Excel output, which displays the full results.

The first task, repairing a component, was tested with significant results. The four predictors accounted for nearly a third of the variance in self-efficacy appraisals ($R^2 = .31$), which was highly significant ($F = 109.9, p < .001$). Strong mastery experience ($H1a: \beta = 1.53, p < .001$) and strong physiological arousal ($H4a: \beta = .99, p < .001$) significantly correlated to higher self-efficacy. Adverse mastery experience ($H1a: \beta = -2.06, p < .001$) and adverse physiological arousal ($H4a: \beta = -1.54$, $H4b: \beta = -1.54$, $H1b: \beta = -2.06$)
p < .001) significantly correlated to lower self-efficacy. Figure 5.2 depicts the results.

The second task, using support equipment, also yielded significant results. The four predictors accounted for over a quarter of the variance in self-efficacy appraisals ($R^2 = .28$), which was also significant ($F = 94.1, p < .001$). Strong mastery experience (H1a: $\beta = 1.50, p < .001$) and strong physiological arousal (H4a: $\beta = .99, p < .001$) significantly correlated to higher self-efficacy. Conversely, adverse mastery experience (H1b: $\beta = -2.03, p < .001$) and adverse physiological arousal (H4b: $\beta = -1.46, p < .001$) significantly correlated to
lower self-efficacy. These results are depicted in Figure 5.3.
CHAPTER 6: DISCUSSION

6.1 Limitations

While this study made some notable contributions, which will be discussed later along with recommendations for future research, it did fall short of its overarching objective - to empirically confirm that four independent sources of self-efficacy exist for a specific task. Perhaps this was because the focus shifted after the problem was identified, a literature review was conducted, and hypotheses were developed. Initially, the statement of the problem (p. 20) identified the overarching issue of no empirical basis for four distinct sources of self-efficacy. Afterward, a literature review (Chapter 3) yielded hypotheses that would address this problem based upon the theory that strong antecedents would increase one's efficacy, while adverse antecedents would decrease it. When developing a methodology to test these hypotheses, it could be speculated that the researcher became overzealous and, therefore, unfocused.

It is possible that some of the scales were confounded by the addition of control variables to these antecedents. As mentioned earlier, these control variables were added to provide an original investigation
of vicarious experience and verbal persuasion in isolation from other antecedents. In retrospect, the addition of these control variables might not have been necessary. Although no research had ever investigated these antecedents in isolation, surely no research had ever investigated the four efficacy antecedents independent of each other in relation to a particular task. Adding control variables expanded the corresponding items to include two additional action verbs that were representative of other efficacy antecedents (control variables) in addition to another action verb representative of the efficacy antecedent being measured (i.e., the independent variable). It is suggested that this not only lengthened the corresponding items, but also made these items a bit more confusing than the items designed to measure mastery experience and verbal persuasion. Regardless, this is only speculation. More investigation needs to be done in this realm, which will be discussed later.

In addition, the scales were developed specifically for this research as a framework to empirically confirm Bandura's (1977, 1986, 1997) that four distinct sources of self-efficacy exist. Unfortunately, this research was
unsuccessful in developing valid items for measuring vicarious experience and verbal persuasion. It should be further amplified that the scales produced in this research are not fully developed, standardized scales that would be adequate for measuring the four self-efficacy antecedents in relation to any particular task and, therefore, should not be used for such purposes.

6.2 Implications for Theory

Although this research failed to confirm that four independent sources of self-efficacy exist for a given task, two considerable implications for theory were realized. First, this research empirically demonstrated that strong mastery experience and physiological arousal correlated to higher self-efficacy, while adverse mastery experience and physiological arousal correlated to lower self-efficacy for a specific task. Moreover, this research provided the first empirical evidence that adverse mastery experience would result in lower self-efficacy.

To be sure, the failure to confirm four independent sources of self-efficacy in relation to a specific task is not believed to discredit Bandura’s (1977, 1986, 1997) theory. Several studies have empirically investigated
both vicarious experience and verbal persuasion with significant results, albeit in hybrid fashions and focusing only on strong antecedents (Chin & Kameoka, 2002; Debowski et al., 2002; Eden & Kinnar, 1991; Gorrell & Capron, 1990; Hagen et al., 1998; Lopez et al., 1997). Although research is still needed to empirically confirm vicarious experience and verbal persuasion independent of other sources, which will be discussed in greater detail later, the previous research does support Bandura’s (1977, 1986, 1997) theory.

