

**SELF-EFFICACY AS A TRAINING EFFECTIVENESS
ASSESSMENT METHODOLOGY AND OPTIMIZATION TOOL**

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ABSTRACT

One of the best predictors of performance on a particular task is an individual's perception of skill on the task. This perception, called self-efficacy, has been demonstrated to impact performance on a broad range of physical and cognitive tasks via changes in motivation, persistence, and affect. The first systematized implementation of a self-efficacy assessment for a military application was performed for an immersive virtual environment replication of the shiphandling task Underway Replenishment (UNREP). Surface Warfare Officers' (SWO) self-efficacy was assessed via self-report. Self-report items were derived from a cognitive task analysis, observation of experts' performance, and subject matter expert interviews. A final set of self-efficacy assessment items was validated after pilot testing.

The resulting self-efficacy measure for the UNREP was then administered both before and after participation in two trials of a virtual environment UNREP scenario. Participants were moderately skilled UNREP officers. Analyses revealed that participants reported higher self-efficacy for performing the actual at sea UNREP after participating in the UNREP virtual environment training task. The final version of the UNREP Self-Efficacy Scale (URSE) demonstrated excellent reliability with a Chronbach's alpha of .97. Perceptual-motor and cognitive skills have been extensively researched, but self-efficacy appraisals have been overlooked despite the significant impact they have on task performance. Further research in this area is warranted to optimize training interventions, create trainees with resilient personal efficacy for other training domains, and to aid in the development of realistic human cognitive models.

ABOUT THE AUTHORS

Dr. Walter D. Scott is an Assistant Professor in the Psychology Department at the University of Wyoming. One of his primary research areas of interest is examining the role of self-efficacy in motivation and performance. He has also served as an associate editor of a major journal on cognitive processes. Dr. Scott received his Ph.D. in psychology from the University of Illinois at Chicago.

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INTRODUCTION

Self-efficacy is arguably the most intensively researched cognitive variable in psychological science today. In a recent review on self-efficacy, we found 933 self-efficacy references in the five years that preceded the publication of our review alone (Cervone & Scott, 1995). This explosion of scientific research is not surprising as self-efficacy has been found to be a powerful determinant and predictor of human performance, surpassing even the predictive power of past performance levels (Bandura, 1997).

Relevance to Military Training Applications

Despite this impressive body of research, little implementation of these principles in real-world training applications has occurred. As a major determinant, and hence indicant, of human performance, self-efficacy theory and research yields a number of applied benefits for training development and evaluation.

First, as the single best predictor of performance (short of performance itself), a self-efficacy measure would serve as an ideal, and cost-effective, performance metric of training effectiveness. Once a self-efficacy measure is developed for any specific type of performance, it can then be utilized as a tool for optimizing training interventions. Several self-efficacy based training protocols have been developed, although so far they have focused primarily on training anxiety management skills. These training protocols have been empirically shown to optimize human skill acquisition. The effective application of self-efficacy principles in this area suggests that the same strategies may be applied in other domains of skill acquisition. A self-efficacy measure of Underway Replenishment (UNREP) could be used to identify shortcomings and weaknesses inherent in training strategies and in the performance itself.

Present Project: Self-Efficacy Applied to UNREP Training

The strength of the self-efficacy construct is in its empirically supported predictivity, valid for diverse complex performance tasks. In the present context, we will develop and examine the utility of a self-efficacy assessment for an immersive virtual environment replication of the shiphandling task. Specifically, we will use self-efficacy assessment methodology to assess the training effectiveness of the immersive virtual environment. The assessment methodology will involve the development of an UNREP Self-Efficacy Scale (URSE). It is a feasible assessment methodology that is empirically based and inexpensive. Moreover, the general construct and assessment process can be applied to assessing the efficacy of any performance training program, and hence possesses potential wider applicability and utility, beyond UNREP, for shiphandling and other training programs. However, before describing the method and findings of this project, we will first provide the theoretical and scientific background of self-efficacy research and methodologies.

Theoretical and Scientific Basis of Self-Efficacy

Defining Self-efficacy. People think about their actions, the world, and themselves. These various cognitive processes have been shown to have an important role in human motivation and performance (Locke & Latham, 1990). Self-efficacy theory focuses on one particular aspect of human cognition, namely, people's thoughts about their capabilities for performance (Bandura, 1989; 1997). More specifically, a self-efficacy judgment is defined as *a perception of one's capability to attain a specified level or type of performance in a given setting* (Cervone & Scott, 1995). For example, perceptions of one's capability to perform socially skilled behaviors; to avoid overeating; to participate in an exercise program; to maneuver an

aircraft through enemy fire or negotiate a ship through a narrow channel; all of these illustrate the class of self-referent thinking referred to as perceived self-efficacy.

Behavioral, Cognitive, and Affective Consequences.

