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Singer's Five-Step Approach: Does Every Bit Count?

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SINGER’S FIVE-STEP APPROACH: DOES EVERY BIT COUNT?

By

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ABSTRACT

The purpose of this study was to determine the relative effectiveness of each substrategy of Singer’s Five-Step Approach (5-SA) for learning a cup-stacking task. The 5-SA is a learning strategy previously shown to enhance the learning of self-paced motor tasks and consists of five substrategies: (1) readying, (2) imaging, (3) focusing, (4) executing, and (5) evaluating. At the theoretical level, it is important to understand which substrategies are responsible for producing changes in performance and learning. At the applied level, performers and instructors are interested in identifying the most effective and efficient learning strategies. It was hypothesized that the addition of each substrategy of the 5-SA would cause a significant increase in performance during a retention test. Male \( (n = 43) \) and female \( (n = 77) \) undergraduate and graduate students between the ages of 18 and 44 participated. Participants were randomly assigned to one of six gender stratified groups. Group 1, a control group, received no training in the use of the 5-SA strategy. Groups 2-6 were trained, respectively, to use from the 5-SA (a) the readying substrategy, (b) the readying and imaging substrategies, (c) the readying, imaging, and focusing substrategies, (d) the readying, imaging, focusing, and executing substrategies, and (e) all substrategies. Participants performed a 6 stack cup stacking task for 50 trials in an acquisition phase and for 20 trials in a retention phase. While manipulation checks provided some evidence that participants used the strategies they were taught, no significant differences between groups on performance time in retention were found. These findings are discrepant with those of previous studies of the 5-SA that have used almost identical study designs. Possible explanations for this discrepancy, including the differential use of other mental strategies across groups, are discussed.
INTRODUCTION

Learning strategies are behaviors and thoughts a learner initiates intentionally with the objective of more effectively and efficiently learning new motor tasks. Previous research has provided some evidence that learning strategies can be effective for learning self-paced motor tasks (Lidor & Singer, 2005). The focus of this thesis is on a learning strategy created to facilitate learning on self-paced motor tasks known as Singer’s (1988) Five-Step Approach (5-SA). The 5-SA involves five substrategies. The first four – readying, imaging, focusing, and executing – are applied immediately before the performance of the criterion motor task as a pre-performance routine and the fifth strategy – evaluating – immediately after the task.

Although the current body of research on the 5-SA has provided some support for the effectiveness of the 5-SA in enhancing learning, there has been no examination of whether its five constituent substrategies are required to produce the learning effects observed in this research. At a theoretical level, it is important to understand which substrategies are responsible for producing changes in performance and learning. At an applied level, performers and instructors are interested in identifying the most effective and efficient learning strategies to use in their busy classrooms and gyms. Therefore, the objective of this thesis is to determine the relative effects of each substrategy of the 5-SA for learning a self-paced motor task.

The thesis begins with a general review of research and theory related to learning strategies and pre-performance routines and continues with a comprehensive review of research on the 5-SA. Following this, limitations of the current research on the 5-SA are discussed. Finally, an explanation is provided of how the study proposed here will help overcome these limitations and advance our understanding of the role of learning strategies in motor skill learning.
CHAPTER 1

LITERATURE REVIEW

Learning Strategies

As the 5-SA has been conceptualized as a form of learning strategy, a discussion of the research and theory related to the concept of learning strategies is warranted here. In this section, the concept of a learning strategy is first introduced before studies of the effects of learning strategies on performance are briefly reviewed. The section ends with a description of theories proposed to explain these effects.

Learning strategies first originated in the educational psychology literature by way of the teaching-learning process framework. Due to the shift from a behaviorist (S-R) approach to a more cognitive approach, more emphasis is placed on the information processing and encoding components of learning (Weinstein & Mayer, 1986). In this regard, the learner is seen as an active and influential participant in the learning process, and learning outcomes are thought to be based on both the material that is presented and how it is processed by the learner. Therefore, encoding is influenced by the behavior of both the teacher and the learner in the form of teaching strategies and learning strategies respectively. Teaching strategies include “the teacher’s performance during teaching” while learning strategies include “behaviors that the learner engages in during learning that are intended to influence affective and cognitive processing during encoding” (Weinstein & Mayer, 1986, p. 316). Thus, when utilized by the learner, learning strategies have the potential to influence the encoding process and, in turn, performance and learning outcomes.

Research on Learning Strategies

There has been a variety of learning strategy types studied. Specifically, imagery and/or attentional focus strategies have been frequently examined. For example, Singer, Ridsdale, and Korienek (1980) conducted a study in which participants performed a serial positioning task using one of three strategy conditions: imagery, chunking, and rhythm. A control group was also used. The authors found that specific strategies significantly increased performance over others at certain spatial positions during the task, but, overall, there was a significant increase in performance for all strategy groups for all positions when compared to the control group.
and Singer (1980) examined the effect of instruction type and strategy use on the performance of five juggling skills. The strategies were as follows: imagery, involving the formation of an internal picture of the skill; directed attention, which denotes the focus of attention on relevant features of each skill; rhythmic verbalization, concerning the verbalization of a word or number during a movement sequence that was previously attached to it; and paraphrasing, which requires the teaching of a skill to a partner or oneself in one’s own words. Participants were assigned to one of four conditions: live instruction/strategy, traditional instruction/no strategy, modular instruction/strategy, or modular instruction/no strategy. Although the strategy groups were found to perform significantly better than the no strategy groups when acquisition and retention scores were combined, there was no significant difference for retention scores alone. Tennant (2000) conducted a study in which beginning and advanced racquetball players performed a diagonal lob serve and rally after being assigned to one of four strategy conditions: self-monitor, involving the development of a positive awareness of one’s performance outcomes; attentional focus, which requires the participant to block out distracters by focusing on relevant features of the task; combined; or control. The results indicated that the attentional focus group performed significantly better than the self-monitor and control groups, but there was no significant difference between the attentional focus and combined groups.

Some studies have also involved the use of feedback in conjunction with learning strategies to facilitate the acquisition of a motor skill. In a series of experiments, Cutton (1993) investigated the effect of cognitive learning strategies and movement sequence feedback on performance of a tennis forehand. Results from the first experiment indicated that a performer self-cueing strategy group and an advance organizer strategy group performed significantly better than two control groups on outcome scores, but the self-cueing group significantly outperformed the advance organizer group on movement sequence scores. Based on these findings, two further experiments were conducted to investigate the effect of pairing the self-cueing strategy with movement sequence feedback. In these experiments, participants were assigned to one of three conditions: self-cueing with feedback, self-cueing without feedback, or feedback only. The first of these experiments also featured a control condition. The results from these experiments indicated that both self-cueing groups performed significantly better on both outcome and movement sequence scores than the feedback and control groups. However, the
results from the second of these two experiments suggested that both self-cueing groups performed significantly better than the feedback group on only the movement sequence scores.

Other strategy research has taken a more task-driven approach, in that strategies were selected based on the type of task being learned. This has been typically undertaken using a task classification scheme, such as the one proposed by Singer and Gerson (1981). Their scheme contains three factors: environmental conditions, feedback availability and utilization, and processing mechanisms with the greatest impact for utilizing information during learning. In theory, every motor task should be classified within the scheme by determining the appropriate combination of factors relevant to the requirements of the task. However, learning strategies developed from this scheme were based primarily upon the processing mechanisms: sensory-perceptual (input operations), short- and long-term storages (central operations), and movement generator and generation (output operations). Each of these mechanisms contains a variety of cognitive processes with possible corresponding strategies. Although the authors did not make claims as to the effectiveness of any specific strategy/ies, they did assert that the utilization of any of the strategies will have a greater effect on performance than if none was used.

In one study, Singer and Cauraugh (1984) assigned participants to either a strategies group or a control group. They used a modified task classification system (Singer & Gerson, 1981) to identify three strategies important for a pursuit rotor task: anticipatory, involving being aware of potential changes to the task condition; rhythmic, concerning the development of a tempo to the rhythmic nature of the task; and monitoring of auditory feedback, which denotes awareness of the tone produced when the stylus is in contact with the disk. The results showed that the strategies group performed significantly better than the control group and spent significantly more time on target. In a similar study, Singer, Cauraugh, Lucariello, and Brown (1985) assigned participants to either a strategies group or a control group. They also used a modified task classification system (Singer & Gerson) to identify three strategies pertinent to a photoelectric maze task: imagery, which involves mentally picturing moving through the correct path; rhythmic patterning of movements, which requires the use of smooth and steady control while moving through the maze; and selective monitoring of feedback, which concerns the visual monitoring of movements. They found that the strategies group was significantly faster at completing the maze than the control group. Finally, Brown, Singer, Cauraugh, and Lucariello (1985) conducted a similar study using a maze task where participants were assigned to either a
strategies group or control group. The authors used a task analysis procedure and previous maze strategy research (Singer et al.) to determine relevant strategies, which were imagery, rhythm, and feedback. In addition, participants were identified as having either a reflective or impulsive cognitive style. Results indicated that both the reflective and impulsive strategies groups performed significantly faster than the control groups.

While this section has provided an introduction to the types of research conducted on learning strategies and indicated that learning strategies generally appear beneficial to learning, the focus of the next section is on theories proposed to explain how these strategies might provide these benefits.

Theories of How Learning Strategies Affect Learning

Although learning strategies are rooted in the educational psychology literature, the emphasis of the present study is on learning strategies within the motor domain. Therefore, the following review contains theories relevant to explaining the effects of learning strategies on learning within the motor domain.

Encoding theory. One theory useful in understanding how learning strategies might exert their effects is encoding theory. Early research on encoding resulted in the formulation of two encoding models: levels of processing (Craik & Lockhart, 1972) and dual-coding (Paivio & O’Neill, 1970). The levels of processing model focuses on the depth at which information is processed. Specifically, information that is processed at a greater depth (i.e., greater semantic involvement) will be remembered better than information that is processed at a shallow level (i.e., greater surface characteristics). The dual-coding model suggests that information can be represented in two forms: mental image or verbal representation. Concrete concepts can be represented in both forms while abstract concepts can only be represented verbally. However, information is better remembered when both representations are used because, if recall of one representation fails, the other one has potential to be retrieved.

Researchers have used encoding theory for the formation of learning strategies in the motor domain (Hall, 1978). Based upon research on encoding, general principles have been derived for instructor application. These principles state that perceptual-motor learning has verbal and visual components, depth of processing is important for encoding, and encoding is dependent on task demands (information used immediately versus information used at a later
time. Based on these principles, learning strategies, such as student verbalization of instructions and imagery, and teaching strategies, such as presentation of visual stimuli and clarification of task demands, have been suggested. Thus according to encoding theory, learning strategies serve to facilitate effective encoding of pertinent information for motor learning.

**Cognitive monitoring.** Another theory with the potential to explain how learning strategies exert their effects is Flavell’s (1979) cognitive monitoring theory. Flavell’s theory involves four central components: (a) metacognitive knowledge, (b) metacognitive experiences, (c) goals, and (d) actions (or strategies). According to this theory, a learner’s metacognitive knowledge is influenced by the metacognitive experiences that occur from actions he or she employs to achieve certain learning goals. For example, a child learning a free throw skill may employ a strategy, such as focusing on the rim of the basket, to acquire the skill. Whether or not the child is able to acquire the skill will consequently dictate how the child views his or her basketball competence.

Relevant to this topic is the concept of comprehension monitoring. Comprehension monitoring occurs during instruction when an individual forms learning goals, monitors the goals, and adjusts his or her learning strategy/ies in order to achieve the goals (Weinstein & Mayer, 1986). In this regard, if the child mentioned above did not successfully acquire the free throw skill by focusing on the rim of the basket, he or she may choose to employ a different strategy, such as using feedback to adjust performance that may result in success. Therefore, according to cognitive monitoring theory, learning strategies facilitate achievement of pertinent learning goals.

**Categories of human performance.** A final theory that intersects with the concept of learning strategies is Gagne’s (1984) categories of human performance. Gagne asserts that there are five categories of learning outcomes within human performance: (a) intellectual skills, (b) verbal information, (c) cognitive strategies, (d) motor skills, and (e) attitudes. Cognitive strategies, of which learning strategies is a subdomain, are defined as higher mental processes that enable “a learner to exercise some degree of control over the processes involved in attending, perceiving, encoding, remembering, and thinking” (p. 381). They help the learner obtain, access, and use information necessary for a given task.

Cognitive strategies are also thought to occur abruptly during the learning process as opposed to evolving gradually through experience. However, evidence from previous research
suggests that cognitive strategies may be rule-guided and that these rules could be discovered through research (Derry & Murphy, 1986). This may have implications for the instruction. Through procedures such as task classification (e.g., Singer & Gerson, 1981) and task analysis (e.g., Robb, 1972), cognitive strategies can be analyzed and taught as intellectual skills; however, further research is needed. Thus, according to the categories of human performance theory, learning strategies function to influence information processing by exerting control over cognitive processes involved in learning.

The theories described above help to explain the effect of learning strategies on learning within the motor domain. Encoding theory attempts to explain the effect of learning strategies on the basis of two models of information processing, levels of processing and dual-coding. According to cognitive monitoring theory, learning strategies facilitate the achievement of relevant goals. Finally, according to the categories of human performance theory, learning strategies allow the learner control of his or her cognitive processes in order to influence information processing.