That said, this research was the first to empirically confirm that adverse mastery experience correlates to lower self-efficacy. Certainly, there were empirical studies that confirmed the existence of mastery experience (Debowski, Wood, & Bandura, 2001; Wise & Trunnell, 2001), but these studies examined the antecedents in a positive fashion. In addition, Ryska (2002) provided empirical support to the theory that adverse self-efficacy antecedents would lower self-efficacy (Bandura, 1977, 1986, 1997; Chowdhury et al., 2002; Wood & Bandura, 1989); however, this study investigated the impact of adverse physiological arousal. This research confirmed that adverse mastery experience
correlates to lower self-efficacy, thereby leaving only vicarious experience and verbal persuasion to be empirically investigated from an adverse perspective.

In addition, this research was the first to examine the effects of both strong and adverse antecedents in relation to a specific task. Specifically, this research confirmed that strong mastery experience and physiological arousal correlates to higher self-efficacy, while adverse mastery experience and physiological arousal correlates to lower self-efficacy for a specific task. Prior to this research, no other empirical study had investigated the impact of any antecedent from both a strong and adverse perspective. Finding empirical support for two of the four self-efficacy antecedents in relation to a specific task is a considerable step forward in this domain of self-efficacy research.

6.3 Recommendations for Future Research

While this study made some notable contributions, it did fall short of its overarching objective - to empirically confirm that four independent sources of self-efficacy exist for a specific task. Empirical support must be obtained for Bandura's (1977, 1986, 1997) theory of four distinct sources of self-efficacy.
Moreover, a model for scale development is highly desirable to facilitate research in multiple task domains and allow meta-analyses between such research. In addition, such a model would allow assessment of self-efficacy antecedents in organizational and other applied settings.

Although this research did not attempt to develop such a model, it did attempt to develop scales designed to measure self-efficacy antecedents in this specific application. Unfortunately, this research did not yield valid scales to measure vicarious experience and verbal persuasion. It was previously suggested that these scales could have been confounded by the addition of control variables to these antecedents. The addition of control variables was believed, perhaps incorrectly, to be necessitated because all previous research pertaining to vicarious experience and verbal persuasion was hybrid in nature. Explicitly, previous research either contained elements of both vicarious experience and verbal persuasion (Eden & Kinnar, 1991; Gorrell & Capron, 1990; Hagen et al., 1998) or contained elements of mastery experience in addition to one or both of the aforementioned antecedents (Chin & Kameoka, 2002;
Debowski et al., 2002; Lopez et al., 1997). In any case, the notion that these control variables were warranted is a basis for needed research. Vicarious experience and verbal persuasion need to be examined independently from both a strong and adverse perspective. Such research might even be necessary prior to the previous recommendation to develop a model for self-efficacy antecedent scales.

With respect to physiological arousal, it has been asserted that this is the least important determinant of self-efficacy among the four antecedents (Chowdhury, Endres, & Lanis, 2002). This assertion has not been empirically tested. Moreover, it is speculated that this might not prove to be accurate. Regression analyses with the vicarious and verbal persuasion items included demonstrated that the beta coefficients for both strong and adverse physiological arousal were second only to mastery experience. To be sure, the items for vicarious experience and verbal persuasion were deemed to be invalid for hypothesis testing after a factor analysis pulled the items apart along the task variable. Nevertheless, these findings warrant a mention. Especially when one considers that physiological arousal
is assumed the least consequential self-efficacy antecedent, but this assumption has never been empirically tested.

