EFFECTS OF EXTERNAL AND SELF-CONTROLLED FEEDBACK SCHEDULE ON RETENTION OF ANTICIPATION TIMING AND BALL THROWING TASK

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ABSTRACT

EFFECTS OF EXTERNAL AND SELF-CONTROLLED FEEDBACK SCHEDULE ON RETENTION OF ANTICIPATION TIMING AND BALL THROWING TASK

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The purpose of this study was to examine whether the feedback schedule controlled by the learner created an optimal environment for retention of motor skills. Two experiments were conducted and participants were randomly assigned to a Control (100% KR), 20% RF KR, Self-controlled and Yoked conditions. In experiment one an anticipation timing task and in experiment two a ball throwing task was used. The second experiment also included a transfer test in order to measure the persistence of the acquired capability for performance. Absolute constant error (|CE|) and variable error (VE) were calculated for four blocks of ten trials in acquisition phase and two blocks of ten trials in retention and transfer phases to analyze the subject's performances by repeated measures ANOVA. Experiment one analysis indicated significant main effects for groups in |CE| and VE. Participants in the self-controlled condition performed significantly better on retention test than the control group. Contrary to the expectations, experiment two analysis showed no significant differences between the groups in acquisition and retention tests. Group differences were only observed in transfer test between the 20% RF KR and Yoked conditions. There was an improvement in the performance by groups as they progressed through the acquisition trials. The results of the experiment were not consistent with regard to effects of KR on learning. The reasons might be attributed to several factors such as the age and the motivation of the subjects, and the nature of the task.

Key Words: Self Regulation, Retention, Transfer, Feedback Schedule, KR, Anticipation, Ball Throwing

ÖZ

DIŞ KAYNAKLI VE ÖĞRENENİN KONTROLÜNDEKİ GERİ BİLDİRİM PLANLAMASININ, SEZİNLEME VE TOP ATMA BECERİSİNİN KALICILIĞI ÜZERİNE ETKİSİ

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Bu çalışmanın amacı öğrenenin isteğine bağlı olarak verilen bir geri bildirim metodunun motor becerilerinin öğrenilmesine daha uygun olup olmadığını incelemektir. Bu doğrultuda iki deney düzeneği planlanmış ve denekler kontrol, %20 sıklıkta, kendi isteğine bağlı ve üçüncü gruptaki bir denek ile eşleştirilerek geri bildirim alan gruplara laboratuara geliş sırası ile rasgele atanmışlardır. İlk deneyde sezinleme zamanı, ikinci deneyde ise top atma becerisi kullanılmıştır. İkinci deney öğrenme testine ek olarak transfer (aktarma) testini de içermektedir. On denemeden oluşan 4 bloklu alıştırma ve 2 bloklu kalıcılık ve transfer mutlak sabit hata (│SH│) ve değişken hata (DH) ortalamaları tekrar ölçümlü varyans analizi ile incelenmiştir. İlk deneyin analizleri hem │SH│ hem de DH için gruplar arasında anlamlı bir farklılık olduğunu göstermiştir. Kendi isteğine bağlı olarak geri bildirim alan grubun kazanımı kontrol grubu ile kıyaslandığında anlamlı şekilde yüksek çıkmıştır. İkinci deneyin analizleri ise beklenenin aksine öğrenme testinde bu gruplar arasında anlamlı bir farklılık olmadığını, sadece transfer testinde eşleştirilen grup ile %20 sıklıkta geri bildirim alan grup arasında anlamlı farklılık olduğunu göstermiştir. Alıştırma ile deneklerin kazanımları artmış fakat sadece birinci deneyde öz denetim yöntemi kullanan grubun öğrenmesinin (kalıcılığının) daha iyi olduğu bulunmuştur. Katılımcıların yaşları, motivasyonları ve becerinin yapısı bu sonuçları etkilediği düşünülebilinir.

Anahtar Kelimeler: Öz Denetim, Kalıcılık, Transfer (Aktarma), Geri Bildirim Planlaması, Sonuç Hakkında Geri Bildirim, Sezinleme, Top Atma

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LIST OF ABBREVIATIONS

AE :	Absolute Error
ICEI :	Absolute Constant Error
KP :	Knowledge of Performance
KR :	Knowledge of Results
RMSE :	Root Mean Square Error
VE :	Variable Error

CHAPTER I

INTRODUCTION

Over the last few decades, researchers have become increasingly concerned with the factors that affect learning. These factors are closely related with the learner, teacher, subject matter and learning environment. Especially factors related with the learning environment are very important for skill learning, generally referred to as motor learning. Motor Learning is commonly defined as "a relatively permanent modification in motor behavior which results from practice or experience, and which is not result of maturation, motivation, or training factors (such as improvements in strength)" (Sage, 1977, p.1-9). It almost goes without saying that one of the most important contributors to skill learning among the factors that are studied in motor learning is providing information about movement.