Pre-performance Routines

The 5-SA could be conceptualized as a form of pre-performance routine given that four of its five substrategies are delivered as a routine prior to the performance of the criterion learning task. Consequently, this section involves a discussion of the research and theory related to pre-performance routines. The section begins with an introduction to pre-performance routines and continues with a brief overview of studies of their effects on performance. The section ends with a description of theories proposed to explain these effects.

Pre-performance routines occur commonly within the sport domain. A pre-performance routine is a structured sequence of cognitions, movements, and emotions established to provide the individual with a preparatory state conducive to optimum performance capabilities (Lidor, 2007). Pre-performance routines are usually performed within a very short period of time (e.g., 5-25 s) and are prevalent in sports that have components of, or are comprised of self-paced motor tasks. A pre-performance routine can encompass a variety of cognitive strategies (e.g., self-talk, relaxation, and cognitive restructuring) and behavioral components (e.g., target alignment, ball bouncing, and movement rehearsal) (Cohn, 1990). The 5-SA has components typically found in a pre-performance routine, such as attaining an optimal arousal state, imaging correct movement
patterns, and using feedback to adjust for subsequent performances. There has been considerable research on the use of pre-performance routines in sport with generally favorable and consistent results. This research is described below.

Research on Pre-performance Routines

One sport that has received ample attention in this area is basketball. A recent study by Lonsdale and Tam (2008) investigated the effect of dominant behavioral routines of professional basketball players on free-throw performance. They found that players were more successful when they used their routine than when they deviated from it. Wrisberg and Pein (1992) also observed pre-performance behavior and free throw accuracy of basketball players and found that high percentage free throw shooters were more consistent in preparation time for task performance than low percentage shooters. Another study (Lobmeyer & Wasserman, 1986) found that basketball players were more successful at free throws when using a pre-performance routine as opposed to no routine. Free throw performance was also examined by Wrisberg and Anshel (1989). They found that players taught a combination of imagery and arousal adjustment performed better than players who learned only imagery or arousal adjustment alone. Moreover,Predebon and Docker (1992) found that basketball players taught a combination of imagery and physical preparation were more accurate than those taught a physical routine alone.

Other sports in which pre-performance routines have been examined are golf and rugby. Crews and Boutcher (1986) found that male golf students using a pre-shot routine performed better during post training than the controls. In another study, Beauchamp, Halliwell, Fournier, and Koestner (1996) found that the use of a cognitive-behavioral program enhanced intrinsic motivation, led to a more consistent pre-shot routine, and improved putting performance over that of a physical skills and control condition. In an observational study of rugby players, Jackson (2003) found evidence to suggest that the amount of time players spent in concentration was higher when the score was close. Additionally, a case study (Jackson & Baker, 2001) of a rugby player revealed that physical preparation time and concentration time increased with the difficulty of the kick.

While this section has provided an introduction to the types of research conducted on pre-performance routines and indicated that pre-performance routines generally appear beneficial to
learning, the focus of the next section is on theories proposed to explain how these routines might provide these benefits.

**Theories of How Pre-performance Routines Affect Learning**

Although studies described in the previous section provide support for the use of pre-performance routines in sport, it is important to consider how the use of these routines affects motor skill learning. Cohn (1990) proposed various theories in this regard. These are described below.

*Schema theory.* Developed by Schmidt (1975), schema theory has been proposed as the most important theory underlying pre-performance routines (Cohn, 1990). A concept central to schema theory is the generalized motor program (GMP). The GMP consists of movement categories stored in memory that, when executed by the program, result in a distinct pattern of action (Schmidt & Lee, 2005). The GMP operates in an open-loop method in which there is no presence of sensory feedback during movement. Certain parameters supplied to the program define the way in which it will be executed. These parameters provide information in the following forms: initial condition, overall force and duration, environmental outcome of the movement, and sensory outcome of the movement. Briefly stored in working memory, this information is used by the individual to form two schemas, recall and recognition.

Recall schema is closely related to the concept of recall memory. Recall memory is primarily concerned with movement production (Schmidt & Lee, 2005) and is an important factor in understanding the relationship between pre-performance routines and motor skill learning. Pre-performance routines help set the parameters for the execution of the GMP by supplying information related to the desired outcome (e.g., initial conditions) (Cohn, 1990). In effect, they also help select the motor program for the appropriate action. Therefore, according to schema theory, pre-performance routines are useful for performers because they facilitate the selection of the appropriate motor program by defining the parameters under which the program will be executed.

*Stages of motor learning.* Another theory that provides support for pre-performance routines is stages of motor learning (Fitts, 1964; Fitts & Posner, 1967). According to this theory, there are three continuous stages of motor learning: cognitive, associative, and autonomous. The cognitive stage is characterized by the individual determining what is to be done in order to
perform the motor task. Once this knowledge has been acquired, the individual enters the associative stage in which small adjustments are made in order to perfect the newly acquired motor skill and errors progressively decrease. The autonomous stage is achieved when the movement pattern can be performed automatically; that is, with little to no cognitive control.

Cohn (1990) suggests that the stages of motor learning support the use of pre-performance routines in the autonomous phase. When one learns a motor task that is stereotyped and performed in a relatively predictable environment, processing tends to progress from controlled (i.e., slow with high attentional demands) to automatic (i.e., fast with low attentional demands). As a result, the individual is able to process information much faster and free up attentional resources. These attentional resources can then be used to process secondary tasks, such as a pre-performance routine. Therefore, in the autonomous phase of the stages of motor learning, pre-performance routines are useful because they occupy an individual’s attentional resources so that the motor task can be performed automatically without conscious control.

Even though pre-performance routines are most useful in the autonomous phase, they can also be tailored to include features relevant to each stage of motor learning. During the cognitive stage, pre-performance routines should focus the individual’s attention on the mechanics of the motor skill to facilitate correct movement patterns. At the associative stage, pre-performance routines should direct the individual to make small adjustments to the motor skill in order to facilitate continued improvement. Finally, pre-performance routines at the autonomous stage should function to free up the attentional resources of the individual in order to facilitate processing of other strategy related information and the automatic run-off of the motor program (Cohn, 1990).

Activity-set hypothesis. Another source of explanation for the use of pre-performance routines comes from the activity-set hypothesis. The premise of the activity-set hypothesis is that, with experience of performing in his or her sport, the performer develops an internal state, or set, that facilitates performance (Nacson & Schmidt, 1971). The internal set is constituted by the underlying systems that support task performance when adjusted to the optimal level for the specific class of responses. If disrupted, the loss of internal set can cause warm-up decrements in performance. This decrement often occurs during periods of rest. Thus, sports characterized by periods of rest and breaks, such as golf, tennis, gymnastics, and baseball, are particularly susceptible to a warm-up decrement. Once play has resumed, the internal set may be reacquired
after approximately 3 to 5 trials depending on the task (Nacson & Schmidt, 1971). Therefore, according to the set hypothesis, pre-performance routines may assist an individual in returning to his or her internal set following a period of rest (Cohn, 1990).

Mental rehearsal. A final area supporting the use of pre-performance routines is mental rehearsal. Mental rehearsal is described as an internalized representation of the execution of the intended motor skill (Cohn, 1990). Although no overt actions are performed during mental rehearsal, it has been shown to facilitate actual performance. There are two views as to why this phenomenon occurs. One view posited by Schmidt and Lee (2005) asserts that mental rehearsal functions to elicit information about the cognitive elements of the task as opposed to actual movement components. The other view claims that during mental rehearsal, the actual motor program for the action is carried out with virtually no evidence of actual movement (Cohn, 1990). In effect, the motor program is primed for execution of the motor skill. Thus according to this view, pre-performance routines serve as a mechanism for readying the neural pathways of the motor program to be executed.

In summary, there are several theories about the role pre-performance routines may play in motor skill learning. With regard to schema theory, pre-performance routines may provide the means for selecting the appropriate motor program for the intended motor skill. In addition, pre-performance routines may facilitate learning at each stage of motor learning. With regard to the set hypothesis, pre-performance routines may help reestablish an individual’s internal set after periods of rest. Finally, pre-performance routines that involve some mental rehearsal component may act to prime neural pathways for the intended motor program.

In this section, the research and theory related to learning strategies and pre-performance routines in general was reviewed. In the next section, there is a specific focus on the 5-SA learning strategy.

Singer’s Five-Step Approach

The 5-SA is a learning strategy developed by Singer (1988) based on anecdotal and empirical support for the utility for learning of its five component substrategies (Lidor, 1997). These are (a) readying, (b) imaging, (c) focusing, (d) executing, and (e) evaluating. Each substrategy is described in more detail below.
Readying. For the readying substrategy, the learner is instructed before commencing a practice trial of the criterion motor task to: (a) think positively about performing the task; (b) become aware of his or her attitudinal-emotional state; (c) determine the state in which he or she performs the task best; (d) attain this state consistently prior to each performance; and (e) attempt to do things in preparation that are associated with previous best performances. The rationale for the inclusion of this substrategy within the 5-SA is that it is purported to create an optimal preparatory state within the learner prior to an execution of the criterion motor task. Previous research has provided evidence that learning can be affected by the psychological state of the learner during practice (Hardy, Jones, & Gould, 1996). To elaborate, it has been theorized that, depending on the task being learned and the personality of the learner, there is an optimal state of attention, motivation, and emotion for learning. Thus, if learners take the time and invest the cognitive effort to identify, attain, and maintain these states during practice, learning should be enhanced.

For example, according to some theories, there may be a level of arousal that is optimal for performing a task. It has been proposed that the relationship between arousal level and performance is curvilinear, following an inverted-U shape (Schmidt & Wrisberg, 2000) when arousal level falls along the x axis and performance along the y. As arousal level increases from low to moderate, performance increases from low to high. Conversely, as arousal level increases from moderate to high, performance decreases from high to low. According to this theory, an individual’s optimal state for learning falls within a range of moderate arousal in which he or she is neither too anxious nor unmotivated. Therefore, the learner who is able to ready himself or herself by attaining a moderate level of arousal during periods of task practice should experience enhanced learning. Thus, the readying substrategy encourages the learner to attempt to identify and attain psychological states conducive to learning (Singer, 1988).

Imaging. For the imaging substrategy, the learner is instructed prior to the task to (a) imagine himself or herself performing the task accurately and quickly and (b) feel confident performing the movements. There is considerable research supporting the positive effects of imagery on learning and performance (for reviews, see Callow & Hardy, 2005; Eccles & Feltovich, 2008). Researchers have proposed that mental imagery can positively affect learning via motivational and cognitive pathways (Hall, 2001). By forming an internalized picture of himself or herself executing the intended act successfully, the learner increases confidence and
affirms his or her capabilities for performing the task (Bandura, 1997). For example, a gymnast, prior to a floor exercise, may image herself performing the routine successfully and, thus, affirm her ability for the actual performance. This increase in confidence is thought to lead to greater motivation for the task, which in turn leads to greater perseverance during practice (Vealey, 2007). For example, Martin and Hall (1995) conducted a study in which participants learned a golf-putting task after being assigned to either an imagery or control group. The results indicated that the imagery group outperformed the control group on time spent practicing, setting challenging goals, and adherence to the training program.

Imagery used to rehearse task relevant procedures can also affect learning through cognitive pathways (Driskell, Cooper, & Moran, 1994). The positive effects of mental rehearsal on learning have been the subject of reviews. For example, Driskell et al. conducted a meta-analysis of 35 mental rehearsal studies that took place between 1934 and 1991. The studies consisted mainly of treatment and control designs, in which treatment groups used either mental, physical, or mental and physical practice to learn a motor task. Participants were typically instructed to sit quietly, not move, and image themselves successfully executing the intended task. Overall, the results indicated that mental practice is better than no practice at all, physical practice is better than mental practice, and a combination of mental and physical practice is better than either mental or physical practice alone.

**Focusing.** For the focusing substrategy, the learner is instructed prior to the task to (a) focus his or her attention on one feature relevant to the task and (b) attempt to block out all other thoughts. The rationale for the inclusion of the focusing substrategy is that it helps focus the learner’s attention on task relevant information and filter out distracters (Singer, 1988). For example, a tennis player might use a focusing strategy that involves telling himself or herself to focus attention on the seams of the ball prior to execution of the serve. As a result, the player is better able to avoid the potentially degrading effect of a variety of distracters on performance, such as an awareness of spectators, evaluation of performance, or presence of opponent.

Research has supported the use of strategies that encourage learners to focus on task-relevant information. For example, Lidor and Mayan’s (2005) interviews of elite male volleyball players revealed that the players used a strategy of attending to specific task-relevant cues such as the upper edge of the volleyball net to block out distracters during performance. Boutcher and Zinsser (1990) examined the verbal reports of novice and elite golfers during putting and found
that while elite golfers tended to focus on a single external or internal putt cue (e.g., the back of the ball or the feel and rhythm of the putt), novice golfers tended to have many thoughts about putting mechanics and focused on avoiding hitting the ball too hard. Furthermore, Boutcher and Crews (1987) examined the use of an attentional pre-shot routine on male and female golf performance and showed that males and females who received routine training decreased the variability of their putting performance and females also improved putting performance.