6.4 Recommendations for Practice

A prerequisite to any other recommendation for practice is ensuring leaders are trained for a general awareness of self-efficacy and its effect on the people of an organization and, consequently, the organization itself. Self-efficacy is positively correlated to performance (Bandura, 1991; Cole & Hopkins, 1995; Gibson, 2001; Malone, 2001; Prussia, Anderson, & Manz, 1998; Renn & Fedor, 2001; Stajkovic & Luthans 1998; Staples, Hulland, & Higgins, 1999). On this account, the leadership of any organization where people are essential to the firm’s success should take an active interest. The self-efficacy of employees should be assessed in relation to each significant task that is expected of them. Moreover, it should be routinely reassessed as self-efficacy changes over time with additional experiences. An attempt to influence self-efficacy can only be made when leadership is aware of its impact on performance and has an appraisal of each member’s efficacy level in the organization.
Once leaders become aware of the ramifications of self-efficacy and acquire efficacy appraisals, they must be trained to understand and influence the immediate antecedents of self-efficacy; i.e., mastery experience, vicarious experience, verbal persuasion, and physiological arousal. In general, a leader must continuously strive to provide exposure to strong efficacy antecedents while limiting exposure to adverse efficacy antecedents. To be sure, this is much easier said than done given the impediments that many leaders face in today’s organizations, e.g., resource shortfalls, time constraints, a rapidly changing environment, etc. Nevertheless, as previously suggested (Bandura, 1977, 1986, 1997; Chowdhury et al., 2002; Wood & Bandura, 1989) and supported by this research, strong efficacy antecedents correlate to higher self-efficacy while adverse efficacy antecedents correlate to lower self-efficacy for a given task. Given the direct correlation between efficacy antecedents and self-efficacy and, sequentially, between self-efficacy and performance, the importance of self-efficacy in organizational settings cannot be overlooked.
Wood and Bandura (1989) suggest that follower efficacy can be built by assigning tasks that will bring success, avoiding situations in which failure is likely, and measuring success by self-improvement versus triumphs over others. This research unequivocally supports Wood and Bandura's (1989) assertion; however, their suggestion is often not feasible or believed to be feasible in the practitioner's environment. At times, it is impossible or impracticable to avoid situations in which failure is a significant possibility. In addition, success is often measured in terms of triumphs over others in a capitalist economy; i.e., competition, greed, scarcity of resources, etc. If an adverse antecedent occurs, this usually will not only adversely impact the individual's self-efficacy and future performance, but also cause an immediate detriment to the organization's performance. For example, a failure to close a sale is immediate lost revenue for the organization. This failure to close is also an adverse efficacy antecedent which will negatively impact performance which, in turn, will again negatively impact the organization's performance, and so on. The potential difficulties when attempting to build the self-
efficacy of employees via mastery experience in actual business situations are significant.

This is precisely why formal training programs are invaluable for building the self-efficacy of employees. Training programs provide a method of building one's self-efficacy through mastery experiences while eliminating the potential detriment to the organization should a failure occur. Moreover, once a success (i.e., a strong mastery experience) is achieved, additional impediments can be added to increase the magnitude of the task demand to further increase one's efficacy. Countless examples exist in a myriad of venues. For example, astronauts are exposed to several repetitions with increasing gradations of difficulty in a simulator before flying in a shuttle during an actual mission. Each season, professional baseball players will routinely bat in several practices and then in exhibition scenarios prior to ever hitting in an actual game. These are but two of the countless examples that exist where self-efficacy can be positively influenced through mastery experiences in a training environment. However, it is posited that countless other situations exist where people will initially be exposed to a mastery experience
during an actual business situation when the task might call for a person to already possess a strong sense of efficacy. Leaders should ensure that their people are initially exposed to strong mastery experiences in a training environment whenever practicable.

In addition to echoing the importance of successful work experiences, Pearlmutter (1998) has suggested that managers have a responsibility to promote staff self-efficacy by creating a culture and environment that increases self-confidence and organizes around teamwork. It is further suggested that managers should mitigate the effects of adverse physiological arousal antecedents to the greatest extent practicable. This could be accomplished in multiple fashions. Examples include fitness facilities or memberships, training programs for stress management, onsite childcare facilities, improved benefit packages, telecommuting and flexible scheduling options when practicable, etc.