Self-efficacy theory views efficacy judgments as proximal determinants of a set of psychological processes that are critical to human achievement (Bandura, 1986; 1997). One process involves choosing activities to undertake. People engage in activities for which they judge themselves highly efficacious, yet avoid activities they judge they cannot handle (Betz & Hackett, 1986; Lent & Hackett, 1987). Once one becomes engaged in an activity, self-efficacy perceptions affect one's degree of effort and task persistence (Bandura & Cervone, 1983; 1986; Weinberg, Gould, Yukelson, & Jackson, 1981). Decisions about how long to persevere are based partly on self-assessments of one's capabilities. When efficacy is doubted, we tend to slacken efforts and give up, whereas those with a strong sense of efficacy persevere (Cervone & Scott, 1995).

Self-efficacy perceptions also influence cognitive processes that are critical to achievement (Bandura, 1997). On cognitively complex activities that require the acquisition of task knowledge and formulation of strategies, people with a higher sense of efficacy develop and test strategies more analytically (Wood & Bandura, 1989). On stressful memory tasks, high efficacy perceptions have been found to enhance performance (Berry, West, & Dennehey, 1989). Those who question their ability to cope with events obsess about how performance can go wrong and this doubt can interfere with performance (Borden, Clum, & Salmon, 1991; Kent & Gibbons, 1987). Finally, self-efficacy perceptions have also been found to influence affective responses. People with a high sense of efficacy experience less anxiety when facing stressful, threatening events (Bandura, Cioffi, Taylor, & Brouillard, 1988; Bandura, Reese, & Adams, 1982; Bandura, Taylor, Williams, Mefford, & Barchas, 1985). And although moderate levels of anxiety can increase performance, excessive levels of anxiety that often accompany low self-efficacy perceptions can impair it.

Perceived Self-efficacy as Cause. Self-efficacy theory does not view efficacy perceptions as mere reflections of performance, but views them as having a causal impact on human performance. There is an extensive literature, both correlational and experimental, that supports the casual role of self-efficacy perceptions on human performance (Bandura, 1986; 1997; Cervone & Scott, 1995).

In the most stringent tests of self-efficacy theory, researchers manipulate self-efficacy perceptions while holding constant all other performance-related factors,

including information and experiences that might influence subject's competencies on a task. Several studies have manipulated self-efficacy judgments in randomly assigned research participants through subtle contextual cues that provide no information about a performance domain but that nonetheless powerfully influence self-efficacy judgments.

For example, self-efficacy judgments have been manipulated by having participants consider apparently random values that represent high or low levels of performance, varying the order in which participants consider hypothetical levels of future performance, and having people briefly contemplate personal and situational factors that might help or hinder their efforts. Variations in self-efficacy due to these subtle manipulations have been consistently found to strongly determine motivation and performance outcomes (Cervone & Scott, 1995). In other words, even when people's high or low self-efficacy judgments stem from trivial factors—such as having received a high or low anchor value by chance—variations in self-efficacy account for variations in motivation and performance.

These findings directly speak to the causality issue. In this research, experimental conditions vary neither exposure to the tasks nor information about the performance activities. Participants differ on self-perceived capabilities but on no other variable that reasonably could be thought to affect their abilities on the tasks. Nonetheless, variations in perceived self-efficacy produce corresponding differences in performance.

Self-efficacy Contribution to Acquisition of Perceptual-Motor Skills.

The contribution of self-efficacy has been illustrated with the kind of complex skilled perceptual and motor performances involved in such performances as the UNREP as well as other military performances (Bandura, 1997). Not only does self-efficacy influence whether one even attempts to learn the skilled motor performance, it also determines how much effort is invested in the undertaking, the level of stick-to-itiveness or persistence when one struggles or displays subpar performances. For instance, studies that have experimentally manipulated self-efficacy beliefs have been found to influence motor performance under competitive (Weinberg, 1986; Weinberg et al., 1981) and noncompetitive conditions (Gould & Weiss, 1981; McAuley, 1985). High efficacy beliefs enhanced motor performance and reduced vulnerability to the adverse effects of initial substandard performance. These studies cover a wide range of athletic activities that also represent performances of varying complexities (i.e., tennis, gymnastics, diving, basketball, distance running).

In one study, the role of self-efficacy and previous expertise in learning new tai-chi style defensive actions was investigated (Ferrari & Bouffard-Bouchard, 1992). Karate students of high and low efficacy beliefs at each of three levels of expertise were given control of a video player to learn the modeled activities and to change the speed of the demonstrations to notice nuances and moves. Self-efficacy was found to contribute independently to the speed at which such complex motoric actions were executed masterfully even when level of prior expertise was statistically controlled. In other words, experts and novices alike benefited from high self-efficacy beliefs.