The focusing strategy may also be considered a form of instructional self-talk (Eccles & Feltovich, 2008; Hardy, Hall, & Hardy, 2005). To elaborate, the function of the strategy may not just be that it helps the performer avoid distractions but also that it specifically directs their attention to task information critical for learning. Evidence for these claims has been provided by researchers who have found that participants learning hard, compared to easy, tasks exhibit more external self-talk (e.g., Duncan & Cheyne, 2002). Similar evidence has been offered from more applied settings. For example, Perkos, Theodorakis, and Chroni (2002) conducted a study to assess the effects of instructional self-talk on learning. Novice basketball players were assigned to either a self-talk or control group, in which the self-talk group was instructed to focus attention on task relevant cues, such as “low, rhythm” for dribbling, “fingers, target” for passing, and “hand, center” for shooting. The results indicated that participants in the self-talk group used more self-talk when performing passing and dribbling skills and subsequently learned those skills faster than the control group. Thus, the focusing substrategy encourages the learner to place attention on the task in order to avoid potential distracters that could degrade performance.

Executing. For the executing substrategy, the learner is instructed immediately prior to performing the task to (a) execute the task without any thought about the act itself or the possible outcome and (b) “just do it.” The rationale for the inclusion of the executing substrategy is that it facilitates the execution of the motor skill by directing the performer to avoid “overthinking” the movements or the desired outcome of the task during execution (Singer, 1988). In effect, it encourages the performer to execute the motor program in an automatic, open-loop manner. To elaborate, open-loop control involves applying conscious control only to initiate the motor program specifying the sequence of motor actions constituting the task. Thus, it does not involve the use of feedback to correct the actions during the execution of the task, only afterwards (Schmidt & Wrisberg, 2000). This may be useful during learning to reduce the tendency by learners to overanalyze the task during its execution; that is, to avoid “paralysis by analysis”.

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Another concept related to this line of thinking is implicit learning. Implicit learning is the process of learning a motor skill without knowledge of its specific mechanics and thus requires little input from consciously controlled processes (Abernethy, Maxwell, Masters, van der Kamp, & Jackson, 2007). Performance decrements are often attributed to an individual’s thoughts about the mechanics of the task (i.e., explicit knowledge). Thus, strategies such as the executing strategy, which encourage learners to learn implicitly, may reduce the extent to which learners may attempt to explicitly control the execution of the task.

**Evaluating.** The evaluating substrategy is the only substrategy undertaken after a given attempt to perform the task being learned. Immediately after the task, the learner is instructed to: (a) use the available feedback to learn from; (b) assess the performance outcome of the task and the effectiveness of each step in the routine; and (c) adjust any procedure next time, if necessary. The evaluating substrategy is included because it directs the learner to use feedback available after the task to analyze both task performance and utilization of the four substrategies used prior to the attempt to perform the task.

There are two key forms of feedback: knowledge of results (KR) and knowledge of performance (KP). KR is information that is available in the environment to the learner about the outcome of the movement. This might be inherent to the task in the way that a golfer can easily observe whether he or she missed a putt or augmented in the way that a golfer might learn from a spectator that he or she had holed a long chip onto a “hidden” green (Schmidt & Lee, 2005). KP, also termed kinematic feedback, is information about the quality of the movement. As with KR, this information can be available inherently, such as from the feel of the movement as it was executed, or be in an augmented form, such as feedback from a coach about how the movement was poor at its beginning.

Regardless of the type of feedback, the frequent (if not continuous) availability of feedback to the learner has been shown to have motivational, reinforcing, and informational properties (Schmidt & Wrisberg, 2000). In terms of motivation, individuals able to access and use feedback report greater enjoyment, try harder, and are willing to practice longer. As a reinforcer, the availability and use of feedback produces consistent and beneficial changes in performance. Finally, the informational property of feedback helps learners keep their errors to a minimum, correct them more quickly, and bring their movement patterns closer to the goal. Thus, the evaluating substrategy encourages the learner to use available feedback to analyze his
or her performance for both the task and implementation of the other substrategies and adjust it accordingly during future trials.

In summary, the five substrategies of the 5-SA are designed to promote learners to actively engage in thinking processes that will enhance learning. Having described the substrategies and the theories underlying their inclusion in the 5-SA, there now follows a review of the extant research on the effectiveness of the 5-SA in enhancing learning of self-paced motor tasks.

**Research on the 5-SA**

There is an important distinction within the field of motor learning between motor skill acquisition and retention (see Schmidt & Lee, 2005, chap. 10). While performance during an initial practice or “acquisition” phase might often increase over practice trials, these gains are in some cases temporary. A retention test, which usually comprises a small number of practice trials undertaken some time after the initial acquisition phase, is often considered to be a more valid test of learning. However, retention tests are not always included in studies of motor learning and, thus, it is made clear in the following review of research on the 5-SA whether learning effects reported in the featured studies were related to acquisition or retention.

Singer, Flora, and Abourezk (1989a) examined the effectiveness of the 5-SA for learning a novel complex motor task in which participants used a stylus to touch a sequence of six pressure sensitive targets. Participants taught the strategy performed significantly faster than the control group with no significant tradeoff for errors. Singer, DeFrancesco, and Randall (1989) studied the effectiveness of the 5-SA using two primary tasks, a novel complex motor task (as described in the previous study) and a table tennis serve, and a transfer task, underhand dart-throwing. The results showed that participants taught the strategy performed significantly faster during both the primary and transfer tasks. Given that most studies have used university students as participants, it is worth noting that the effectiveness of the 5-SA has also been demonstrated with older adults performing a golf putting task (Steinberg & Glass, 2001).

Although most studies of the 5-SA have taken place in the laboratory, some have been conducted in the field. Lidor, Arnon, and Bronstein (1999) tested the effectiveness of the 5-SA using basketball players during their regular practice sessions and found that players taught the strategy improved their foul throw performance over that of the controls. Moreover, a case study revealed that a basketball player taught the 5-SA over a period of six sessions in the gym
consistently improved his free throw accuracy (Lidor & Tenenbaum, 1994). Chung, Kim, Janelle, and Radlo (1996) tested the effectiveness of the 5-SA on air gun shooting at an international shooting site and found that the treatment group performed significantly better than the control. Additionally, Lidor (1997) found that elementary and middle school students could effectively utilize the 5-SA when learning, respectively, a bowling throw and overhand ball throw in a school setting.

Other studies have been focused on specific aspects of, or conditions under which the 5-SA is effective. Singer and Suwanthada (1986) examined the effect of a content-dependent versus content-independent version of the 5-SA on an underhand dart throwing task and transfer to throwing a “jart”, an oversized dart (related), and soccer foul shooting (non-related) tasks. The content-dependent strategy instructions were directed to the motor task being learned while the content-independent strategy instructions were directed to the learning of motor tasks in general. They found that the performance of individuals using the content-independent version was better, but not significantly, on the related task and significantly better on the non-related task compared to the content-dependent version. Kim, Singer, and Radlo (1996) examined the effect of the 5-SA on the learning of three motor tasks that imposed a low, moderate, and high cognitive load respectively. The results showed that learning, indicated by performance on a retention test, was significantly greater for the low and moderate cognitive load groups compared to the controls. However, there was no significant difference between the high cognitive load and control groups. Bouchard and Singer (1998) investigated the effect of different modes of 5-SA delivery on performance and learning. Participants were given strategy instruction via either videotaped modeling or audiotape/written transcript. There was also a control group that received no strategy information. Although all participants showed a significant improvement in performance and learning, there were no significant differences in performance or learning between the groups.

Another area of research focus has been the effects on performance of the point during the acquisition phase at which the 5-SA is first introduced. Singer, Flora, and Abourezk (1989b) examined the effects on performance of three different points of introduction during this phase for the 5-SA: before all trials, after 25% of trials, and after 50% of trials. The results indicated that participants exposed to the strategy before all trials performed significantly better than those who received the strategy at either point later in acquisition. However, a similar study (Tennant,
Murray, & Tennant, 2004) looked at four different points of introduction: before all trials, and after either 17%, 50%, or 83% of trials. A control group received no strategy instruction. The results for acquisition indicated that the 50% group performed significantly better than the no strategy, 17%, and 83% groups; however, no significant results were found for retention.

Since the 5-SA comprises substrategies that promote awareness (substrategies 1, 2, 3, & 5) and nonawareness (substrategy 4), some studies have compared it to learning strategies comprising only an awareness (focusing attention on the movement) or nonawareness (performing movement without thought) approach. Singer, Lidor, and Cauraugh (1993, 1994) conducted two such studies using an overhand ball throwing task and a key pressing task, respectively, using four conditions: 5-SA, nonawareness, awareness, and control. The results showed that the 5-SA and nonawareness groups had significantly less error and variability on the overhand ball throwing task than the awareness and control groups, and the 5-SA group performed significantly faster on the key pressing task than the nonawareness, awareness, and control groups. Lidor, Tennant, and Singer (1996) conducted a similar study using a ball throwing and dart throwing task and found that the 5-SA group was significantly more accurate and less variable than the nonawareness, awareness, and control groups. Finally, Lidor (2004) compared the effects of the three different strategies on learning basketball free throws in a junior-high school physical education class. Lidor found that the 5-SA and nonawareness groups had significantly more accurate free throws than the awareness and control groups.

In summary, the studies reviewed here provide at least some support for the effectiveness of the 5-SA in enhancing performance and in some cases learning (i.e., retention) of motor tasks.

Statement of Purpose

Although some studies have shown the 5-SA to be an effective learning strategy for motor skill learning, some researchers (Chung et al., 1996; Singer et al., 1989a) have proposed that the combination of substrategies within the 5-SA is more powerful than any individual substrategy alone. However, this has not been tested empirically. At the theoretical level, it is important to understand which substrategies are responsible for producing changes in performance and learning. Some researchers (Lidor, 2004; Singer et al., 1993) have proposed that the executing substrategy (substrategy 4) of the 5-SA may account for most of the 5-SA’s effects on learning but there has been no research focused on testing this specific hypothesis.
At the applied level, performers and instructors often operate within various resource constraints and thus are interested in identifying the most effective and efficient learning strategies. Researchers have described the 5-SA as a time-consuming and complicated technique (Singer et al., 1993) and have suggested that emphasis of a single substrategy may be more simple and effective (Lidor et al., 1996). Therefore, the purpose of this study is to determine the relative contribution of each substrategy of the 5-SA to learning a self-paced motor task.

According to Lidor and Singer (2005), motor tasks used in 5-SA research typically fall into one of three categories: laboratory, applied, or sport. Laboratory tasks are usually unrepresentative of most everyday tasks and are chosen because participants usually have no prior experience with them. Therefore, experience is effectively equated for all participants and thus controlled. Examples of laboratory tasks are touching a sequence of six pressure sensitive targets (Singer et al., 1989, 1989a, 1989b), key pressing (Singer et al., 1994), and mirror trace (Kim et al., 1996). Applied tasks are tasks that are more representative of real sport tasks than laboratory tasks but have been modified so that, like laboratory tasks, they are effectively novel for all participants. Applied tasks include underhanded dart throwing (Singer & Suwanthada, 1986), modified table tennis serve (Singer et al., 1989), and overhand throw at a target (Singer et al., 1993). Sport tasks most closely resemble actual sport skills. While it is harder to control for prior task experience in studies that make use of real sport tasks, these studies have the highest ecological validity and thus provide the best opportunity for obtaining evidence that learning strategies may be of use in the real world. Sport tasks have consisted of soccer foul shooting (Singer & Suwanthada), basketball free throw (Lidor et al., 1999; Lidor & Tenenbaum, 1994), tennis serve (Bouchard & Singer, 1998), and air gun shooting (Chung et al., 1996). However, most sport tasks used in 5-SA research are self-paced tasks that have been selected from many other tasks that are a natural part of a given sport (e.g., the free throw is only one of many tasks required within basketball) as opposed to a sport that consists entirely of a self-paced task or tasks. Therefore, an additional purpose of this study is to provide more ecological validity to the current body of research on the 5-SA by using a sport that is composed entirely of self-paced tasks (i.e., cup stacking).

Based upon the theoretical support and empirical findings for the 5-SA, this study will involve testing the relative contribution of each substrategy to the acquisition and retention of a self-paced motor task. Theoretically, the substrategies within the 5-SA may have interactive
rather than independent effects on learning. To test all the interactive effects possible would require a design that involves all combinations of the five substrategies but maintains the order of the substrategies. This would require over 30 conditions, which is not feasible. Thus, an additive design is used in which the first condition involves only the readying substrategy, the second condition the readying and imaging substrategies, and so on until all five substrategies feature. This allows for the identification of the contribution of each additional substrategy to learning. The hypothesis is that each additional substrategy will cause a significant decrease in performance time (i.e., an increase in performance) in retention.
CHAPTER 2

METHOD

Participants

This study featured 120 participants of whom 77 were female and 43 male. Participants were undergraduate and graduate students between the ages of 18 and 44 from a southeastern university in the United States, $M = 22.5$ years, $SD = 4.3$. Participants were recruited primarily through the university’s college of education. Participation was voluntary and no incentive or course credit was given. At the time of recruitment, there was a check that participants had no previous experience with the study task. Consent (see Appendix A) was obtained from all participants.

Conditions

There were six conditions. Accordingly, participants were randomly allocated to one of six groups of 20 participants. The size of the groups was chosen to provide sufficient statistical power to obtain moderate effect sizes during the analysis (Cohen, 1992). An attempt was made to balance gender across groups, which resulted in four groups of 13 females and 7 males and two groups of 12 females and 8 males. There was no significant difference between groups on age, $F(5, 114) = .09, p = .99$. Group 1, a control group, received no training in the use of the 5-SA strategy. Groups 2-6 were trained, respectively, to use from the 5-SA (a) the readying substrategy, (b) the readying and imaging substrategies, (c) the readying, imaging, and focusing substrategies, (d) the readying, imaging, focusing, and executing substrategies, and (e) all substrategies (see Appendix B).