Certainly, the extent to which a manager can effect the physiological arousal antecedents of employees is more limited than in the case of the other antecedents. For example, a manager can direct a subordinate to perform a task that is job related; i.e., a manager can
direct a mastery experience. Conversely, a manager can suggest, but not usually direct subordinates to change their diet and exercise habits or employ stress management techniques in order to yield physiological results that would facilitate success in job tasks. Nevertheless, it is suggested that managers must attempt to create a culture and climate that mitigates the effects of adverse physiological arousal antecedents whenever possible.
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Chen, G. & Bliese, P. D. (2002). The role of different levels of leadership in predicting self- and
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Research, 26, 499-510.


Jones, M. V., Mace, R. D., Bray, S. R., & MacRae, A. W.


breeds failure: The role of self-efficacy in escalating commitment to a losing course of action.  

Exercise Psychology, 23, 268-280.


http://www.wvu.edu/~physed/sportpsych/zizzi/MR.pdf

Using the scale below, please rate how sure you are that you can repair a component in each situation. Please record your answer in the column labeled Confidence. You are not identifiable by these responses. Please don’t write your name on this form.

### Confidence (0-10)

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1. Repair a component when I’ve successfully repaired the component before with no difficulty
2. Repair a component when I’ve successfully repaired the component before with some difficulty
3. Repair a component when I’ve been unsuccessful in all previous attempts to repair the component
4. Repair a component when I’ve watched someone repair the component with no difficulty, but have never attempted to repair the component myself or been told that I was capable of repairing the component
5. Repair a component when I’ve watched someone repair the component with some difficulty, but have never attempted to repair the component myself or been told that I was capable of repairing the component
6. Repair a component when I’ve watched someone attempt to repair a component unsuccessfully and have never attempted to repair the component myself or been told that I was capable of repairing the component
7. Repair a component when I’ve been told that I am capable and would have no difficulty, but have never attempted to repair the component myself or watched anyone attempt to repair the component
8. Repair a component when I’ve been told that I am capable even though it would be difficult, but have never attempted to repair the component myself or watched anyone attempt to repair the component
9. Repair a component when I’ve been told that I am not capable of repairing the component and have never attempted to repair the component myself or watched anyone attempt to repair the component
10. Repair a component when I’m feeling energized and cheerful
11. Repair a component when I’m feeling physically and emotionally normal
12. Repair a component when I’m feeling fatigued and stressed

*Please complete the questions on the reverse*
Using the scale below, please rate how sure you are that you can use an item of support equipment in each situation. Please record your answer in the column labeled Confidence. You are not identifiable by these responses. Please don’t write your name on this form.

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13. Use an item of support equipment when I’ve successfully used the support equipment before with no difficulty

14. Use an item of support equipment when I’ve successfully used the support equipment before with some difficulty

15. Use an item of support equipment when I’ve been unsuccessful in all previous attempts to use the support equipment

16. Use an item of support equipment when I’ve watched someone use the support equipment with no difficulty, but have never attempted to use the support equipment myself or been told that I was capable of using the support equipment

17. Use an item of support equipment when I’ve watched someone use the support equipment with some difficulty, but have never attempted to use the support equipment myself or been told that I was capable of using the support equipment

18. Use an item of support equipment when I’ve watched someone attempt to use an item of support equipment unsuccessfully and have never attempted to use the support equipment myself or been told that I was capable of using the support equipment

19. Use an item of support equipment when I’ve been told that I am capable of using it with no difficulties, but have never attempted to use the support equipment myself or watched anyone attempt to use the support equipment

20. Use an item of support equipment when I’ve been told that I am capable of using it even though it would be difficult, but have never attempted to use the support equipment myself or watched anyone attempt to use the support equipment

21. Use an item of support equipment when I’ve been told that I am not capable of using it and have never attempted to use the support equipment myself or watched anyone attempt to use the support equipment

22. Use an item of support equipment when I’m feeling energized and cheerful

23. Use an item of support equipment when I’m feeling physically and emotionally normal

24. Use an item of support equipment when I’m feeling fatigued and stressed
Using the scale below, please rate how sure you are that you can repair a component in each situation. Please record your answer in the column labeled Confidence. You are not identifiable by these responses. Please don’t write your name on this form.