Purpose of Present Project. The present project consisted of two phases. The first phase involved the development of a psychometrically sound self-efficacy measure for the UNREP maneuver. The second phase involved further psychometric evaluation of the UNREP Self-Efficacy Scale (URSE) as well as the evaluation of the Virtual Environment Underway Replenishment Maneuver (VE-UNREP) as a training procedure using the URSE as the performance outcome measure.

STUDY 1: INITIAL ITEM-DEVELOPMENT FOR THE URSE

Self-efficacy researchers have generally used self-report questionnaire measures to assess perceived self-efficacy. In accord with self-efficacy theory, these instruments are tailored to a particular activity or domain of functioning. One cannot develop a generalized self-efficacy measure. By definition, perceived self-efficacy refers to perceptions of capabilities for performance within a given situation, activity, or domain. This definition recognizes that efficacy perceptions may vary substantially across situations and tasks.

The construction of sound self-efficacy scales relies therefore on a thorough conceptual analysis of the relevant domain of functioning. Knowledge of the activity domain specifies which aspects of self-efficacy should be measured. If self-efficacy items are targeted to factors that, in fact, have little or no impact on the domain of functioning then there is little likelihood that a self-efficacy measure will yield a predictive relationship with performance.

Study 1: Method and Procedures

UNREP Domain Specification. To accomplish such a conceptual analysis of the UNREP maneuver, several steps were taken. First, we visited the Virtual Environment Training Technology Lab (VETT) at the Naval Air Warfare Center Training Systems Division (NAWCTSD) in Orlando, Florida so the UNREP maneuver could be demonstrated in a virtual environment for the first author. Second, an interview

was conducted with a Naval Officer who had conducted nearly 100 UNREP at sea maneuvers. Third, we obtained several completed cognitive task analyses of the UNREP maneuver (Norris, 1998; Williams, 1997). These task analyses were thoroughly reviewed and the most important aspects of the UNREP task performance were identified. Finally, we reviewed a standard textbook used in Navy shiphandling training that contained sections covering the UNREP maneuver (Crenshaw, 1975). Based on the SME interview, the cognitive task analyses, and the textbook, an initial set of critical UNREP performance subtasks were identified.

Development of Initial Self-efficacy Items. In translating these performance subtasks into an initial set of self-efficacy items, we had five primary goals. First, only those performance subtasks that were deemed important to successful performance implementation of the UNREP were represented. Second, there was an attempt to identify subtasks that represented gradations of challenge and environmental impediments to successful performance. Obviously, if there are no obstacles to surmount in the UNREP, the activity is easily performable and everyone has uniformly high self-efficacy for it, thereby reducing variability. Third, there was an attempt to write the items so that they were clear and readable, and consistent with the reading level and jargon of the typical UNREP trainee. Fourth, the items were designed to capture both self-efficacy *strength*, that is one's subjective confidence in being able to attain designated levels of performance, and the *self-efficacy level*, that is the absolute performance level one believes he can achieve. The former was accomplished by phrasing the items so that participants could indicate degrees of confidence ranging from "certain can't do it" to "moderately certain can do it" to "certain can do it." The latter was accomplished by including UNREP subtasks of varying difficulties. Finally, standard self-efficacy instructions and response formats were employed. A hundred-point scale format was used as using fewer steps leads to less sensitive and less reliable scales (Bandura, personal communication, 6/99).

Eliciting Feedback from UNREP SME's. After creating the initial self-efficacy items, an additional scale was created: UNREP Self-Efficacy Scale for Subject Matter Experts (URSE-SME; copy available upon request). Two separate groups of UNREP Subject Matter Experts (SME's)--one at NAWSTSD (N = 2) and another at Sonalyst, Inc. (N = 4)--completed the URSE-SME and participated in a follow-up interview with the first author. Collectively, the two groups had completed over 600 UNREP's. The URSE-SME contained the initial set of 50 self-efficacy items. In addition, each of these individual self-efficacy items

contained three sub-items that had each expert rate the performance subtask's *level of difficulty*, *level of importance*, and the item's *readability*.

Following the completion of these 50 items and corresponding sub-items, the experts were asked to write any additional specific activities important to the Waiting Station/Lifeguard Station, Approach, Alongside, and Breakaway phases that had not been adequately represented in the initial set of self-efficacy items but that were important to the successful performance of the UNREP task. Finally, after each expert had completed the URSE-SME, the first author reviewed with the expert his responses on the URSE-SME and he asked open-ended questions to identify any other challenges or impediments that make the UNREP difficult to perform.

Results of Study 1: Analysis of initial URSE items

Based on analysis of the data and feedback collected from these UNREP SME's, the initial 50-item set of the URSE was revised extensively. Several items with minimum variation were discarded, or were revised to represent more difficult versions of the subtasks described. Items that had been rated by SME's as low in readability were also either rewritten or discarded. Items that were rated as describing subtasks of very low levels of difficulty by nearly all the SME's were also discarded, with the exception of a few low difficulty activities that were deemed of critical high importance by all SME's. Items that were viewed as "too general" by SME's were also discarded.