Motor Task

The motor task learned was a 6 stack cup stack task (hereon referred to as the 6 stack task). This is a task performed at World Sport Stacking Association (WSSA) competitions and is a closed skill consisting of up stacking and down stacking, as fast as possible, six official WSSA cups in a pyramid design using a prescribed “3-2-1” stacking method (see Appendix C for a task analysis). To illustrate the potential for learning in this task, consider that the 2007 WSSA world record for the collegiate division 3-6-3 stack task, which requires three sequential cup stack
tasks, the middle one being the 6 stack task used in the present study, was 2.96 s (World Sport Stacking Association, 2007). By contrast, in a pilot test of the present study, novices took approximately 10 s to complete the 3-6-3 stack task. Although the 6 stack task is part of the 3-6-3 stack task, it is typical for novices to learn each stack task comprising the 3-6-3 task separately before attempting to perform them in sequence.

The 6 stack task was performed using official WSSA equipment. Participants stood in front of a laboratory table. A WSSA StackMat® (Speed Stacks Inc., Deerfield Beach, FL), which serves as the stacking surface, and precision timer (Speed Stacks Inc., Deerfield Beach, FL) was placed on the table. The timer consisted of two touch pads. Touch and release of both pads one time starts the timer and a subsequent touch stops the timer. Six official cups were placed stacked on an “X” mark in the middle of the StackMat®. At the beginning of a trial, participants placed one hand on each touch pad and waited for approximately 1 s to arm the timer. When the timer was armed, a green light illuminated and the participant, whenever ready, removed both hands from the touch pads to begin the stack task. Once the task was completed, participants placed one hand back on each touch pad stopping the timer and ending the trial. After task completion, knowledge of results of performance time was available to participants via the display on the precision timer.

Performance Measures

To help obtain measures of performance, task performance was recorded via digital video recorder (Sony DCR-HC28, San Diego, CA) throughout testing. However, the face of the participant was not captured to protect the participant’s anonymity and reduce unwanted stress on the participant.

Speed is the performance measure in the sport of cup stacking but errors such as an improper stack sequence or uncorrected fumbles (cups that fall during the up/down stacking process) during a stack attempt in competition result in the dismissal of that attempt. However, as the participants in the present study were novices, such errors were committed on occasion as they began to try to perform the learned sequence more quickly. Thus, rather than discard trials involving errors, both speed (termed here performance time) and accuracy were measured in the present study. Performance time was measured as it is in the sport of cup stacking via inspection of the display of the WSSA precision timer, which measures to ± .01 s accuracy.
With regard to accuracy, pilot testing revealed that, provided that the cup pyramid, which is the result of the up stacking portion of the stack sequence, and the final cup stack, which is the result of the down stacking portion of the sequence, are both completed within a trial, errors made in the up or down stacking sequences typically increase performance time (i.e., make performance worse). In no pilot trial observed did the commission of any error in up stacking or down stacking decrease performance time (i.e., make performance better). It seems that the prescribed sequence of stacking movements is highly if not optimally efficient, at least in the absence of extended opportunities for experimentation of alternatives. Such opportunities were unavailable to participants in the study. Therefore, all trials from four participants within each group (i.e., 20%) were inspected via the recorded video for evidence that the pyramid and final cup stacks were correctly formed. Observed failures to correctly form the pyramid, termed pyramid errors, and final cup stack, termed final stack errors, were tabulated. Additionally, cases in which the touch pads were accidentally pressed before task completion were coded as final stack errors. The four participants for whom error data were collected were selected at random by an impartial third party using an internet-based random number generator (Mads, 2007) and were not disclosed to the experimenter until after testing.

Procedure

Participants were tested individually (see Appendix D, for a graphic depiction of the test procedure). They first read and signed an informed consent (see Appendix A) before being assigned to groups. Next, they undertook an instructional phase, which lasted approximately 20 min. Participants were first exposed to the task equipment and then shown a commercially produced instructional video designed for novice cup stackers (Speed Stacks Inc.) about how to perform the motor task. The video was edited from its original version to include only instruction for the motor task and lasted approximately 3 min. Participants then undertook three practice trials of the task, watched the video again, and then undertook another three practice trials. The aim of this phase was to have the participant pass through, as fully as possible, the cognitive stage of acquiring the skill and enter the associational phase (Fitts & Posner, 1967). In other words, the desire was that the participant knew by the end of this phase what to do to complete the task and could begin to exhibit at a behavioral level how to do it. Thus, the participant was asked after the termination of the instructional phase to demonstrate that he or she had learned
and could perform the movement sequence constituting the task. Specifically, the participant was asked to attempt to complete the movement sequence without error using one trial only. He or she was also asked not to be concerned with speed during the attempt but to focus on correctly recalling and executing each movement in the sequence. Pilot testing revealed that the instruction and practice described here were sufficient for this purpose and, accordingly, all participants in the main testing phase were able to successfully demonstrate the motor task.

Next, participants were asked to listen to an audiotape using headphones that was introduced as providing more information about cup stacking. Each group listened to a different audiotape. While each group’s audiotape provided some general information about the sport of cup stacking, the audiotapes of treatment groups 2-6 also provided instruction about how to apply the substrategy/ies relevant to their group to learning the motor task. The amount of general information provided about cup stacking on each group’s audiotape was altered according to the number of substrategies (i.e., 0-5) being described to the group so that each group listened to an equal number of spoken words and equal length audiotape (see Appendix E for group strategy instructions). After the audiotape was finished, participants in the control group were asked to describe the content of the audiotape to the experimenter. Participants in the treatment groups were asked to describe each of his or her respective substrategy/ies to the experimenter to ensure comprehension of the strategy instructions. At no time was it stated or implied that the substrategy/ies were hypothesized to help with learning the motor task. Furthermore, substrategy/ies were always referred to as a “routine”, which connotes less of a learning benefit. Where miscomprehension or gaps in comprehension about the substrategy/ies were detected, the experimenter repeated the description of the substrategy/ies.

Participants then began an acquisition phase comprising 5 blocks of 10 trials, which lasted approximately 30 min. Participants were instructed to focus primarily on the accuracy of their movements but also to perform the movements as quickly as possible. Prior to each block, participants in the control group were instructed that, on the experimenter’s signal, they should (a) place both hands on the touch pads, (b) wait for the “armed” light to illuminate, and (c) when they are ready to begin the task, remove their hands from the touch pads and begin. Participants in the treatment groups were instructed that, on the experimenter’s signal, they should (a) place both hands on the touch pads, (b) wait for the “armed” light to illuminate, (c) begin to employ
their respective substrategy/ies, and (d) when finished and ready to begin the task, remove their hands from the touch pads to begin.

A 1 min inter-block interval served to reduce fatigue. A 15 s inter-trial interval within each block was also used to reduce fatigue and, in addition, allowed the experimenter to record the performance time from the previous trial and reset the timer before the next trial. The inter-trial interval also allowed participants in Group 6 to employ the evaluation substrategy. The experimenter used her engagement in the recording of the performance time at the end of each trial as a natural means to avoid interrupting participants in Group 6 as they employed the evaluation substrategy.

After the acquisition phase, participants undertook a 1 hr retention interval. Although the minimum recommended retention interval for testing learning effects is 24 hrs (Schmidt & Lee, 2005), the 1 hr interval used here was chosen to reduce the potential for participant attrition. During the interval, participants watched a 50 min episode of the Discovery Channel show Mythbusters™. Participants were informed that they were to answer three questions about the episode after it had finished. The intent of the video and the questions was to occupy the participants’ minds so that they would not think about and, in particular, mentally practice the task during the break. The three questions were administered following the video but were not scored as it was believed that the questions would serve as sufficient motivation for the participants to attend to the video.

Following the retention interval, participants were asked to undertake a retention phase, which lasted approximately 10 min. This phase consisted of 2 blocks of 10 trials of the motor task with a 1 min inter-block interval. Prior to each block, all groups received instructions identical to those provided to the control group in the acquisition phase. Consequently, in contrast to the acquisition phase, the treatment groups were not reminded to use their respective substrategy/ies prior to each block.

**Manipulation Checks**

*Preparation time.* An indirect, behavioral measure of strategy use was obtained, which was termed *preparation time.* Preparation time was measured using the recorded video film of the participant’s performance and was operationalized as the elapsed time from when a participant first placed his or her hands on the touch pads to the first evidence on the film of the
participant’s removal of his or her hands in order to begin the motor task. Hand movement was pinpointed via inspection of the film and with the aid of Microsoft Windows Movie Maker version 5.1 software. The use of this software afforded ± .07 s measurement accuracy.

It was hypothesized that a participant’s use of the substrategies would be reflected in the length of their preparation time such that preparation time would lengthen as more substrategies were used. Thus, Groups 5 and 6 should exhibit a longer mean preparation time than Groups 1, 2, 3, and 4; Group 4 should exhibit a longer mean preparation time than Groups 1, 2, and 3; and so on. (Recall that Group 6, like Group 5, was asked to use 4 substrategies during the preparation phase but, unlike Group 5, undertake a fifth substrategy - evaluating - after the trial during the inter-trial interval.)

**Self-reported strategy use.** Participants were also asked to report on their use of the substrategy/ies. Following the guidelines of Ericsson and Simon (1980, p. 220), treatment group participants reported verbally about their use of the substrategy/ies during specific acquisition trials (which contrasts with the more common methodological approach of asking participants to report generally about their strategy use during an experiment). Verbal reports about strategy use on the previous trial were requested at the end of the inter-trial interval following the sixth, first, and eighth trial in the first, third, and fifth trial block of the acquisition phase respectively. These trial numbers were specified using a random number generator (Mads, 2007). Verbal reports were elicited using two written questions. The objective of the first question was to assess whether the participant could recall having used the substrategy/ies immediately prior to the trial: “Did you use the routine immediately before this particular attempt at the cup stack? If you cannot recall having used it, that’s fine; please feel free to be perfectly honest and indicate NO. If you can definitely recall having used it *on this particular attempt* to any extent at all, please indicate YES” (This was adjusted for Group 6 to also measure use of the evaluation substrategy.) Thus, the question allowed a *recalled strategy use* score of “Yes” or “No” to be obtained.

Participants answering “Yes” to the first question were then asked a second question designed to assess participants’ recall of the extent to which they had used the strategy: “I am interested in whether you recall having thought through all parts of the routine or just some. Please indicate the extent to which you recall having thought through all parts of the routine.” To obtain an *extent of recalled strategy use* score, participants responded to this item on a Likert scale ranging from 1 (“I thought through barely any of the routine”) to 7 (“I thought through all
parts of the routine”). If the participant answered “No” to the first question, they were assigned a zero score for extent of recalled strategy use.

At the end of the retention phase, participants in the treatment groups were asked to write down whether they “definitely recall using any other strategies during the acquisition phase other than that/those suggested in the audiotape.” Participants in the control group were asked to write down whether they “definitely recall using any mental strategies to help them learn and perform the task.” To further encourage participants to carefully consider their response to this item, they were asked to describe, in as much detail as possible, the nature of any recalled strategies.

**Motivation Check**

A motivation measure was taken in an attempt to determine participants’ motivation to perform the motor task. It was administered once following the retention phase and consisted of the question: “How motivated were you to perform your best when learning and performing this task?” Participants responded on a Likert scale ranging from 1 (“Not motivated at all”) to 7 (“Very highly motivated”). Testing procedures overall lasted approximately 2 hrs.

**Analysis**

*Performance measures.* Alpha was set at .05 for all statistical analyses unless otherwise stated. For each error type (i.e., pyramid errors and final stack errors), *mean amount of errors* and *percentage of errors* (given the number of trials; *n* = 70) were computed for each group. (Recall that 4, not 20 participants’ error data were collected within each group.) Due to the small sample size, means and percentages were compared across groups using a qualitative analysis to identify whether any group differed markedly from the other groups on either error score.

Prior to an analysis of performance time, there was a consideration of whether to attempt through the use of analysis of covariance to control for two extraneous variables that may have affected this measure. These were preparation time and extent of recalled strategy use. Differences in preparation time between groups were expected as a natural result of differences between groups in strategy training and in turn strategy use during the preparation phase. However, longer preparation times effectively increase the distribution of practice as they increase the time that elapses between the trials. Increases in the distribution of practice have been shown to facilitate learning (Schmidt & Lee, 2005). Thus, any observed difference in
performance between groups may be due to differences in the distribution of practice between groups, not differences in strategy training and thus use.

Extent of recalled strategy use (assuming that the measure validly reflects actual strategy use) might also be considered a covariate because any observed difference in performance time between groups may be due to differences in the extent (i.e., quantity) of strategy use between groups, not differences in strategy training and thus type (i.e., quality) of strategy use. For example, while it was hypothesized that learning might be superior for Group 3 compared to Group 2, owing to the training on an additional substrategy provided to Group 3, the participants in Group 2 might, on average, use the single strategy they are taught more than the participants in Group 3 use the two they are taught. Consequently, Group 2 might learn better than Group 3.