Providing learners' with information about their behavior or the consequences of their behavior is called feedback and is essential for learning new movement. A lot of attention has been directed toward the understanding of the role of feedback in skill learning (Newell, Morris, & Scully, 1985; Salmoni, Schmidt, & Walter, 1984; Schmidt, 1975). Understanding the role of feedback is especially significant for practitioners and teachers as it enables them to provide proper feedback to individuals about their actions to enhance the rate and the retention of learning.

Individuals can get some information about their actions from various sensory organs after and even during the movement intrinsically. If the performer detects some errors in the action, he/she will try to eliminate these errors during the execution or in the subsequent movement trials. In some situations detecting the errors with intrinsic sensory feedback alone is feasible, but in some other situations it is not. In such situations, if critical task requirements are not clear, or the learner is not familiar with the relationship between the goals and required movements, additional feedback from an outside source might be necessary for learning to occur. This type of feedback such as comments of an instructor or therapist (in the form of knowledge of performance – KP), the digital display of a stopwatch, the hand marked score of a judge (in the form of knowledge of results – KR), the film of a game, and the videotape replay of a movement, and so on is generally called as enhanced feedback or augmented feedback (Schmidt & Wrisberg, 2000).

When an instructor or trainer presents augmented feedback for learners, the feedback can serve several functions which are motivational, reinforcement, informational and dependency producing functions (Schmidt & Wrisberg, 2000). Firstly, augmented feedback energizes individuals and increases their motivation. Especially in certain tasks which are boring and repetitive, an immediate increase in performance proficiency is observed by the addition of feedback. At this point, feedback acts like a kind of stimulus that makes individuals going again. Augmented feedback also acts as reinforcement. The feedback has a reinforcing function when learners get positive feedback from instructors. By receiving feedback, learners get a lot of information about their movement as well. They can learn the kind of direction they need to correct their errors and have an opportunity to modify their future performance. Moreover informational properties of feedback make the role of an instructor or teacher an essential part of the learning process. Instructors or teachers have to engage in some important questions about the kinds of information, the amount and precision of feedback, and the frequency of feedback presentation. For this reason the past decade has seen renewed interest in the effects of variations in format, timing and scheduling of augmented feedback to determine the conditions under which motor skill learning is optimized.

Early researchers theorized that the provision of more frequent, immediate or precise feedback during practice facilitated the learning of skills (Bilodeau & Bilodeau, 1958; Bilodeau, Bilodeau, & Schumsky, 1959; Thorndike, 1927 (as cited in Schmidt & Wrisberg, 2000)). The understanding of how feedback functioned for skill learning was mostly based on Thorndike's law of effect (Thorndike, 1927 (as cited in Schmidt & Wrisberg, 2000)). According to this law, learning involved the strengthening of the bond between a stimulus and a response, and extrinsic feedback increased the strength of that bond. Therefore, he assumed that feedback should be presented as often as possible and proposed that, if feedback was not presented after a movement attempt and learners could not determine the outcome from their own intrinsic feedback, no strengthening of the bond would occur. However, most recent works have changed the views about the nature of the learning effects of feedback (Salmoni et al., 1984; Swinnen, 1996). Findings from these studies suggest that practice, in conditions with less frequent and less immediate feedback is more detrimental to performance but more beneficial for the ultimate learning of motor skill that can be observed with the retention tests (Schmidt, Young, Swinnen, &

Shapiro, 1989; Swinnen, Schmidt, Nicholson, & Shapiro, 1990; Winstein & Schmidt, 1990).

These findings are closely related with dependency producing function of feedback. When instructors give feedback frequently, it is likely to guide the learner's action in the direction of the goal movement. To explain the dependency producing function of feedback, researchers presented the guidance hypothesis that feedback is a mean to guide performers' actions with a both positive and negative "side effects" (Salmoni et al, 1984; Schmidt et al, 1989; Schmidt & Wrisberg, 2000). The beneficial effects come about informational properties of augmented feedback. By using knowledge about the outcome of a movement, learners can correct errors and improve following performance. The side effect of frequent augmented feedback is also due to over-reliance on the guiding properties of the feedback. Therefore, it prevents with critical between-trial information processing involving encoding, storage and retrieval operations which is known to be important for learning (Bjork, 1988; Landauer & Bjork, 1978; Schmidt & Lee, 1999; Schmidt & Wrisberg, 2000).