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**Mastery Experience**

1. Repair a component when I’ve successfully repaired the component before with no difficulty

2. Repair a component when I’ve successfully repaired the component before with some difficulty

3. Repair a component when I’ve been unsuccessful in all previous attempts to repair the component

4. Repair a component when I’ve watched someone repair the component with no difficulty, but have never attempted to repair the component myself or been told that I was capable of repairing the component

5. Repair a component when I’ve watched someone repair the component with some difficulty, but have never attempted to repair the component myself or been told that I was capable of repairing the component

6. Repair a component when I’ve watched someone attempt to repair a component unsuccessfully and have never attempted to repair the component myself or been told that I was capable of repairing the component

7. Repair a component when I’ve been told that I am capable and would have no difficulty, but have never attempted to repair the component myself or watched anyone attempt to repair the component

8. Repair a component when I’ve been told that I am capable even though it would be difficult, but have never attempted to repair the component myself or watched anyone attempt to repair the component

9. Repair a component when I’ve been told that I am not capable of repairing the component and have never attempted to repair the component myself or watched anyone attempt to repair the component.

10. Repair a component when I’m feeling energized and cheerful

11. Repair a component when I’m feeling physically and emotionally normal

12. Repair a component when I’m feeling fatigued and stressed

Please complete the questions on the reverse...
Using the scale below, please rate how sure you are that you can use an item of support equipment in each situation. Please record your answer in the column labeled Confidence. You are not identifiable by these responses. Please don’t write your name on this form.

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<td>STR</td>
<td>16. Use an item of support equipment when I've watched someone use the support equipment with no difficulty, but have never attempted to use the support equipment myself or been told that I was capable of using the support equipment</td>
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<td>19. Use an item of support equipment when I've been told that I am capable of using it with no difficulties, but have never attempted to use the support equipment myself or watched anyone attempt to use the support equipment</td>
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<td>21. Use an item of support equipment when I've been told that I am not capable of using it even though I have never attempted to use the support equipment</td>
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<td>ADV</td>
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Page 2
Appendix C

The attached survey is for a study entitled:

CONFIRMING THE FOUR SOURCES OF SELF-EFFICACY

<table>
<thead>
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<th>Supervisory Researcher</th>
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<tr>
<td>Bob Muretta</td>
<td>Dr. Suzanne Peterson</td>
</tr>
<tr>
<td>FASO Detachment Brunswick</td>
<td>Professor of Business Administration</td>
</tr>
<tr>
<td>PhD Candidate, Touro University International</td>
<td>Miami University</td>
</tr>
<tr>
<td>(207)921-2903; DSN: 476-2903</td>
<td>(513)529-4232</td>
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Self-efficacy is person’s belief his/her ability to muster the motivation, resources, and courses of action required to perform a specific task. It is theorized that one’s self-efficacy can be influenced by four distinct sources: mastery experience (i.e., doing), vicarious experience (i.e., watching), verbal persuasion (i.e., being verbally appraised by another), and physiological arousal (e.g., stress, energy level, mood). Little quantitative investigation has occurred that pertains to these sources. The attached survey is intended to provide the basis for such an investigation.

Your participation would be greatly appreciated. It should take less than 10 minutes to complete this survey. In addition, your participation is strictly voluntary and you may choose to withdraw at any time. Although you will not personally benefit by participating, your participation will help produce a better understanding of self-efficacy and could facilitate future research.

Participation in this study is strictly anonymous. You are not identifiable by your responses. In addition, the information from completed surveys will not be shared with anyone under any circumstance. The overall results off this study, however, will be reported to the research community for industrial and organizational psychology to the greatest extent practicable.

Again, your participation would be greatly appreciated. Should any questions arise, please feel free to contact Bob Muretta at the number listed above. Please deposit completed surveys into the clearly marked container near Production Control by close of business on Friday, April 9, 2004.