In addition, a few new items were constructed to capture critical aspects of the UNREP performance that had not been represented in the initial item set, particularly for emergency breakaway maneuvers. Finally, some aspects of the UNREP operating parameters were modified. These modifications were required as earlier assumptions were viewed as either unnecessary or as unrealistic by SME's. The goal was to make the UNREP operating assumptions fairly standard but also to make them of a moderate level of difficulty.

All these modifications resulted in a revised URSE consisting of 25 items. A Cronbach alpha of .81 was achieved for this modified version of the URSE (without including the newly created items and the changes to the UNREP operating parameters).

STUDY 2: EVALUATING THE EFFECTIVENESS OF THE VE-UNREP AS A TRAINING PROCEDURE

The purpose of Study 2 was to evaluate the effectiveness of the VE-UNREP as a training procedure using the URSE as the performance outcome measure. However, we also recognized a potential problem with a

self-presentational style presumed to be common amongst Navy personnel.

Development of Overconfident Self-presentation Scale. Given that Navy training personnel are described as often presenting as confident and fully capable of executing performances (Graybiel & Knepton, 1976), we constructed a new set of items for the URSE that described activities that were assumed to be beyond the current performance capabilities of the typical UNREP trainee. These activities were unrelated to the UNREP maneuver (i.e., serving as commander of a ship, flying an F-14, etc.).

A response style of expressing extreme confidence in executing these latter type of performances could be viewed as representing an overconfident self-presentational style. These non-UNREP performance items could then be subtotaled to form a measure of an overconfident self-presentational style, or a tendency to over-represent one's abilities.

Study 2: Method and Procedures

To evaluate the effectiveness of the VE-URSE as an UNREP training procedure, we administered the revised URSE to a cohort of 9 Naval Officers attending the Naval Officer Training School at Monterey, California. One of the participants failed to complete the pre-training URSE, which resulted in a final sample of 8 participants.

Questionnaires. Prior to completing two trials of the VE-UNREP task, all participants completed 2 questionnaires: *Demographics Questionnaire* and the *URSE*. The Demographics Questionnaire assessed various demographic information and prior experience with both performing the actual at sea UNREP and with virtual environments with head-mounted displays.

The URSE was the revised URSE, which included 25 items assessing self-efficacy for performing the actual at sea UNREP. An additional 5 items assessed participant's self-efficacy for performing non-UNREP tasks that were presumably outside the range of most participant's ability levels. All participants completed the URSE two times, once prior to VE-UNREP training and once again after two consecutive trials on the VE-UNREP.

After completing the Demographics Questionnaire and the baseline-URSE, all participants completed two consecutive VE UNREPs. Prior to performing the task, participants were provided an informative briefing of the VE ship's characteristics, general reminders regarding hydrodynamic effects, and rules of thumb applicable to UNREP. The session began with the participant's review of written instructions describing the task and pictures of the location of the supply ship's

UNREP station displayed on a PC monitor. The participants were instructed to issue commands and requests for information as in the real world. These commands and information requests were input to the simulator by an experimenter via keyboard strokes. Replies to commands were made by a pre-recorded speech system, and replies to requests for information were provided verbally by the experimenter. The participants were given a brief rest period between the two VE-UNREP trials.

VE UNREP Scenario. The VE UNREP scenario task was to execute an UNREP from the port bridgeway of a guided missile cruiser (CG) and conn the ship alongside a supply ship, maintain the alongside position (at 120 feet lateral separation) for two minutes, and breakaway from the supply ship. At the scenario start, ownship was positioned 1000 yards directly behind the supply ship, and both ships were traveling on a heading of 130 degrees at a speed of 15 knots (the UNREP course and speed). The participant completed the task by issuing verbal commands to control the ship and obtain task relevant information.

Apparatus. The VE testbed was comprised of the following hardware: Dual Processor Octane R 10000 Processors, MXI Graphics, Octane Channel Option, and Indigo² Impact R 10000 IDS by Silicon Graphics, Inc. Participants used a VR4 Head Mounted Display (HMD) by Virtual Research, and IS600 Inertial Tracker by Intersence to view the graphics. The commercial software components were dVise by Division and Vega Marine by Paradigm. Further specifications can be found in Davidson (1996, 1997a, 1997b).

Study 2: Results and Discussion

It is important to note that the 8 participants in this study had considerable training and experience in performing the actual at sea UNREP maneuver (See Table 1). The original design plan had intended to use novice trainees. However, given the relative expertness of the actual participants, this created the danger of a ceiling effect, in which any benefit derived from training on the VE-UNREP would be difficult to demonstrate given the preexisting high skill level of the participants.

Therefore, the analyses we conducted were considerably underpowered. In addition to participants being officers with moderate levels of experience in performing actual at sea UNREP maneuvers, we had few participants.