Some forms of feedback scheduling methods were presented to reduce the negative effects and increase the positive effects of feedback. These methods are summary, average, bandwidth, relative frequency, reduced relative frequency, and faded feedback scheduling. With these methods, teachers or instructors can reduce the learner's dependence on feedback information.

Even though, many studies consider the importance of different types and schedules of feedback to the learning process, generally they neglect to consider the fact whether the learner is in need of feedback or not. In these studies, feedback is generally provided to the learners regardless of their intentions. While in these studies, there is a lack of emphasis on the role of learner, a growing body of literature has considered the active role of the learner. It is showed that by actively involving the learner in the learning process, retention of crucial information is significantly enhanced (Hardy & Nelson, 1988; Holt, 1982; Zimmerman, 1989). When the learner tries to control and direct his or her own activity and becomes an active participant in his or her own learning process, a greater amount of learning or long-term retention is expected to occur.

Researchers have shown that the learner attains a deeper level of information processing by managing their own learning experiences in many different ways (Seigler, 1991; Zimmerman, 1989). These different ways are usually termed as self-regulating strategies in the literature. The use of self-regulating strategies positively affects the levels of intrinsic motivation, self-efficacy and achievement of learners (Pintrich & Garcia, 1991). These strategies also have certain positive effects on motor skill learning. This notion was implemented to motor skill learning by the studies of Janelle and his colleagues (Janelle, Barba, Frehlich, Tennat, & Cauraugh, 1997; Janelle, Kim, & Singer, 1995). In these studies, learners improve their retention of essential information by actively involving in the skill acquisition process and controlling some aspects of information feedback.

A feedback schedule controlled by the learner could provide a more effective learning environment than a predetermined feedback schedule controlled by an outside source (an instructor or a researcher). An environment in which the schedule of feedback is completely dependent on subjects’ own elicitation might provide a more ideal environment for retention of motor skills. In order to test this assumption previous investigators used a KR group that resembles the KR experiment group (bandwidth or summary KR) (Chen, Hendrick, & Lidor, 2002; Chiviacowsky & Wulf, 2002). This group of subjects is usually labeled as Yoked or Match feedback group and was matched to the experiment group. Thus this procedure allowed to experimenter to test the hypothesis whether the time and/or the amount of information is specific to subject for retention of learning or only the KR scheduling was important.

Logically the perception of self-control obtained from augmented feedback given only at the learner's request may result in the production of more effective learning strategies for the cognitive as well as the motor skills.

1.1. The Problems of the Study

The following two studies investigated the application of self-regulation of feedback to simple motor tasks to find out whether an environment in which the schedule of feedback that was completely dependent on the subject's own desire created an optimal environment for retention of motor skills. The goal was to examine the effect of reduced frequency KR (researcher controlled) and self-controlled (learner controlled) conditions in contrary to a control condition (100% KR) across acquisition and retention trials. In the first experiment, anticipation timing task and in the second experiment a ball throwing task was used.

In comparison to the first experiment, in the second experiment a fundamental movement task (a ball throw) and more importantly a transfer task was also used to see whether reduced frequency KR and self-controlled condition enhanced learning of a new parameter namely increasing the distance of the throw.

1.2. The Hypotheses

The purpose of this study was to test the following hypotheses:

1) Participants in the control condition would exhibit smaller |CE| and VE scores than the relative frequency, self-controlled, and yoked conditions during the acquisition tests.
2) Participants in the self-controlled condition would exhibit smaller |CE| and VE scores than the control condition but similar |CE| and VE scores as the relative frequency, and yoked conditions during the retention tests.
3) Participants in the self-controlled condition would exhibit smaller |CE| and VE scores than the control condition but similar |CE| and VE scores as the relative frequency, and yoked conditions during the transfer test.

1.3. Operational Definitions

Motor Learning: A set of internal processes associated with practice or experience leading to relatively permanent changes in the capability for motor skill (Schmidt & Lee, 1999).

Feedback: Sensory information that results from movement (Schmidt & Lee, 1999).

Augmented Feedback: A generic term used to describe information about performing a skill that is added to sensory feedback and comes from a source external to the person performing the skill. It is sometimes referred to as extrinsic or external feedback (Magill, 2001b).