However, the addition of a covariate to an analysis of variance reduces the power of the analysis by adding a degree of freedom. Therefore, statisticians do not recommend the inclusion of a covariate unless it accounts for some of the variance in (i.e., is related to) the dependent variable. Keppel and Zedeck (1989, p. 457) proposed that a potential covariate and the dependent variable must have a correlation of $r = \pm .2$ to justify the inclusion of that covariate in an analysis of variance. Consequently, the Pearson Product Moment correlation between performance time (mean across all trials; $n = 70$) and preparation time (mean across all trials; $n = 70$) was computed for each group and then with all groups collapsed. In addition, the Pearson Product Moment correlation between performance time and extent of recalled strategy use (mean across all trials; $n = 3$) was computed for each group and then with treatment groups (2-6) collapsed. These correlations are reported in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group 1#</th>
<th>Group 2#</th>
<th>Group 3#</th>
<th>Group 4#</th>
<th>Group 5#</th>
<th>Group 6#</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation Time</td>
<td>-.20</td>
<td>-.02</td>
<td>.03</td>
<td>-.39*</td>
<td>-.22</td>
<td>.06</td>
<td>-.10##</td>
</tr>
<tr>
<td>Extent of Strategy Use</td>
<td>--</td>
<td>.01</td>
<td>.08</td>
<td>-.25</td>
<td>.26</td>
<td>-.08</td>
<td>.01###</td>
</tr>
</tbody>
</table>

*p < .05, # n = 20, ## n = 120, ### n = 100
As there appeared no noteworthy relationship overall between performance time and preparation time, nor performance time and extent of recalled strategy use, neither variable was included as a covariate. Instead, a 6 group by 7 trial block (5 blocks in the acquisition phase, 2 blocks in the retention phase) analysis of variance was undertaken for performance time. Group was a between-participants factor and trial block a within-participants factor. Post hoc and simple factorial tests were employed if main effects and interactions, respectively, were revealed.

Manipulation checks. Group differences in preparation time were analyzed using a 6 group by 7 trial block analysis of variance. Group was a between-participants factor and trial block a within-participants factor. Post hoc and simple factorial tests were employed if main effects and interactions, respectively, were revealed. An inter-rater reliability analysis of preparation time, whereby an additional rater would record preparation time, was considered. However, this was deemed unnecessary due to the relatively objective nature of the measure. Recall that the onset of preparation time was operationalized as the point in time at which the participants placed their hands on the touch pads and the offset when they removed them to begin the task. It was determined that there was little if any subjectivity in identifying these behaviors and thus no reliability test has deemed necessary.

For each of the three measures of recalled strategy use, chi-square tests were used to identify differences between treatment groups (groups 2-6) in frequency distributions of recalled strategy use (“yes” vs. “no”). For each participant, the mean of the three extent of recalled strategy use scores was computed and group differences in this new variable were analyzed using a one-way analysis of variance, with group as the between-participants factor. Post hoc tests were employed if a main effect was revealed. In addition, a chi-square test was also undertaken to identify differences between groups in frequency distributions of reported other strategy use.

Motivation check. The motivation score was analyzed using a one-way analysis of variance, with group as a between-participants factor. Post hoc tests were employed if a main effect was revealed.
CHAPTER 3
RESULTS

Throughout this section, the group label (e.g., Group 1) will be used rather than the condition label (e.g., control condition) for ease of presentation. Recall that Group 1 received the control condition and Groups 2-6 the treatment conditions. Specifically, Group 2 received instructions to use the readying substrategy; Group 3 the readying and imaging substrategies; Group 4 the readying, imaging, and focusing substrategies; Group 5 the readying, imaging, focusing, and executing substrategies; and Group 6 the readying, imaging, focusing, executing, and evaluating substrategies (i.e., all five substrategies of the 5-SA).

Missing Data

Missing performance time data were typically due to participant error on use of the touchpad (e.g., accidental double touches). The mean number of trials for which a performance time datum was missing per participant was .56. The maximum number was 5. Missing preparation time data were typically due to a corrupted video feed. The mean number of trials for which a preparation time datum was missing per participant was .88. The maximum number was 17. (Recall that the total number of trials was 70.) There were too few data to allow for a statistical analysis of between-group differences in amount of missing data. However, a qualitative analysis of group differences indicated that there were no meaningful differences between groups for both performance and preparation time.

Manipulation Checks

Preparation time. Means and standard deviations for preparation time for each block and group are reported in Table 2. A qualitative check for outliers was performed by examining a histogram of frequencies of all preparation time scores for all participants. Scores were sought that were located above and below the normal range of scores and were highly unrepresentative of the remaining population’s scores. This process revealed two such scores: 45.22 s and 63.28 s. The next nearest score was 33.61 s, where the range of scores began at 0.14 s. There was no reason to believe that the scores were generated by a means different from the means underlying
the generation of the remaining scores; therefore, they were not excluded from the analyses (Hawkins, 1980).

Table 2

Means and SDs for Group Preparation Time in Seconds Across Blocks

<table>
<thead>
<tr>
<th>Condition</th>
<th>Acquisition Phase</th>
<th>Retention Phase</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Block 1</td>
<td>Block 2</td>
<td>Block 3</td>
</tr>
<tr>
<td>Group 1</td>
<td>1.34(0.31)</td>
<td>1.37(0.37)</td>
<td>1.27(0.26)</td>
</tr>
<tr>
<td>Group 2</td>
<td>2.59(1.47)</td>
<td>1.84(0.91)</td>
<td>1.90(1.31)</td>
</tr>
<tr>
<td>Group 3</td>
<td>2.98(2.45)</td>
<td>2.67(2.75)</td>
<td>2.66(3.00)</td>
</tr>
<tr>
<td>Group 4</td>
<td>3.72(3.14)</td>
<td>3.41(3.98)</td>
<td>3.53(4.31)</td>
</tr>
<tr>
<td>Group 5</td>
<td>4.39(5.02)</td>
<td>4.51(5.61)</td>
<td>4.84(5.81)</td>
</tr>
<tr>
<td>Group 6</td>
<td>4.04(4.45)</td>
<td>3.38(4.78)</td>
<td>3.48(5.28)</td>
</tr>
<tr>
<td>Total</td>
<td>3.19(3.33)</td>
<td>2.86(3.70)</td>
<td>2.96(3.97)</td>
</tr>
</tbody>
</table>

The analysis of variance revealed a significant main effect for block, $F(2, 237) = 10.24, p < .001$. Pairwise comparisons revealed that all acquisition blocks had significantly higher preparation times than either retention block (see Table 3). However, there was only one significant difference between any two blocks within acquisition (Block 1 and Block 2) and no significant difference between the two blocks in retention.

The analysis of variance of preparation time revealed no significant main effect for group, $F(5, 114) = 1.95, p = .09$. Therefore, the hypothesis that a participant’s use of the
substrategies (or, with regard to the control group, lack of use) should be reflected in the length of their preparation time such that preparation time would lengthen significantly as more substrategies were used was not supported.

Table 3  
*Mean Differences Between Blocks on Preparation Time*

<table>
<thead>
<tr>
<th>Block</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>____</td>
<td>-.32*</td>
<td>-.22</td>
<td>-.18</td>
<td>-.21</td>
<td>-.76**</td>
<td>-.82**</td>
</tr>
<tr>
<td>2</td>
<td>____</td>
<td>.10</td>
<td>.15</td>
<td>.12</td>
<td>-.43*</td>
<td>-.50*</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>____</td>
<td>.05</td>
<td>.02</td>
<td>-.54*</td>
<td>-.60*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>____</td>
<td>-.03</td>
<td>-.58*</td>
<td>-.64*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>____</td>
<td>-.55*</td>
<td>-.61*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>____</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>____</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .01, **p < .001

The significant main effect of block on preparation time constitutes a source of evidence that participants in the treatment groups used the substrategy/ies less during retention than acquisition. Given that the only difference between the phases is the withdrawal of the instruction to treatment groups to use the substrategy/ies before each block in the retention phase, it can be inferred that participants in the treatment groups used the substrategy/ies more during acquisition than retention, leading to longer preparation times.

Although the main effect of group was not significant, there is an interesting trend visible in Figure 1 that provides some evidence to support this assertion. With one exception (Group 6), mean preparation time for groups increases respective of the number of substrategies groups were taught (i.e., 0-5). Also visible in the figure is a trend for the magnitude of the decrease in
mean preparation time from the last block in acquisition (Block 4) to the first block in retention (Block 6) to be positively related to the number of substrategies taught to each group. Although no significant interaction was observed between block and group \((F(12, 273) = 1.15, p = .32)\), this trend is also observed when the magnitude of the difference between the mean of all blocks in acquisition and the mean of both blocks in retention is compared across groups (see Table 4). It appears that the absence of the instruction to use the substrategy/ies in retention compared to acquisition leads to a decrease in mean preparation time from acquisition to retention, the magnitude of which is related positively to number of strategies taught (with one exception; Group 3).

![Figure 1](image-url)

*Figure 1.* Mean preparation time in seconds across groups during the acquisition and retention phase. Error bars are not provided as they result in the graph being too cluttered for interpretation.
In summary, evidence that participants used the substrategy/ies assigned to them during acquisition is provided by (a) the significant decrease in preparation time from acquisition to retention, (b) the trend for mean preparation time in acquisition to increase across groups according to the number of strategies a group was taught, and (c) the trend for the magnitude of the decrease in mean preparation time from acquisition and retention to increase across groups according to the number of substrategies a group was taught.

**Self-reported strategy use.** Frequency distributions for recalled strategy use are reported in Table 5. For each of the three measures of recalled strategy use, most participants reported using their respective strategy regardless of treatment group; the minimum in a group over the three measures was 13 (or 65%). In addition, chi-square tests revealed no significant differences between treatment groups in the frequency distribution of recalled strategy use for each of the three measures (see Table 6). This finding indicates that the treatment groups did not differ significantly in terms of recalled strategy use.
Table 5
*Frequency Distribution for Recalled Strategy Use*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Measure 1</th>
<th>Measure 2</th>
<th>Measure 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Group 2*</td>
<td>16</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Group 3*</td>
<td>17</td>
<td>3</td>
<td>14</td>
</tr>
<tr>
<td>Group 4*</td>
<td>18</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>Group 5*</td>
<td>15</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Group 6*</td>
<td>16</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>82</td>
<td>18</td>
<td>76</td>
</tr>
</tbody>
</table>

* n = 20

Table 6
*Chi-Square Tests of Differences Between Treatment Groups in the Frequency Distribution of Recalled Strategy Use*

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Measure 1</th>
<th>Measure 2</th>
<th>Measure 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\chi^2$</td>
<td>P</td>
<td>$\chi^2$</td>
</tr>
<tr>
<td>Yes vs. no</td>
<td>1.76</td>
<td>.78</td>
<td>5.15</td>
</tr>
</tbody>
</table>

Means and standard deviations for extent of recalled strategy use are reported in Table 7. The analysis of variance for extent of recalled strategy use revealed no significant differences between the three measures, $F(2, 190) = 2.10, p = .13$. There was also no significant difference between treatment groups, $F(4, 95) = .16, p = .96$. 
Table 7  
*Means and SDs for Extent of Recalled Strategy Use*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Measure 1</th>
<th>Measure 2</th>
<th>Measure 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 2*</td>
<td>3.55 (2.28)</td>
<td>2.85 (2.48)</td>
<td>3.45 (2.21)</td>
<td>3.28 (1.69)</td>
</tr>
<tr>
<td>Group 3*</td>
<td>3.90 (2.17)</td>
<td>3.10 (2.47)</td>
<td>3.80 (2.90)</td>
<td>3.60 (2.15)</td>
</tr>
<tr>
<td>Group 4*</td>
<td>4.25 (1.62)</td>
<td>2.85 (2.41)</td>
<td>3.60 (2.26)</td>
<td>3.57 (1.67)</td>
</tr>
<tr>
<td>Group 5*</td>
<td>3.15 (2.11)</td>
<td>3.45 (1.70)</td>
<td>3.15 (2.25)</td>
<td>3.25 (1.67)</td>
</tr>
<tr>
<td>Group 6*</td>
<td>3.45 (2.19)</td>
<td>3.75 (2.31)</td>
<td>3.40 (2.58)</td>
<td>3.53 (2.11)</td>
</tr>
<tr>
<td>Total</td>
<td>3.66 (2.08)</td>
<td>3.20 (2.27)</td>
<td>3.48 (2.41)</td>
<td>3.45 (1.84)</td>
</tr>
</tbody>
</table>

*n = 20

*Other strategy use.* Frequency distributions for other strategy use are reported in Table 8. The number of participants reporting using other mental strategies varies notably across groups. A chi-square test revealed a significant difference between groups in the frequency distribution of reported other strategy use, \( \chi^2(5) = 13.33, p < .05 \). Individual chi-square tests were conducted to identify which groups differed significantly. The tests revealed that Group 1 had significantly more participants reporting other strategy use than Group 4 and Group 2 had significantly more participants reporting other strategy use than groups 3-6 (see Table 9).
Table 8
*frequency distribution for other strategy use*

<table>
<thead>
<tr>
<th>Condition</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1*</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>Group 2*</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Group 3*</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Group 4*</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>Group 5*</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>Group 6*</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>66</td>
<td>54</td>
</tr>
</tbody>
</table>

*n = 20*

Table 9
*chi-square tests of differences between groups in the frequency distribution of other strategy use*

<table>
<thead>
<tr>
<th>Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>.14</td>
<td>3.75</td>
<td>6.47*</td>
<td>3.75</td>
<td>2.67</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>5.23*</td>
<td>8.29**</td>
<td>5.23*</td>
<td>3.96*</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>.42</td>
<td>.00</td>
<td>.10</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.42</td>
<td>.92</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.10</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05, **p < .01*
Performance Measures

No marked differences between groups on pyramid or final stack errors were observed from the qualitative analysis (see Table 10). The largest between-group difference occurred for pyramid errors: The mean for Group 5 was 6.0 compared to 1.5 for Group 6. However, all groups made pyramid errors on less than 10% of the trials ($n = 70$); Therefore, error was not considered a possible confound.