Note: By completing this survey, you are agreeing to participate in the study and agree that all questions/concerns have been addressed to your satisfaction.
Appendix D

Unrotated Factor Loadings and Communalities

\( t_1 = \) repair a component
\( t_2 = \) use support equipment
\( h_1 = \) mastery experience
\( h_2 = \) vicarious experience
\( h_3 = \) verbal persuasion
\( h_4 = \) physiological arousal
\( h_5 = \) strong antecedent strength
\( h_6 = \) moderate antecedent strength
\( h_7 = \) adverse antecedent strength

*denotes the highest factor loading

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<td>-0.733</td>
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<td>-0.266</td>
<td>4.016</td>
</tr>
<tr>
<td>( t_1 )</td>
<td>-1.759*</td>
<td>0.014</td>
<td>-0.737</td>
<td>-0.077</td>
<td>0.528</td>
<td>3.922</td>
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<tr>
<td>( t_2 )</td>
<td>-1.777*</td>
<td>0.164</td>
<td>-0.275</td>
<td>0.619</td>
<td>-0.368</td>
<td>3.794</td>
</tr>
<tr>
<td>( t_1 )</td>
<td>-3.333*</td>
<td>1.151</td>
<td>0.010</td>
<td>0.186</td>
<td>0.300</td>
<td>6.797</td>
</tr>
<tr>
<td>( t_2 )</td>
<td>-2.018*</td>
<td>1.293</td>
<td>0.692</td>
<td>0.559</td>
<td>-0.500</td>
<td>6.878</td>
</tr>
<tr>
<td>( t_1 )</td>
<td>-0.793</td>
<td>-0.928*</td>
<td>-0.039</td>
<td>-0.325</td>
<td>-0.173</td>
<td>1.627</td>
</tr>
<tr>
<td>( t_2 )</td>
<td>-0.829</td>
<td>-1.208*</td>
<td>0.054</td>
<td>0.091</td>
<td>-0.542</td>
<td>2.452</td>
</tr>
<tr>
<td>( t_1 )</td>
<td>-0.796</td>
<td>-1.064*</td>
<td>0.208</td>
<td>-0.292</td>
<td>0.031</td>
<td>2.253</td>
</tr>
<tr>
<td>( t_2 )</td>
<td>-0.882</td>
<td>-1.450*</td>
<td>0.626</td>
<td>0.215</td>
<td>-0.177</td>
<td>3.349</td>
</tr>
<tr>
<td>( t_1 )</td>
<td>-2.307*</td>
<td>-0.661</td>
<td>0.675</td>
<td>0.188</td>
<td>1.209</td>
<td>4.097</td>
</tr>
<tr>
<td>( t_2 )</td>
<td>-1.127*</td>
<td>-1.070</td>
<td>1.492</td>
<td>0.593</td>
<td>0.804</td>
<td>5.641</td>
</tr>
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</table>

| Variance | 55.300 | 14.974 | 8.130 | 6.649 | 5.713 | 90.765 |
| Var     | 0.475  | 0.129  | 0.070 | 0.057 | 0.049 | 0.779 |
Varimax Rotated Factor Loadings and Communalities