Knowledge of Results (KR): Augmented feedback related to the nature of the result produced in terms of the environmental goal (Schmidt & Lee, 1999).

Absolute Frequency of Knowledge of Results: The absolute number of KRs given in a sequence of trials (Schmidt & Lee, 1999).

Relative Frequency of Knowledge of Results: The percentage of trials for which KR is provided; the absolute frequency divided by the number of trials (Schmidt & Lee, 1999).

Guidance Hypothesis: A hypothesis indicating that the role of augmented feedback in learning is to guide performance to be correct during practice where, if it is provided too frequently, it can cause the learner to develop a dependency on its availability and therefore to perform poorly when it is not available (Magill, 2001b).

Self-regulation: The degree that individuals are metacognitively, motivationally, and behaviorally active participants in their own learning process (Zimmerman, 1994).

Retention Test: A test of a practiced skill that learner performs following an interval of time after practice has ceased (Magill, 2001b).

Transfer Test: A test in which a person performs a skill that is different from the skill that he or she practiced, or performs the practiced skill in a context or situation different from the practice context or situation (Magill, 2001b).

1.4. Assumptions of the Study

It is assumed that subjects in all groups followed the instructions provided by the experimenter at the beginning of the test.

It is also assumed that subjects in self-controlled group asked for feedback based on their needs not arbitrarily.

1.5. Limitation of the Study

The limitation of this study was that the tasks were simple and they were only implemented in the laboratory situations not in the real target context.

1.6. Significance of the Study

Instruction in the form of feedback during and after practice sessions is an important factor that affects the rate and the amount of learning. KR studies and feedback studies in general indicate that information after every attempt is not always a good practice. Some way of scheduling where the learner gets less information during practice may hinder acquisition during the training but enhances learning measured by retention tests.

Self regulation of the provision of information that the learner receives during practice might be a way to minimize the negative side effect of dependency producing properties of feedback which is introduced when external source provides feedback.

Self regulation of the factors that affects the learning, in this case the use and the timing of feedback, will empower the learner so that the learner will not be just a passive player in his/her learning environment but will be an active one. This will benefit not only the learner but also the practitioners (teachers, coaches, etc.) because of the less decision making process that are required in the organization of the learning sessions.

One added benefit that might arise from this experiment is that if transfer of the strategies or the decision making capabilities of the self-controlled group is observed then the learners are expected to adjust their environment or look for alternative solutions in an environment where some parameters of the learned behavior has changed or where the environment is somewhat new to them.

CHAPTER II

REVIEW OF LITERATURE

Feedback refers to performance-related information that the individual obtains during and after performing the skill, when it is used in reference to performing a motor skill. It has been well established that feedback plays an important role in acquiring motor skills (Magill, 2001a). Certainly, one of the most critical variables affecting motor skill learning, aside from practice itself, is feedback (Schmidt, 1988). There are two kinds of feedback in motor skill performance situations. The first one is task-intrinsic feedback which is available to the person naturally by performing the skill. In most skill learning, individuals are able to see and feel something about the movements they are performing. If learners are throwing a dart at a target, they can see where it lands and feel the temporary sensation in their arm and shoulder. If learners are playing a musical instrument, they can hear the pleasant and not so pleasant sounding notes they produce and feel the sensation in their mouths and fingers. Through these sensory channels, people can gain information about many aspects of their movements even before completed.

The second kind of performance feedback is the performance-related information a person receives as well as task-intrinsic feedback. This type of feedback is not always available. Individuals receive them from some outside sources, such as the comments of an instructor or the film of a game, the videotape replay of a movement and so on. This type of feedback is termed as augmented feedback in the research literature.

2.1. Augmented Feedback

Augmented feedback is an important component of the communication between instructor and learner in skill learning. It is especially important in performance situations where intrinsic sensory feedback is not available, where critical task requirements are not clear, or the learner is not familiar with the relationship between the goal and required movements.

2.1.1. Roles of Augmented Feedback in Skill Acquisition

Augmented feedback plays two important roles in the skill learning process. Firstly, it provides the learner with information about the patterns of action. Informational feedback provides people the nature and direction of their errors. Also, it suggests ways of correcting these errors. Furthermore, acquiring such feedback throughout the learning process is what gives instructors and therapists a crucial role.

The second role is to motivate the learner to continue striving toward a performance achievement goal. Individual motivation is further improved, when they are progressing to the goals they set for themselves. Providing augmented feedback to the learner serves the functions of energizing individuals and increasing their motivation.