With this caveat in mind, we conducted several analyses to examine the effectiveness of the VE-UNREP as a training procedure. First, to examine the effect of VE-UNREP training on overall self-efficacy, a one-way repeated-measures ANCOVA controlling for prior UNREP experience (i.e., the total number of

approaches, alongsides, and breakways) was conducted. In short, we found that participants reported significantly higher overall UNREP efficacy levels after completing two VE-UNREP trials, $F(1, 6) = 4.53, p = .04$. Although strictly speaking this analysis was underpowered (observed power = .43; ideal power is around .80), the effect size was extremely large (eta squared = .43; see Table 2 for individual participant and overall means).

Table 1: Participant's Level of Experience with UNREP

	Min.	Max.	Mean	SD
Total				
Conning Experience	2 yrs	10 yrs	4 yrs, 627 mos	
Number of Approaches	3	45	16	12.62
Number of Alongsides	2	100	23.9	29.5
Number of Breakaways	2	45	13.7	13.5
Number of VE Experiences	0	15	3.1	4.7

Table 2: Individual and Overall Baseline and Post-VE-UNREP Means

Efficacy Level		
Participant	Baseline	After VE-UNREP
1	66.00	79.20
3	95.60	100.00
4	84.80	95.20
5	83.60	86.36
6	96.80	99.60
7	89.20	99.20
8	98.16	99.04
9	70.20	93.76
Overall Means	85.55 (SD=12.08)	94.04 (SD=.55)

Finally, as participants were in fact officers, the exaggerated self-efficacy scale was deemed invalid, as several of the performances described on the scale were presumably within the abilities of the participants (i.e., functioning as department head or XO of a ship). Therefore, no analyses were conducted with this scale.

STUDY 3: FURTHER PSYCHOMETRIC EVALUATION OF THE URSE

The data collected from Study 2, which examined the effectiveness of the VE-UNREP as a training procedure, was also used to further evaluate the psychometric characteristics of the UNREP Self-Efficacy Scale (URSE). To remind the reader, an initial URSE scale was modified for Study 2 based on initial SME feedback and item analyses. A revised version was then used in Study 2. We now evaluate the psychometric characteristics of this revised version of the URSE.

Study 3: Results and Discussion

We used the URSE data that were collected at baseline from Study 2 participants. These URSE items were subjected to further psychometric analysis (see Tables 3 and 4).

In short, as a result of the revisions made to the first version of the URSE that was based on feedback from UNREP SME's, the reliability of the new URSE items improved substantially with a Cronbach alpha of .97.

However, these item analyses do suggest a few more items for possible deletion. A caveat though is that the study's participants were not novice trainees. Items that have minimum spread and lower inter-item correlations for officers with moderate levels of UNREP experience may not be the same items that show poor spread and inter-item correlations for novice trainees.

With this caution in mind, however, three items are recommended for deletion.

Specifically, items 1, 9, and 10 exhibited low variation and low inter-item correlations. Consequently, they are recommended for deletion. Although items 11 and 19 also revealed low variation, they did exhibit adequate inter-item correlations and they are consequently not recommended for deletion. This leaves a final version of the URSE of 22 items (copy of scale available upon request from first author), not counting the 5 items intended to tap an overconfident self-presentational style. Given the level of training of the current study's participants (i.e., Naval Officers), it would not be appropriate to report item characteristics of this overconfident self-presentational style scale. This will require additional non-officer participants.

Table 3: Descriptive Statistics for URSE-Revised Items

Item	Min	Max	Mean	SD
1*	90.0	100.0	98.7	3.5
2	50.0	100.0	87.5	17.5
3	50.0	100.0	88.1	16.5
4	50.0	100.0	88.1	18.9
5	50.0	100.0	84.4	19.9
6	50.0	100.0	81.9	17.3
7	50.0	100.0	81.9	17.3
8	50.0	100.0	81.9	17.3
9*	80.0	100.0	96.3	7.4
10*	80.0	100.0	92.5	8.9
11	80.0	100.0	93.7	7.4
12	60.0	100.0	91.2	13.6
13	50.0	100.0	73.8	16.9
14	50.0	100.0	81.9	19.3
15	60.0	100.0	91.3	13.6
16	60.0	100.0	93.1	13.9
17	50.0	100.0	88.1	17.7
18	50.0	100.0	83.1	18.3
19	80.0	100.0	91.3	9.9
20	50.0	100.0	87.5	16.7
21	50.0	100.0	77.5	21.2
22	50.0	100.0	78.7	19.6
23	50.0	100.0	76.2	19.2
24	50.0	100.0	75.0	19.3
25	50.0	100.0	75.0	19.3