Table 10
*Frequencies and Percentages for Pyramid and Final Stack Errors for Groups*

<table>
<thead>
<tr>
<th></th>
<th>Pyramid Errors</th>
<th></th>
<th>Final Stack Errors</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$ (SD)</td>
<td>%</td>
<td>$M$ (SD)</td>
<td>%</td>
</tr>
<tr>
<td>Group 1*</td>
<td>3.50 (5.69)</td>
<td>5.00%</td>
<td>.50 (.58)</td>
<td>0.71%</td>
</tr>
<tr>
<td>Group 2*</td>
<td>3.25 (5.85)</td>
<td>4.64%</td>
<td>.25 (.50)</td>
<td>0.36%</td>
</tr>
<tr>
<td>Group 3*</td>
<td>3.00 (5.35)</td>
<td>4.29%</td>
<td>.00 (.00)</td>
<td>0.00%</td>
</tr>
<tr>
<td>Group 4*</td>
<td>3.50 (5.07)</td>
<td>5.00%</td>
<td>.50 (.58)</td>
<td>0.71%</td>
</tr>
<tr>
<td>Group 5*</td>
<td>6.00 (4.24)</td>
<td>8.57%</td>
<td>.25 (.50)</td>
<td>0.36%</td>
</tr>
<tr>
<td>Group 6*</td>
<td>1.50 (3.00)</td>
<td>2.14%</td>
<td>.50 (.58)</td>
<td>0.71%</td>
</tr>
<tr>
<td>Total</td>
<td>3.46 (4.60)</td>
<td>4.94%</td>
<td>.33 (.48)</td>
<td>0.48%</td>
</tr>
</tbody>
</table>

$n = 4$

Means and standard deviations for performance time for each block and group are reported in Table 11. A qualitative check for outliers was performed by examining a histogram of frequencies of all performance time scores for all participants. Scores were sought that were located above and below the normal range of scores and were highly unrepresentative of the remaining population’s scores. This process revealed one such score, which was a performance time score of 24.83 s. The next nearest score was 18.57 s, where the range of scores began at
1.77 s. There was no reason to believe that the score was generated by a means different from the means underlying the generation of the remaining scores; therefore, it was not excluded from the analyses (Hawkins, 1980).

Table 11
Means and SDs for Group Performance Time in Seconds Across Blocks

<table>
<thead>
<tr>
<th>Condition</th>
<th>Acquisition Phase</th>
<th>Retention Phase</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Block 1</td>
<td>Block 2</td>
<td>Block 3</td>
</tr>
<tr>
<td>Group 1</td>
<td>6.19 (1.23)</td>
<td>5.29 (1.18)</td>
<td>4.85 (0.86)</td>
</tr>
<tr>
<td>Group 2</td>
<td>6.05 (1.28)</td>
<td>5.17 (1.11)</td>
<td>4.95 (0.92)</td>
</tr>
<tr>
<td>Group 3</td>
<td>6.19 (1.47)</td>
<td>5.10 (0.82)</td>
<td>4.82 (0.85)</td>
</tr>
<tr>
<td>Group 4</td>
<td>6.21 (1.00)</td>
<td>5.13 (0.62)</td>
<td>4.71 (0.77)</td>
</tr>
<tr>
<td>Group 5</td>
<td>6.18 (1.22)</td>
<td>5.19 (1.01)</td>
<td>4.98 (1.08)</td>
</tr>
<tr>
<td>Group 6</td>
<td>5.87 (1.30)</td>
<td>4.92 (0.82)</td>
<td>4.47 (0.95)</td>
</tr>
<tr>
<td>Total</td>
<td>6.12 (1.23)</td>
<td>5.13 (0.93)</td>
<td>4.80 (0.91)</td>
</tr>
</tbody>
</table>

There was a significant main effect for block, $F(5, 524) = 107.35, p < .001$. Inspection of block means reveals that performance time decreased across each block in acquisition. However, pairwise comparisons revealed that performance time is significantly shorter in Block 2 than in Block 1 and in Block 3 than in Block 2. However, no significant difference was found between Block 4 and Block 3 nor Block 5 and Block 4 (see Table 12).
Table 12  
*Mean Differences Between Blocks on Performance Time in Seconds*

<table>
<thead>
<tr>
<th>Block</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>____</td>
<td>-.98***</td>
<td>-1.32***</td>
<td>-1.36***</td>
<td>-1.48***</td>
<td>-1.19***</td>
<td>-1.54***</td>
</tr>
<tr>
<td>2</td>
<td>____</td>
<td>-.34***</td>
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<td>-.16*</td>
<td>.13*</td>
<td>-.22**</td>
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<td>-.17*</td>
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</table>

*p < .05, **p < .01, ***p < .001

Inspection of block means also reveals that performance time increased from the last acquisition block (Block 5) to the first retention block (Block 6) but decreased across the two blocks in retention. Pairwise comparisons revealed that performance time is significantly longer in Block 6 than in Block 5 and shorter in Block 7 than in Block 6. Of note is the significant decrease in performance time from the first acquisition block (Block 1) to the first retention block (Block 6) because this finding provides evidence that learning occurred during the acquisition phase (Schmidt & Lee, 2005). Overall, the changes in performance time across the acquisition blocks indicate that participants performing the motor task followed the normal performance curve described by Schmidt and Lee: the significant decrease in performance time for any two consecutive blocks in acquisition was greatest between the first two consecutive blocks (i.e., from Block 1 to Block 2), followed by the next two consecutive blocks (i.e., from Block 2 to Block 3). The two decreases to follow were, by comparisons, small enough that they did not reach a level of significance (i.e., from Block 3 to Block 4 and Block 4 to Block 5).

Furthermore, the changes in performance time across blocks indicate that participants performing the motor task exhibited normal retention effects described by Schmidt and Lee: performance time increased significantly between the end of acquisition and beginning of
retention (i.e., from Block 5 to Block 6) and decreased significantly across the blocks in retention (i.e., from Block 6 to Block 7). These effects can be observed in Figure 2.

The analysis of variance of performance time revealed no significant main effect for group, $F(5, 114) = .36, p = .88$. Thus, the hypothesis that the addition of each substrategy of the 5-SA would cause a significant decrease in performance time in retention was not supported. There was also no significant block by group interaction effect, $F(23, 524) = 1.26, p = .19$.

![Figure 2](image-url)

*Figure 2.* Mean performance time in seconds across groups during the acquisition and retention phases. Error bars are not provided as they result in the graph being too cluttered for interpretation.
Motivation Check

Means and standard deviations for motivation are reported in Table 13. The analysis of variance revealed no significant differences between groups on reported motivation, $F(5, 114) = .67, p = .65$. This finding indicates that the groups did not differ significantly on reported level of motivation for performing the motor task during testing.

Table 13
Means and SDs for Motivation Across Groups

<table>
<thead>
<tr>
<th>Condition</th>
<th>Motivation</th>
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<tbody>
<tr>
<td>Group 1</td>
<td>6.05 (0.83)</td>
</tr>
<tr>
<td>Group 2</td>
<td>5.95 (1.05)</td>
</tr>
<tr>
<td>Group 3</td>
<td>5.75 (1.02)</td>
</tr>
<tr>
<td>Group 4</td>
<td>5.60 (1.05)</td>
</tr>
<tr>
<td>Group 5</td>
<td>5.65 (1.04)</td>
</tr>
<tr>
<td>Group 6</td>
<td>5.85 (0.68)</td>
</tr>
<tr>
<td>Total</td>
<td>5.81 (0.95)</td>
</tr>
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</table>
CHAPTER 4

DISCUSSION

The purpose of this study was to determine the relative contribution of each substrategy of the 5-SA to learning a self-paced motor task. This study is the first to explore the relative contribution of each substrategy of the 5-SA to learning a motor task and in particular whether the executing substrategy might account for most of the learning effects, as hypothesized by several researchers (Lidor, 2004; Singer et al., 1993). Given that the majority of tasks used in 5-SA research are laboratory or applied tasks, an additional purpose of this study was to provide more ecological validity to current body of research on the 5-SA by using a real sport.

In this study, it was hypothesized that the addition of each substrategy of the 5-SA would cause a significant decrease in performance time in retention. The findings do not support this hypothesis. No significant differences were found in acquisition or retention between the control group, which received no training in the 5-SA, and any of the treatment groups, which received training in various substrategies of the 5-SA. Of these findings, a lack of significant difference between the control group and the treatment group that received training in all five substrategies of the 5-SA is of note because previous studies utilizing very similar methods and experimental designs have shown the 5-SA to be effective in enhancing performance and learning. Specifically, the present study was similar to previous studies on the following design dimensions: participant sample, task type, quantity and quality of strategy training, number of trials and blocks in acquisition and retention, performance measures, and statistical analyses.

For example, participants in a study by Chung et al. (1996) and another by Singer and Suwanthada (1986) received 5-SA and/or general instructions by audiotape and were allowed practice trials with the task before testing. Both of these studies featured acquisition phases similar to that employed here. Participants in the study by Chung et al. performed 4 blocks of 10 trials with a 10 s inter-trial interval and a 1 min inter-block interval and in the study by Singer and Suwanthada 5 blocks of 10 trials (no mention of inter-trial or inter-block intervals was made). While neither study featured a retention phase, the study by Singer and Suwanthada featured a transfer test, an alternative measure of learning to a retention test (Schmidt & Lee, 2005), that featured 3 blocks of 10 trials, which is similar in structure to the retention test employed here, which featured 2 blocks of 10 trials.
Why then were there no significant differences between groups on performance time in the present study? The reason may be that training in the use of substrategies of the 5-SA simply did not benefit the participants’ learning. Although there is much evidence to support the use of the 5-SA for motor learning, it is possible there are other studies that have found contradictory evidence, like this one, but have not been published. In the scientific community, studies with significant or supportive findings are more likely to get published than their counterparts. As a result, it is impossible to know the full body of literature on this topic. Therefore, it is difficult to draw conclusions about the findings in this study in relation to the current published literature on the 5-SA. However, there may be other reasons for the results obtained here. These are addressed below.

**Participants Did Not Apply the Strategies They Were Taught**

One possibility is that participants did not employ the strategies they were taught with the extent or regularity required to reveal any potential treatment effects. However, there are two sources of evidence against this line of reasoning.

One line of evidence comes from reported strategy use. Participants were asked (a) if they used the “routine” they had been trained to use, and, if so, (b) to what extent they used the “routine”. The results indicated that the treatment groups did not significantly differ in terms of reported strategy use and extent of strategy use. Specifically, about three quarters of participants in each treatment group reported using their respective substrategy/ies. In addition, the average extent of strategy use score for all treatment groups was 3.45 on a 7-point Likert scale, indicating a moderate extent of strategy use. Therefore, this provides some evidence that participants were using their respective substrategy/ies while performing the motor task. However, this finding must be considered cautiously. Despite the use of self-report instructions designed to enhance the validity of reports on cognitions, self-report measures of cognitions remain contentious (Ericsson & Simon, 1980). Additionally, the measure was taken at the end of only three randomly selected trials. While we believe three to be representative, there is no definitive way of knowing what happened on the other trials.

An additional line of evidence that participants used their respective substrategy/ies comes from preparation time (i.e., an indirect measure of strategy use). Preparation times during acquisition blocks were significantly higher than during retention blocks. Being that the only
difference between acquisition and retention was the presence of strategy reminders, this finding provides evidence that participants may have been using their respective substrategy/ies during the acquisition phase. In addition, visual inspection of graphed means showed a general trend for preparation time to increase across groups in line with the number of substrategies each group was taught. Although there were no significant between-group differences for preparation time, this trend may also indicate that participants were using the substrategy/ies assigned to them. There was also a trend for the magnitude of the decrease in mean preparation time from the last block in acquisition (Block 5) to the first block in retention (Block 6) to be positively related to the number of substrategies taught to each group. This trend was also observed when the magnitude of the difference between the mean of all blocks in acquisition and the mean of both blocks in retention is compared across groups. Although this interaction was not significant, it does provide additional evidence that participants were using the substrategy/ies during acquisition.

Participants were also asked to report their level of motivation for performing the task on a 7-point likert scale. The findings indicate that participants did not differ on motivation. Therefore, this measure provides some evidence that differences in motivation between groups are unlikely to explain the lack of significant differences between groups on performance time.

Participants Used Other Learning Strategies

Although each group was assigned to use specific substrategies from the 5-SA, it is reasonable to assume that participants may have also used mental strategies other than those taught to them. This was the rationale for asking participants whether they had used any other strategies and, if so, to report what kind of strategies they used. The results revealed significant between-group differences for other strategy use. Specifically, Group 1 contained significantly more participants reporting other strategy use than Group 4 and Group 2 contained significantly more participants reporting other strategy use than Groups 3-6.