Early studies indicated that when augmented feedback was not given, subjects tended to become bored (Arps, 1920 (as cited in Salmoni et al., 1984); Crawley, 1926 (as cited in Salmoni et al., 1984)). When augmented feedback was given, it caused subjects to try harder, to practice longer after augmented feedback was withdrawn, and generally to be more interested in the task. In previous study, the addition of feedback produced an immediate increase in performance proficiency, as if the feedback were a kind of stimulant that got individuals going. Elwell and Grindleys' experiment (1938, as cited in Magill, 2001a) being one of the earliest research in which participants practiced a two hand coordination task with augmented feedback provided. The experimenters interpreted the performance decline as evidence that the participants had lost interest in the task, which they also based on the increase in participants' complaints and late arrivals for experimental sessions after the augmented feedback was removed. Such studies suggest a direct motivational role for augmented feedback in performance.

Other motivational role of augmented feedback is that it rewards correct actions and punishes incorrect actions (Adams, 1968). Considering the Thorndike's (1927, as cited in Schmidt and Wrisberg, 2000) Law of Effect, augmented feedback strengthened the bond between same stimulus and a response, so that repeated practice of the movement with augmented feedback allowed the learner to produce the proper response.

Although the motivational and informational role of augmented feedback is important for skill acquisition, there is no need to augmented feedback in every situation. The need for augmented feedback to learn a skill relies on particular characteristics of a skill or learning environment. If task-intrinsic feedback provides the essential information to determine the performance error, there is no need for additional augmented feedback. Even, additional feedback may lead to more negative rather than positive learning outcomes. For certain skills and skill performance situations, the critical task-intrinsic information needed to determine the appropriateness of a movement is not available or cannot be used by learner. In such situations, augmented feedback can be essential for skill acquisition.

2.1.2. Types of Augmented Feedback

The research literature about augmented feedback and motor skill acquisition refers to two types of augmented feedback: knowledge of performance (KP) and knowledge of results (KR).

2.1.2.1. Knowledge of Performance

KP refers to augmented information about the movement characteristics associated with performing the skill. KP is more related to the kinds of feedback instructors give to their students, being directed toward the correction of improper movement patterns rather than just the outcome of the movement in the environment. Examples of KP include a football coach intimating to the quarterback that his shoulders were not square to the receiver when the ball was released, or a basketball coach telling his point guard that a chest passes rather than a bounce pass would have been a better decision.

KP can also be supplied by the use of technology, such as by providing a videotape replay of a throw or a computer-generated display of the kinematics of the arm movement.

2.1.2.2. Knowledge of Results

KR has been defined as augmented feedback related to the nature of the result produced in terms of environmental goal (Schmidt & Lee, 1999). This form of feedback is useful in situations where the performer must wait for the judges' scores -- as in gymnastics, diving, etc. -- or in sports such as archery and rifle, where it is not always possible to immediately view the results. KR is frequently used in the laboratory setting to enable controls in the information given to subjects. Early experiments conducted to evaluate the importance of KR indicate that when a learner cannot detect his/her own performance errors through intrinsic feedback, very little learning occurs unless KR is evident.

KR is widely considered as a crucial variable in the acquisition of skills. It is generally viewed as the most important variable for determining learning (Bilodeau, 1966). Disregarding KR as a variable in the study of learning would decrease our understanding of skill acquisition considerably.

For many years, researchers try to answer the question of how often, or under which kind of schedule, should KR be provided to maximize learning and performance. In the early studies of feedback, it was generally assumed that the provision of more frequent, immediate or precise knowledge of result (KR) during practice facilitated the learning of skills (Bilodeau & Bilodeau, 1958; Bilodeau et al., 1959; Schmidt, 1975). The general problem of these early studies is that most experimenters have nearly uniformly failed to distinguish the temporary effects of KR manipulations from their relatively permanent effects which are regarded as being due to learning. Because the vital feature of learning is that it causes a relatively permanent change in behavior.

The most common and widely accepted definition of learning is that it is a relatively permanent change, resulting from practice or experience, in the capability for responding. Central to this focus is the strength of this capability as a function of variables associated with practice. These various capabilities can be considered as states that underlie a skilled behavior. Therefore, changes in behavior with practice may reflect changes in an underlying capability for responding that is learning. Also, the acquired capability should be relatively permanent, that is the effect of acquired capability should persist well beyond the practice session. These notions are important to the design of experiments on learning.