Note: Items with asterisk are recommended for deletion

Table 4: URSE Item-Total Correlations and Alphas if Item was Deleted

Item Num.	Item-Total Correlation	Corrected Alpha if Item Deleted
*1	.14	.97
2	.85	.96
3	.79	.96
4	.91	.96
5	.91	.96
6	.86	.96
7	.86	.96
8	.86	.96
*9	-.02	.97
*10	.14	.97
11	.45	.97
12	.49	.97
13	.92	.96
14	.99	.96
15	.49	.97
16	.46	.97
17	.88	.96
18	.84	.96
19	.36	.97
20	.89	.96
21	.74	.96
22	.90	.96
23	.79	.96
24	.80	.96
25	.80	.96

Note: Items with asterisk are recommended for deletion

GENERAL DISCUSSION

The purpose of the present set of studies was to develop a psychometrically sound instrument for assessing self-efficacy for performing the actual at sea UNREP maneuver. A second purpose was to use this instrument to evaluate the effectiveness of VE-UNREP training for performing the actual at sea UNREP maneuver. The present set of studies demonstrates that the URSE is a reliable scale and that the VE-UNREP training procedure increases self-efficacy levels even in moderately experienced UNREP ship handlers. A limitation, however, of the present study is the small sample size. Although a large scientific literature suggests that URSE efficacy levels would predict actual at sea UNREP performance (Bandura, 1997), it is hoped that this scale will be used in future studies to examine its predictive utility for the at sea UNREP performance.

Implementing Self-efficacy Based (Guided Mastery) Instructional Methods

There is a major potential benefit to developing an UNREP self-efficacy measure beyond providing a potentially cost-effective measure of training effectiveness. Specifically, an UNREP self-efficacy measure would enable one to implement self-efficacy based instructional methods that have been shown to outperform traditional instructional protocols.

A notable strength of self-efficacy theory is that it not only analyzes mediators of behavioral performance but also provides guidelines for maximizing the effectiveness of training protocols. Establishing self-efficacy as the mediator of skilled UNREP performance would support the implementation of self-efficacy based training principles into existing training protocols for the VE-UNREP training procedure.

A large empirical literature examining self-efficacy has implications for developing training protocol to facilitate performance mastery. In this regard, a variety of self-efficacy based training procedures have been developed, such as “guided mastery” and “participant modeling.” These training procedures have been typically employed to train anxiety management skills, although they have been increasingly implemented in athletic training programs as well. These self-efficacy based training procedures are easily transferable to teaching UNREP and other skilled perceptual and motor performances of the type military training demands commonly require.

These self-efficacy based training principles have been shown to outperform traditional instructional procedures (Scraba, 1990). Moreover, evidence suggests that such self-efficacy based training procedures produce robust and durable changes in self-efficacy and performance. Social cognitive theory emphasizes four basic processes in changing behavioral performances: acquisition, generality, durability, and resilience (Bandura, 1997). Acquisition refers to the development of knowledge and skills. Generality refers to the scope to which the acquired capabilities apply, including generality across situational demands. Durability refers to how long changes are sustained over time. Resilience refers to the ability to recover quickly and fully from adverse circumstances.

In short, self-efficacy based training protocols such as the use of guided mastery procedures have been found to accelerate the acquisition process and to reduce its stressfulness (Bandura, 1997). They have also been found to contribute to the generality and durability of acquired performance skills. For example, individuals who have received self-efficacy based training in performing previously feared activities (e.g., driving in

traffic after traumatic accidents; approaching people in social situations) have been found to remain fully self-efficacious and fearless in their behaviors in follow-up assessments that have extended over five-years (Bandura, Jeffery, & Gajdos, 1975).

VE-UNREP as an Ideal Environment for Implementing Self-Efficacy Based Training Procedures

Virtual environments are ideally suited to utilizing and taking advantage of self-efficacy based training principles. Although it is often impractical and too expensive to have the bulk of the training experience consist of performing the actual task, virtual environment simulations are increasingly able to simulate actual task environments and performances.

For example, virtual reality environments have been effectively used for training anxiety management. Rather than coping with actual threats, phobics manage progressively more threatening aspects in a computer-generated environment (Lamson & Meisner, 1994). In a controlled experiment examining the effectiveness of VE for treating agoraphobics (i.e., phobias of heights), height phobics reported reductions in anxiety, distress, and avoidance of heights after mastering graded virtual threats (Rothbaum et al., 1995). In sum, there is evidence that mastery in VE simulations transfer to performance in actual environments.

VE technology is perfectly suited for self-efficacy based training procedures in part because of its versatility. One can accelerate mastery by graduating the level of challenge, and by introducing and fading out mastery aids within the simulated environment. Voice-over accompaniments can be used to provide optimal provision of feedback in accordance with self-efficacy principles. For instance, feedback can be framed positively, and can be laced with enabling instructions. One can insure more resilient and generalized self-efficacy by exposing the trainee to a range of VE simulated environmental circumstances, demands, and contingencies. Specific performance deficiencies can be targeted, with VE providing performance challenges targeted to the deficiencies at appropriate levels of difficulty that are designed to maximize probability of success and to make for a more efficient learning curve. With mastery of these performance levels in the area of deficiency, VE can then expose the trainee to further challenging performance demands leading to eventual expertise and performance mastery across a range of difficulty levels. Although obviously not a complete substitute for actual mastery experiences with performing the UNREP at sea, VE-UNREP training that is based on self-efficacy principles would provide an extremely convenient, useful, efficient, and optimal training adjunct.