Inspection of the written reports of the strategies used by participants in both Group 1 and 2 revealed some evidence that strategies similar to those in the 5-SA were used such as imaging, focusing, and executing. (see Appendix F). This may help explain why there were no significant differences between groups on performance time. It may be that Group 1 (i.e., control) and Group 2 (i.e., readying) were using strategies similar to those used in Groups 3 to 6. Bouchard
and Singer (1998) also reported that other strategy usage by their control group may have explained why groups using the 5-SA in their study did not show significant differences in performance from the control group. However, Singer, Lidor et al. (1993) instructed their control group to use their own strategies and still found significant differences between the 5-SA and control group. It is apparent that future research on the topic is warranted. One way to reduce this problem in future research would be to ask participants to undertake a secondary task during the inter-trial intervals, which would make the use of additional mental strategies difficult.

The Cognitive Demands of the Task Were Too High

An argument could be made that the motor task required a high level of cognitive demand. Kim et al. (1996) examined the effect of the 5-SA on tasks of varying cognitive demand: low, medium, and high. When compared to a control group, their findings indicated that the 5-SA was effective for tasks with low to medium cognitive demand, but not for tasks with high cognitive demand. The motor task in this study, cup-stacking, required repeated instruction and practice before the participant gained knowledge sufficient to perform the task. However, participants appeared to only really have to concentrate hard to pass the cognitive stage of learning and begin to enter the associative phase; that is, they appeared to carefully listen and attempt to memorize the task in order to learn “what to do” and to be able to begin to actually do it, however slowly. Once participants had learned what to do and how to do it, demonstrated by their correct execution of the full stack sequence, they appeared to concentrate less as they simply repeated the sequence of movements in an attempt to perform it faster. Thus, it remains unclear whether the cognitive demand of the task was the reason why no significant differences in performance time were observed across groups.

An additional argument could be made that the motor task in this study was more serial in nature than discrete, at least early in learning. Since the 5-SA was designed for learning discrete motor skills, tasks of more complexity (i.e., require multiple discrete steps) may not benefit from use of the strategy. The cup-stacking task in this study consisted of a series of such steps. However, detracting from this explanation is that Singer et al. (1989a) used a similar task in their study, which consisted of six pressure sensitive copper plates that had to be pressed in order using a stylus, and found positive effects of the 5-SA for learning.
In line with the results of Kim et al. (1996), future research testing the relative efficacy of each substrategy of the 5-SA might make use of motor tasks with lower cognitive demand, which could be identified via a task analysis. Additionally, motor tasks should be easily classified as discrete and closed since that is the type of task for which the 5-SA was designed.

**Not Enough Training in Strategy Use Was Provided**

An argument could also be made that participants did not receive enough strategy instruction or enough practice with the strategy before implementing it with the motor task. Thus, while they appeared to attempt to apply the substrategy/ies, as evidenced by the findings discussed above, perhaps the application of the substrategy/ies requires practice for the substrategy/ies to be effective. However, the strategy instruction procedure was consistent with previous laboratory research (Kim et al., 1996; Lidor et al., 1996; Singer et al., 1989; Singer et al., 1989b). To elaborate, strategy instructions were delivered only once and were not practiced before beginning the task. Perhaps additional instruction and practice with the 5-SA may have produced the hypothesized effects. This is a very important area for future research as other researchers have also indicated this limitation in their studies (Lidor, 2004; Lidor et al., 1999; Lidor et al., 1996). Three important factors should be addressed: (a) the length of the training session, (b) the number of training sessions, and (c) the amount of practice needed with the strategy. This information could prove very useful to researchers and practitioners alike.

**The Retention Interval Was Unconventional**

A final argument could be made that the retention interval was not lengthy enough to allow any potentially transient performance effects to “wash out” and thus reveal differences in learning between groups. Schmidt and Lee (2005) suggest that a retention interval of at least 24 hrs is preferred as a test of learning. The current study included a distracter task during the 1 hr retention interval, with the intent of decreasing the chance of participants thinking about, and in particular mentally rehearsing the motor task during this interval. Participants were asked to watch a video and informed that they would be asked to answer questions about the video’s content at its conclusion. However, despite the inclusion of the distracter task, it remains possible that the participants were able to think about the motor task during the interval.
Researchers of previous studies on the 5-SA have measured learning either through the use of retention tests (Bouchard & Singer, 1998; Kim et al., 1996; Steinberg & Glass, 2001) or transfer tasks (Lidor et al., 1996; Singer et al., 1989; Singer & Suwanthada, 1986). For studies involving retention tests, the retention intervals ranged from 60 min to 4 days. It is important to note that a study using a 60 min retention interval (Steinberg & Glass) did not make use of a distracter task but nonetheless reported significant differences in retention scores between a treatment group receiving 5-SA training and a control group. Therefore, the lack of significant differences between groups in retention in the current study might not be explained by the short length of the retention interval used. However, it may be worthwhile in future research to examine retention after different intervals (e.g., 1 hr, 1 day, 1 week, etc).

In summary, it remains unclear why no significant effects of the 5-SA on learning were revealed in the present study given that close attention was paid to replicating study designs used in previous studies in which such effects were obtained. Explanations for the lack of differences between groups may include but may not be limited to participants using their own mental strategies similar to those in the 5-SA, the motor task may have been too cognitively demanding and not definitely discrete, participants not receiving the instruction or practice with the substrategy/ies required to use them effectively, and the retention interval not being lengthy enough to reveal significant learning effects.

In conclusion, the purpose of this study was to determine the relative contribution of each substrategy of the 5-SA for performing and learning a motor task. Previous research has provided evidence that the 5-SA learning strategy can enhance motor skill learning. However, this finding was not supported by the results of this study, even though the design of the study was informed by the design of previous studies that provided evidence of the efficacy of the 5-SA for learning. It is intriguing that some evidence was provided to suggest that participants were using the 5-SA substrategy/ies during acquisition that they had been trained to use, yet there were no significant differences between groups in the retention of the task. Thus, on the basis of these findings, there is no rationale to recommend the use of the 5-SA learning strategy as a learning tool. Additionally, there were no significant differences in retention between any of the treatment conditions, and thus no evidence to suggest that any specific substrategy of the 5-SA is more effective than the others. As a result, there is also no rationale to recommend the use of any one component of the 5-SA as a learning strategy.
This was the first study to address whether or not all substrategies of the 5-SA are necessary in order to achieve the same performance and learning effects. Although the findings of the study do not provide conclusive results, the study provides a jumping off point for future investigation. Continued research on learning strategies in general, and the 5-SA in particular, will further our understanding of how motor skills are learned and should be taught.
APPENDIX A

INFORMED CONSENT

INFORMED CONSENT FORM: Singer’s Five-Step Approach: Does Every Bit Count?

I freely and voluntarily and without element of force or coercion, consent to be a participant in the research project entitled “Singer’s Five-Step Approach: Does Every Bit Count?” In particular, my participation, or choice not to participate, is not related to any form of assessment by the FSU. This research is being conducted by Melanie Hinkle who is a graduate student in Educational Psychology and Learning Systems at the Florida State University under the supervision of faculty advisor, Dr. David Eccles (850-644-5465; deccles@lsi.fsu.edu). I understand the purpose of her research project is to determine the effect of various learning strategies on movement skill acquisition. I understand that this study will last approximately 2 hours. I also understand that I will receive no incentive for my participation. I understand my participation is totally voluntary, and I may stop participation at anytime. I understand that I will be video taped throughout the majority of the study. Any video tapes and related data that results from my participation will be made strictly confidential to the extent allowed by law, and will not be attributable to any individual. I understand that there are six features of the study process designed to maximize my anonymity. These are described below.

1. I understand that I can withdraw from the study at any time, and I can request that the video tape be destroyed in my presence, along with any other related data obtained through my participation. This decision is at my discretion.
2. I understand that, at any time after the study, I can request that the video tape be destroyed in my presence, along with any other related data obtained through my participation. This decision is at my discretion.
3. I understand that the video tape will not show my face at any time, and it will be marked only with an anonymous code and the name of the researcher that conducted the study.
4. I understand that related data that result from my participation will be marked only with an anonymous code and the name of the researcher that conducted the study.
5. I understand that the video tapes will be automatically destroyed before December 31, 2017.
6. I understand that all video tapes and related data will be kept by the researcher in a locked filing cabinet and/or in password protected files.

I understand there is a possibility of a minimal level of risk involved if I agree to participate in this study. I might experience embarrassment typically associated with learning a new movement skill in everyday life. Thus, I am able to stop my participation at any time I wish. I understand there are benefits for participating in this research project. First, by trying to learn the movement task, I may discover more about how to learn and about my potential for learning tasks of this type. I understand that this consent may be withdrawn at any time without prejudice, penalty or loss of benefits to which I am otherwise entitled. I have been given the right to ask and have answered any inquiry concerning the study. Questions, if any, have been answered to my satisfaction. I understand that I may contact the principle investigator, Melanie Hinkle (904-838-9025; meh06k@fsu.edu), for answers to questions about this research or my rights. I understand I can also contact the Office of Research, Human Subjects Committee, 2035 E. Paul Dirac Drive, Box 16, 100 Sliger Bldg., Innovation Park, Tallahassee, FL 32306-2763 (850-644-8633) with any grievances. The results of the study will be sent to me upon my request.
I have read and understand this consent form. I am 18 years of age or older.

__________________________________________  _____________________
(Subject)                   (Date)

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2742
(850) 644-8673 · FAX (850) 644-4392

RE-APPROVAL MEMORANDUM

Date: 11/13/2008

To: Melanie Hinkle

Address: 1753 Augustine Place, Tallahassee, FL 32301
Dept.: EDUCATIONAL PSYCHOLOGY AND LEARNING SYSTEMS

From: Thomas L. Jacobson, Chair

Re: Re-approval of Use of Human subjects in Research
Singer's Five-Step Approach: Does Every Bit Count?

Your request to continue the research project listed above involving human subjects has been approved by the Human Subjects Committee. If your project has not been completed by 11/12/2009, you are must request renewed approval by the Committee.

If you submitted a proposed consent form with your renewal request, the approved stamped consent form is attached to this re-approval notice. Only the stamped version of the consent form may be used in recruiting of research subjects. You are reminded that any change in protocol for this project must be reviewed and approved by the Committee prior to implementation of the proposed change in the protocol. A protocol change/amendment form is required to be submitted for approval by the Committee. In addition, federal regulations require that the Principal Investigator promptly report in writing, any unanticipated problems or adverse events involving risks to research subjects or others.

By copy of this memorandum, the Chair of your department and/or your major professor are reminded of their responsibility for being informed concerning research projects involving human subjects in their department. They are advised to review the protocols as often as necessary to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

Cc: David Eccles, Advisor, HSC No. 2008.1921
## APPENDIX B

### 5-SA SUBSTRATEGY ALLOCATION TO GROUPS

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
<th>Group 5</th>
<th>Group 6</th>
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APPENDIX C

TASK ANALYSIS: 6 STACK (3-2-1 METHOD)
APPENDIX D

TEST PROCEDURE

<table>
<thead>
<tr>
<th>Instructional Phase</th>
<th>Acquisition Phase</th>
<th>Retention Interval</th>
<th>Retention Phase</th>
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</thead>
<tbody>
<tr>
<td>View motor task instructional video</td>
<td>Perform 5 blocks of 10 trials of motor task</td>
<td>View non-task related 50 min video</td>
<td>Perform 2 blocks of 10 trials of motor task</td>
</tr>
<tr>
<td>Perform practice trials of motor task</td>
<td></td>
<td>Answer questions about the non-task related video</td>
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</tr>
<tr>
<td>Listen to audiotape of strategy instructions</td>
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APPENDIX E

5-SA STRATEGY INSTRUCTIONS PER GROUP

Group 1: Control

In addition to the instructional video on performing the 6 stack cup stacking sequence, I am going to present to you some information about the sport of cup stacking.

History

- Sport stacking originated in the early 1980’s in southern California and received national attention in 1990 on a segment of the “Tonight Show”, with Johnny Carson.
- The World Sport Stacking Association (WSSA) was formed in 2001 and is the governing body for sport stack rules and regulations.
- It also promotes the standardization and advancement of sport stacking worldwide.
- The association was originally titled World Cup Stacking Association (WCSA), but in 2005, the name was changed to its current WSSA in response to growing awareness that stacking is considered a sport.

Equipment

- Speed Stacks® brand sport stacking cups are “The Official Cups of the WSSA” and currently the only brand that can be used at WSSA Sanctioned and/or Recognized Tournaments and Events.
- The cup has been specially designed for sport stacking and use in sport stacking events or competitions. It is also the standard for individual and program use.
- The mat and timing device are endorsed by the WSSA and gives stackers the optimum stacking surface providing accurate times to the hundredths of a second.

Fumbles

- **TIPPER**: a cup falls off a stack and onto the floor or the table.
- **SLIDER**: a cup slides down onto cups lower in the stack.
- **TOPPLER**: the down stacked group of cups falls over on its side.
- **SLANter**: During the up stack, the top cup of a stack rests in a slanted position on one of the other cups below it. During the down stack, the top cup(s) of a stack rests in a partially slanted position.

Tournaments

- The 2007 Florida state sport stacking championships was held at the University of West Florida in Pensacola.
- The 2007 WSSA World Sport Stacking Championships was held in Denver, CO
- There are currently five events and many divisions for Individuals or Teams offered at WSSA World Sport Stacking Championships.
- The five WSSA events are as follows: 3-3-3 individual timed event, 3-6-3 individual timed event, cycle individual timed event, “doubles” 3-6-3 timed event, timed team relay 3-6-3, and individual all around champion.
• Besides the United States, countries that compete in WSSA national tournaments are Australia, Denmark, Germany, Canada, Japan, and the United Kingdom.