<table>
<thead>
<tr>
<th>Variable</th>
<th>Factor1</th>
<th>Factor2</th>
<th>Factor3</th>
<th>Factor4</th>
<th>Factor5</th>
<th>Community</th>
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<td>t1 h1 h1</td>
<td>0.024</td>
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<td>0.124</td>
<td>1.117</td>
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<td>t2 h1 h1</td>
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<td>0.050</td>
<td>0.342</td>
<td>1.221*</td>
<td>-0.056</td>
<td>1.614</td>
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<tr>
<td>t1 h1 mo</td>
<td>0.656</td>
<td>0.489</td>
<td>-0.095</td>
<td>1.257*</td>
<td>0.003</td>
<td>2.017</td>
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<tr>
<td>t2 h1 mo</td>
<td>0.525</td>
<td>0.163</td>
<td>0.413</td>
<td>1.254*</td>
<td>-0.224</td>
<td>2.095</td>
</tr>
<tr>
<td>t1 h1 lo</td>
<td>2.028*</td>
<td>0.907</td>
<td>-0.310</td>
<td>0.705</td>
<td>-0.122</td>
<td>5.545</td>
</tr>
<tr>
<td>t2 h1 lo</td>
<td>2.160*</td>
<td>0.271</td>
<td>0.301</td>
<td>0.421</td>
<td>-0.318</td>
<td>5.166</td>
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<tr>
<td>t1 h2 hi</td>
<td>0.458</td>
<td>1.446*</td>
<td>0.548</td>
<td>0.693</td>
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<td>t2 h2 hi</td>
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<td>0.750</td>
<td>-0.049</td>
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<td>t1 h2 mo</td>
<td>0.816</td>
<td>2.568*</td>
<td>0.454</td>
<td>0.485</td>
<td>-0.194</td>
<td>3.604</td>
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<tr>
<td>t2 h2 mo</td>
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<td>0.770</td>
<td>1.318*</td>
<td>0.556</td>
<td>-0.325</td>
<td>3.638</td>
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<tr>
<td>t1 h2 lo</td>
<td>1.519</td>
<td>1.770*</td>
<td>0.402</td>
<td>0.257</td>
<td>-0.328</td>
<td>5.720</td>
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<tr>
<td>t2 h2 lo</td>
<td>1.690*</td>
<td>0.633</td>
<td>1.264</td>
<td>0.026</td>
<td>-0.289</td>
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<td>t1 h3 hi</td>
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<td>2.706*</td>
<td>0.842</td>
<td>0.709</td>
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<td>t2 h3 hi</td>
<td>0.241</td>
<td>0.771</td>
<td>1.741*</td>
<td>0.541</td>
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<tr>
<td>t1 h3 mo</td>
<td>0.593</td>
<td>1.647*</td>
<td>0.815</td>
<td>0.340</td>
<td>-0.277</td>
<td>3.922</td>
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<tr>
<td>t2 h3 mo</td>
<td>0.668</td>
<td>0.666</td>
<td>1.484*</td>
<td>0.427</td>
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<tr>
<td>t1 h3 lo</td>
<td>1.907*</td>
<td>1.308</td>
<td>1.106</td>
<td>-0.300</td>
<td>-0.270</td>
<td>6.797</td>
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<tr>
<td>t2 h3 lo</td>
<td>2.227*</td>
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<td>1.279</td>
<td>-0.228</td>
<td>-0.308</td>
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<tr>
<td>t1 h4 hi</td>
<td>0.062</td>
<td>0.439</td>
<td>0.160</td>
<td>1.138*</td>
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<tr>
<td>t2 h4 hi</td>
<td>-0.042</td>
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<td>0.578</td>
<td>1.392*</td>
<td>-0.417</td>
<td>2.452</td>
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<tr>
<td>t1 h4 mo</td>
<td>0.163</td>
<td>0.505</td>
<td>0.144</td>
<td>1.201*</td>
<td>-0.713</td>
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<tr>
<td>t2 h4 mo</td>
<td>-0.002</td>
<td>-0.074</td>
<td>0.421</td>
<td>1.384*</td>
<td>-1.119</td>
<td>3.349</td>
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<tr>
<td>t1 h4 lo</td>
<td>0.380</td>
<td>0.894</td>
<td>0.193</td>
<td>0.287</td>
<td>-2.142*</td>
<td>4.097</td>
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<tr>
<td>t2 h4 lo</td>
<td>0.420</td>
<td>-0.022</td>
<td>0.290</td>
<td>0.604</td>
<td>-2.239*</td>
<td>5.641</td>
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</table>

% Var    | 0.230    | 0.172   | 0.143   | 0.139   | 0.096   | 0.779     |

*denotes the highest factor loading
### Appendix E

#### Table 5.3

**TASK 1 - REPAIR A COMPONENT**

**Regression Statistics**

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<th>Value</th>
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<tr>
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<td>Standard Error</td>
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<td>Observations</td>
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</table>

**ANOVA**

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<tr>
<th>Source</th>
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<th>SS</th>
<th>MS</th>
<th>F</th>
<th>Significance F</th>
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<td>426.879</td>
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<td>3756.349</td>
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<thead>
<tr>
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<th>P-value</th>
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<tr>
<td>Intercept</td>
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<td>120.477</td>
<td>&lt; .001</td>
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<tr>
<td>H1a</td>
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<tr>
<td>H1b</td>
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<tr>
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<td>-1.539</td>
<td>-12.173</td>
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**TASK 2 - USE SUPPORT EQUIPMENT**

**Regression Statistics**

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<tr>
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<td>Observations</td>
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**ANOVA**

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<th>MS</th>
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