One particularly exciting use of self-efficacy principles in a virtual environment is the potential for “real time” self-efficacy feedback into the virtual simulator program. Specifically, it is known that low efficacy levels are associated with higher levels of physiological arousal during challenging performance tasks (Bandura, 1997). One possibility is to have the trainee’s physiological state continuously monitored as he is performing the VE-UNREP. The simulator program could utilize such physiological data, which is continuously feeding into the simulator, to assess moment-by-moment efficacy levels of the trainee. This information could then inform the program as to the ideal levels of challenge, performance aids, and feedback to present to the trainee to maximize learning curves.

In short, we believe virtual environments are the ideal medium in which to take full advantage of self-efficacy based training procedures.

CONCLUSION

In summary, the present study provides some evidence that virtual environment training improves self-efficacy for performing the actual at sea UNREP maneuver. It is noteworthy that such evidence was obtained even with the deck stacked against finding such an effect. The participants indicated a very high level of efficacy even prior to participating in the VE-UNREP trials. This was not surprising given their prior level of experience. Despite the possible danger of a ceiling effect, however, participating in the VE-UNREP training raised self-efficacy levels significantly.

An extensive correlational and experimental scientific literature, reviewed in this final report, reveals that such raised self-efficacy levels ought to be predictive of increased effort, persistence, a higher quality of cognitive processing during the challenging performance, and ultimately higher performance levels.

Finally, the present study has developed a self-efficacy measure for performing the at sea UNREP (URSE). The URSE has attained a high level of inter-item reliability. Moreover, the URSE has been evaluated by UNREP SME’s as representative of the UNREP performance, with adequate levels of difficulty, and comprehensibility. It is hoped that future studies will establish the predictive utility of this measure for the at sea UNREP maneuver and that the scale will be used to implement empirically superior self-efficacy based training procedures that are ideally suited for virtual environments.

REFERENCES

- Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84, 191-215.
- Bandura, A. (1986). Social foundations of thought and action: A social-cognitive theory. Englewood Cliffs, NJ: Prentice Hall.
- Bandura, A. (1989). Human agency in social cognitive theory. American Psychologist, 44, 1175-1184.
- Bandura, A. (1997). Self-efficacy: The exercise of control. New York: W. H. Freeman and Company.
- Bandura, A., & Cervone, D. (1983). Self-evaluative and self-efficacy mechanisms governing the motivational effects of goal systems. Journal of Personality and Social Psychology, 45, 1017-1028.
- Bandura, A., & Cervone, D. (1986). Differential engagement of self-reactive influences in cognitive motivation. Organizational Behavior and Human Decision Processes, 38, 92-113.
- Bandura, A., & Cioffi, D., Taylor, C.B., & Brouillard, M. E. (1988). Perceived self-efficacy in coping with cognitive stressors and opioid activation. Journal of Personality and Social Psychology, 55, 479-488.
- Bandura, A., & Jeffery, R. W., & Gajdos, E. (1975). Generalizing change through participant modeling with self-directed mastery. Behaviour Research and Therapy, 13, 141-152.
- Bandura, A., Reese, L., & Adams, N.E. (1982). Microanalysis of action and fear arousal as a function of differential levels of perceived self-efficacy. Journal of Personality and Social Psychology, 43, 5-21.
- Bandura, A., Taylor, C. B., Williams, S. L., Mefford, I. N., & Barchas, J. D. (1985). Catecholamine secretion as a function of perceived coping self-efficacy. Journal of Consulting and Clinical Psychology, 53, 406-414.
- Berry, J. M., West, R.L., Dennehey, D. M. (1989). Reliability and validity of the memory of self-efficacy questionnaire. Developmental Psychology, 25, 701-713.
- Bandura, A., & Wood, R. (1989). Effect of perceived controllability and performance standards on self-regulation of complex decision-making. Journal of Personality and Social Psychology, 56, 805-814.
- Betz, N.E., & Hackett, G. (1981). The relationship of career-related self-efficacy expectations to perceived career options in college women and men. Journal of Counseling Psychology, 28, 399-410.
- Betz, N.E., & Hackett, G. (1986). Applications of self-efficacy theory to understanding career choice behavior. Journal of Social and Clinical Psychology, 4, 279-289.
- Biran, M., & Wilson, G. T. (1981). Treatment of phobic disorders using cognitive and exposure models: A self-efficacy analysis. Journal of Consulting and Clinical Psychology, 49, 886-899.
- Borden, J. W., Clum, G. A., & Salmon, P.G. (1991). Mechanisms of change in the treatment of panic. Cognitive Therapy and Research, 15, 257-272.
- Brown, I., Jr., & Inouye, D. K. (1978). Learned helplessness through modeling: The role of perceived similarity in competence. Journal of Personality and Social Psychology, 36, 900-908.
- Cervone, D., & Scott, W. D. (1995). Self-efficacy theory of behavioral change: Foundations, conceptual issues, and implications. Theories of behavior therapy: Exploring behavior change. Washington, D.C.: American Psychological Association.
- Collins, J. L. (1982, March). Self-efficacy and ability in achievement behavior. Paper presented at the annual meeting of the American Educational Research Association, New York.
- Cutrona, C. E., & Troutman, B. R. (1986). Social support, infant temperament, and parenting self-efficacy: A mediational model of postpartum depression. Child Development, 57, 1507-1518.
- Feltz, D. L. (1982). Path analysis of the causal elements in Bandura's theory of self-efficacy and an anxiety-based model of avoidance behavior. Journal of Personality and Social Psychology, 42, 764-781.
- Feltz, D. L. (1988). Gender differences in the causal elements of self-efficacy on a high avoidance motor task. Journal of Sport and Exercise Psychology, 10, 151-166.
- Ferrari, M., & Bouffard-Bouchard, T. (1992, June). Self-efficacy and expertise in motor learning and performance. Paper presented at the annual meeting of the Canadian Psychological Association, Quebec City.
- Gould, D., & Weiss, M. (1981). Effect of model similarity and model self-talk on self-efficacy in