Group 2: Readying

In addition to the instructional video on performing the 6 stack cup stacking sequence, I am going to present to you some information about the sport of cup stacking.

History
• Sport stacking originated in the early 1980’s in southern California and received national attention in 1990 on a segment of the “Tonight Show”, with Johnny Carson.
• The World Sport Stacking Association (WSSA) was formed in 2001 and is the governing body for sport stack rules and regulations.
• It also promotes the standardization and advancement of sport stacking worldwide.
• The association was originally titled World Cup Stacking Association (WCSA), but in 2005, the name was changed to its current WSSA in response to growing awareness that stacking is considered a sport.

Fumbles
• TIPPER: a cup falls off a stack and onto the table or the floor.
• SLIDER: a cup slides down onto cups lower in the stack.
• TOPPLER: the down stacked group of cups falls over on its side.
• SLANTER: During the up stack, the top cup of a stack rests in a slanted position on one of the other cups below it. During the down stack, the top cup(s) of a stack rests in a partially slanted position.

Tournaments
• The 2007 WSSA World Sport Stacking Championships was held in Denver, CO
• There are currently five events and many divisions for Individuals or Teams offered at WSSA World Sport Stacking Championships.
• The five WSSA events are as follows: 3-3-3 individual timed event, 3-6-3 individual timed event, cycle individual timed event, “doubles” 3-6-3 timed event, timed team relay 3-6-3, and individual all around champion.
• Besides the United States, countries that compete in WSSA national tournaments are Australia, Denmark, Germany, Canada, Japan, and the United Kingdom.

Now I am going to present you with a routine that I would like you to use before every attempt to undertake the cup stacking task. It is called readying.

Readying
• First, get your body in a position most comfortable to you. Once you have found a comfortable position, try to repeat it each time before performing the cup stacking sequence.
• Next, think positively about performing the cup stacking sequence. Try to set a reasonable, attainable goal for performing the sequence prior to each attempt.
Sometimes you may feel anxious prior to performing the cup stacking sequence. If you feel yourself getting anxious, try a relaxation technique such as deep breathing before performing the sequence.

Be consistent when attaining this preparatory state: get comfortable physically, think positively, and set a reasonable goal.

Group 3: Readying, Imaging

In addition to the instructional video on performing the 6 stack cup stacking sequence, I am going to present to you some information about the sport of cup stacking.

Fumbles

- **TIPPER**: a cup falls off a stack and onto the table or the floor.
- **SLIDER**: a cup slides down onto cups lower in the stack.
- **TOPPLER**: the down stacked group of cups falls over on its side.
- **SLANTER**: During the up stack, the top cup of a stack rests in a slanted position on one of the other cups below it. During the down stack, the top cup(s) of a stack rests in a partially slanted position.

Tournaments

- The 2007 WSSA World Sport Stacking Championships was held in Denver, CO.
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- Besides the United States, countries that compete in WSSA national tournaments are Australia, Denmark, Germany, Canada, Japan, and the United Kingdom.

Now I am going to present you with a 2-step routine that I would like you to use before every attempt to undertake the cup stacking task. They are readying and imaging.

**Step 1 - Readying**

- First, get your body in a position most comfortable to you. Once you have found a comfortable position, try to repeat it each time before performing the cup stacking sequence.
- Next, think positively about performing the cup stacking sequence. Try to set a reasonable, attainable goal for performing the sequence prior to each attempt.
- Sometimes you may feel anxious prior to performing the cup stacking sequence. If you feel yourself getting anxious, try a relaxation technique such as deep breathing before performing the sequence.
- Be consistent when attaining this preparatory state: get comfortable physically think positively, and set a reasonable goal.
Step 2 - Imaging

- I want you to imagine yourself performing the cup stacking sequence.
- To do this, first picture yourself standing in front of a table with 6 stacked cups on top of it.
- Picture yourself picking up 3 cups in your right hand and 2 cups in your left hand.
- Picture the movements of your hands as you alternate between right and left when placing the cups in their appropriate locations.
- Picture yourself performing the sequence accurately and quickly; you make no mistakes and feel confident performing the movements.

Group 4: Readying, Imaging, Focusing

In addition to the instructional video on performing the 6 stack cup stacking sequence, I am going to present to you some information about the sport of cup stacking.

Fumbles

- **SLANTER**: During the up stack, the top cup of a stack rests in a slanted position on one of the other cups below it. During the down stack, the top cup(s) of a stack rests in a partially slanted position.

Tournaments

- There are currently five events and many divisions for Individuals or Teams offered at WSSA World Sport Stacking Championships.
- Besides the United States, countries that compete in WSSA national tournaments are Australia, Denmark, Germany, Canada, Japan, and the United Kingdom.

Now I am going to present you with a 3-step routine that I would like you to use before every attempt to undertake the cup stacking task. They are readying, imaging, and focusing.

Step 1 - Readying

- First, get your body in a position most comfortable to you. Once you have found a comfortable position, try to repeat it each time before performing the cup stacking sequence.
- Next, think positively about performing the cup stacking sequence. Try to set a reasonable, attainable goal for performing the sequence prior to each attempt.
- Sometimes you may feel anxious prior to performing the cup stacking sequence. If you feel yourself getting anxious, try a relaxation technique such as deep breathing before performing the sequence.
- Be consistent when attaining this preparatory state: get comfortable physically think positively, and set a reasonable goal.

Step 2 - Imaging

- I want you to imagine yourself performing the cup stacking sequence.
- To do this, first picture yourself standing in front of a table with 6 stacked cups on top of it.
- Picture yourself picking up 3 cups in your right hand and 2 cups in your left hand.
• Picture the movements of your hands as you alternate between right and left when placing the cups in their appropriate locations.
• Picture yourself performing the sequence accurately and quickly; you make no mistakes and feel confident performing the movements.

Step 3 - Focusing
• First, I want you to center yourself. Direct your thoughts toward the center of gravity in your body, which is located just behind your navel. Take 3 full breaths…inhale….exhale….inhale….exhale….inhale….exhale.
• Now, I want you to focus your attention on the lips of the stacked cups just prior to performing the cup stacking sequence.
• Think only of this feature, and attempt to block out all other thoughts.

Group 5: Readying, Imaging, Focusing, Executing

In addition to the instructional video on performing the 6 stack cup stacking sequence, I am going to present to you some information about the sport of cup stacking.

Fumbles
• SLANTER: During the up stack, the top cup of a stack rests in a slanted position on one of the other cups below it. During the down stack, the top cup(s) of a stack rests in a partially slanted position.

Now I am going to present you with a 4-step routine that I would like you to use before every attempt to undertake the cup stacking task. They are readying, imaging, focusing, and executing.

Step 1 - Readying
• First, get your body in a position most comfortable to you. Once you have found a comfortable position, try to repeat it each time before performing the cup stacking sequence.
• Next, think positively about performing the cup stacking sequence. Try to set a reasonable, attainable goal for performing the sequence prior to each attempt.
• Sometimes you may feel anxious prior to performing the cup stacking sequence. If you feel yourself getting anxious, try a relaxation technique such as deep breathing before performing the sequence.
• Be consistent when attaining this preparatory state: get comfortable physically think positively, and set a reasonable goal.

Step 2 - Imaging
• I want you to imagine yourself performing the cup stacking sequence.
• To do this, first picture yourself standing in front of a table with 6 stacked cups on top of it.
• Picture yourself picking up 3 cups in your right hand and 2 cups in your left hand.
• Picture the movements of your hands as you alternate between right and left when placing the cups in their appropriate locations.
• Picture yourself performing the sequence accurately and quickly; you make no mistakes and feel confident performing the movements.

Step 3 - Focusing
• First, I want you to center yourself. Direct your thoughts toward the center of gravity in your body, which is located just behind your navel. Take 3 full breaths…inhale….exhale….inhale….exhale….inhale….exhale.
• Now, I want you to focus your attention on the lips of the stacked cups just prior to performing the cup stacking sequence.
• Think only of this feature, and attempt to block out all other thoughts.

Step 4 - Executing
• I want you to execute the cup stacking sequence without any thought about the act itself or the possible outcome.
• Just do it.
• Perform the sequence as if the movement command came from your body instead of your mind.

Group 6: Readying, Imaging, Focusing, Executing, Evaluating

Now I am going to present you with a 5-step routine that I would like you to use before every attempt to undertake the cup stacking task. They are readying, imaging, focusing, executing, and evaluating.

Step 1 - Readying
• First, get your body in a position most comfortable to you. Once you have found a comfortable position, try to repeat it each time before performing the cup stacking sequence.
• Next, think positively about performing the cup stacking sequence. Try to set a reasonable, attainable goal for performing the sequence prior to each attempt.
• Sometimes you may feel anxious prior to performing the cup stacking sequence. If you feel yourself getting anxious, try a relaxation technique such as deep breathing before performing the sequence.
• Be consistent when attaining this preparatory state: get comfortable physically think positively, and set a reasonable goal.

Step 2 - Imaging
• I want you to imagine yourself performing the cup stacking sequence.
• To do this, first picture yourself standing in front of a table with 6 stacked cups on top of it.
• Picture yourself picking up 3 cups in your right hand and 2 cups in your left hand.
• Picture the movements of your hands as you alternate between right and left when placing the cups in their appropriate locations.
• Picture yourself performing the sequence accurately and quickly; you make no mistakes and feel confident performing the movements.
**Step 3 - Focusing**
- First, I want you to center yourself. Direct your thoughts toward the center of gravity in your body, which is located just behind your navel. Take 3 full breaths…inhale….exhale….inhale….exhale….inhale….exhale.
- Now, I want you to focus your attention on the lips of the stacked cups just prior to performing the cup stacking sequence.
- Think only of this feature, and attempt to block out all other thoughts.

**Step 4 - Executing**
- I want you to execute the cup stacking sequence without any thought about the act itself or the possible outcome.
- Just do it.
- Perform the sequence as if the movement command came from your body instead of your mind.

**Step 5 - Evaluating**
- I want you to use the available feedback to learn from.
- Assess the performance outcome of both your accuracy and speed and the effectiveness of each step in the routine.
- Adjust any procedure next time, if necessary.
APPENDIX F

OTHER STRATEGY USE QUALITATIVE DATA

<table>
<thead>
<tr>
<th>Group</th>
<th>Mental Strategy</th>
</tr>
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</table>
| 1     | focus on 3rd cup (x3)  
      | imagery (x4)  
      | cups in central vision and green light in periphery  
      | concentrate on finger position (x2)  
      | instruction rehearsal (x3)  
      | focus on timer  
      | thinking about other things |
| 2     | keep hands relaxed (x2)  
      | focus on finger position  
      | not thinking about it (x3)  
      | formed a method for stacking if picked up 4 cups  
      | imagery (x4)  
      | instruction rehearsal  
      | focus on cups during 15 sec. break |
| 3     | increase arousal  
      | focus on specific spot on cups  
      | focus on 3rd cup (x2)  
      | not thinking about it  
      | self-talk for motivation and confidence |
| 4     | self-talk for motivation and concentration  
      | not thinking about it (x3)  
      | repeat arousal state from successful trials |
| 5     | focus on 3rd cup  
      | rhythmic breathing |
| 6     | distraction between trials  
      | hand placement on cups (x2)  
      | self-talk for encouragement  
      | experimenting with level of arousal  
      | increase arousal  
      | time pressure (increase arousal?)  
      | focus on 3rd cup |
REFERENCES

Attentional processes in skill learning and expert performance. In G. Tenenbaum & R. C. 
Eklund (Eds.), *Handbook of sport psychology* (3rd ed.) (pp. 245-263). Hoboken, NJ: John 
Wiley & Sons, Inc.

of cognitive style. *Perceptual and Motor Skills, 63*, 1311-1317.

traditional instruction on motor skill learning and retention. *Research Quarterly for 
Exercise and Sport, 51*, 451-462.


behavioral psychological skills training on the motivation, preparation, and putting 


strategy interaction in the performance of primary and related maze tasks. *Research 
Quarterly for Exercise and Sport, 56*, 10-14.

Callow, N., & Hardy, L. (2005). A critical analysis of applied imagery research. In D. Hackfort, 
J. L. Duda, & R. Lidor (Eds.), *Handbook of research in applied sport and exercise 
Information Technology.


Cohn, P. J. (1990). Preperformance routines in sport: Theoretical support and practical 
applications. *The Sport Psychologist, 4*, 301-312.


Melanie Elizabeth Perreault was born in Lake City, Florida on April 30, 1983. She graduated with high honors from Columbia High School in June 2001. She has been a tennis player for 17 years and competed at the high school level. Melanie attended the University of North Florida in Jacksonville, Florida where she graduated Summa Cum Laude with a Bachelor of Science in Psychology in April 2006. She entered the Sport Psychology Master’s program at Florida State University (FSU) in August 2006. While attending FSU, Melanie worked as a research assistant for the Learning Systems Institute. She also volunteered for FSU Challenge, a challenge course program, Challenger Swim, a swim team for children with disabilities, and Project LOVE, an activity program for elderly residents. After completing her Master’s degree in May 2009, Melanie plans to pursue a career in recreation therapy.