muscular endurance. Journal of Sport Psychology, 3, 17-29.

Graybiel, A. & Knepton, J. (1976). Sopite Syndrome: A sometimes sole manifestation of motion sickness. Aviation, Space, and Environmental Medicine, August, 873-882.

Hays, R. D., & Ellickson, P. L. (1990). How generalizable are adolescents beliefs about pro-drug pressures and resistance self-efficacy? Journal of Applied Social Psychology, 20, 321-340.

Jourden, F. (1991). The influence of feedback framing on the self-regulatory mechanisms governing complex decision making. Ph.D. dissertation, Stanford University, Stanford, CA.

Kent, G., & Gibbons, R. (1987). Self-efficacy and the control of anxious cognitions. Journal of Behavior Therapy and Experimental Psychiatry. 18, 33-40.

Lamson, R.J., & Meisner, M. (June 8-10, 1994). The effects of virtual reality immersion in the treatment of anxiety, panic, & phobia of heights. Paper presented at the Second Annual International Conference on Virtual Reality and Persons with Disabilities, California State University, Northridge.

Lent, R. W., & Hackett, G. (1987). Career self-efficacy: Empirical status and future directions. Journal of Vocational Behavior, 30, 347-382.

Locke, E. A., & Latham, G. P. (1990). A theory of goal setting and task performance. Englewood Cliffs, NJ: Prentice Hall.

Martin, M. K., Sheldon, E., Kass, S., Mead, A. M., Jones, S. A., & Breaux, R. (1997). Using a virtual environment to elicit shiphandling knowledge. Unpublished Manuscript.

McAuley, E. (1985). Modeling and self-efficacy: A test of Bandura's model. Journal of Sport Psychology, 7, 283-295.

Rothbaum, B.O., Hodges, L. F., Kooper, R., Opdyke, D., Williford, J. S., & North, M. (1995). Effectiveness of computer-generated (virtual reality) graded exposure in the treatment of acrophobia. American Journal of Psychiatry, 152, 626-628.

Scraba, P. J. (1990). Self-modeling for teaching swimming to persons with physical disabilities. Ph.D. dissertation, University of Connecticut, 1989. Dissertation Abstracts International, 50, 2830A.

Sexton, T. L., & Tuckman, B. W. (1991). Self-efficacy beliefs and behavior: The role of self-efficacy

and outcome expectations over time. Personality and Individual Differences, 12, 725-736.

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. Science, 211, 453-458.

Weinberg, R. (1986). Relationship between self-efficacy and cognitive strategies in enhancing endurance performance. International Journal of Sport Psychology, 17, 280-293.

Weinberg, R. S., Gould, D., Yukelson, D., & Jackson, A. (1981). The effect of preexisting and manipulated self-efficacy on a competitive muscular endurance task. Journal of Sport Psychology, 4, 345-354.

Williams, S. L. (1990). Guided mastery treatment of agoraphobia: Beyond stimulus exposure. Progress in Behavior Modification, 26, 89-121.

Wood, R., & Bandura, A. (1989). Impact of conceptions of ability on self-regulatory mechanisms and complex decision making. Journal of Personality and Social Psychology, 56, 407-415