Actually, the notion of differentiating the relatively permanent effect from the transitory effects of practice is not new. Most researchers, who examined learning, had designed their experiments according to these effects.

In most KR experiments, the important consideration is the relative importance of trials with KR versus trials without KR in facilitating learning. In answering such questions, two primary variables have come out from such research (Salmoni et. al., 1984; Schmidt, 1988). These are absolute frequency and relative frequency.

2.1.3. Relative and Absolute Frequency of KR

Absolute frequency refers to the absolute number of times in a learning sequence that KR is provided to learner. If there are 50 trials, and KR is provided on half of them selected randomly, then the absolute frequency of KR is 25. Relative frequency is a ratio, expressed as a percentage, of the number of KR presentations to the total number of practice trials. In this case, the relative frequency of KR is 25/50, or 0.5.

It is well known that absolute frequency is an important variable for learning (Bilodeau et al., 1959; Newell, 1974). In tasks where subjects cannot receive information about their own error via intrinsic feedback, it is not surprising that if KR is given 100% of the time (for a given absolute frequency), performance is more effective than if KR is provided on some lesser percentage of the trials. In the study of Bilodeau and Bilodeau (1958), the relative frequency of KR has been manipulated by using simple linear-positioning task. Subjects were given 10 trials with varying no-KR trials between KR trials forming four conditions with 10%, 25%, 33 and 100% relative frequency. When the performance accuracy on the trials immediately following KR (every trial for the 100% relative frequency, every four trial for 33% relative frequency groups, etc.) were compared, the conditions showed almost identical performance on Groups-by-Trials analysis of variance. Thus, it is quite clear that increasing the relative frequency increases performance in acquisition.

One main theoretical issue is related to the concept of Thorndike (1914, as cited in Salmoni et al., 1984) that KR is crucial for learning, strengthening a bond between stimulus and response elements. If so, then a schedule of 50% relative frequency will be less efficient than a schedule of 100% relative frequency. Because there will be ineffectiveness of the blank trials in the 50% condition. A second concept of Thorndike's is that the variable of absolute frequency of KR would be expected to be a determiner of the amount of learning, and relative frequency of KR would be unimportant, because KR was considered the critical variable for learning. But, the evidences are strongly inconsistent with such position. This conclusion is somewhat different when the effect on learning, measured by performance on a no-KR transfer test, is examined. A number of investigations show that, with the total number of KR trials (absolute frequency) fixed, decreased relative frequency improves performance on a no-KR transfer tests.

A number of studies have revealed that reducing the frequency (Winstein & Schmidt, 1990; Wulf, Shea & Matschiner, 1998) or average precision (Young & Schmidt, 1992) of KR during practice trials enhances the retention and transfer of criterion movements in the absence of KR, especially when retention or transfer tests are given at least 24 hr after initial practice. In the study of Winstein and Schmidt (1990), the effects of variations on acquisition KR relative frequency has been examined in a series of experiments. In three experiments, the task was to produce a goal movement pattern using a lever in 800 ms criterion time. In the first experiment, there were two KR relative frequency conditions (100% and 33%) and four retention test conditions (0%, 33%, 66%, and 100%), thus totally eight distinct acquisition-retention test groups. The result of the first experiment had showed that compared to a 100% KR practice condition, relative frequency variations were not significant. But, the reduced KR relative frequency conditions were found to be as effective for learning as measured in various retention tests. The interesting finding of this experiment was low KR relative frequency practice conditions suspected to be not detrimental to learning but no evidence for this was provided. This was the base of further experiments. In the second and third experiments a variable ratio schedule (starting from 100% to 25% relative frequency) with an average of 50% relative frequency was employed. The reduced averaged relative frequency of 50% was found to enhance learning in a delayed no-KR retention test and in a KR provided retention test. The result of the Winstein and Schmidt (1990) together with Sherwood's (1988) study have suggested that lower KR relative frequencies promote consistency and reduce trial to trial variability. Also, many other studies suggest that practice in conditions with less frequent and less immediate KR is more detrimental to performance but more beneficial for the ultimate learning of motor skills than practice in conditions where KR is provided following every trial with little post-response delay (Schmidt et al, 1989; Swinnen et al, 1990).

2.1.4. Guiding Properties of Augmented Feedback

Guidance hypothesis proposed and generally supported by Schmidt and his colleagues, enlightens the efficiency of less frequent and immediate feedback for learning (Salmoni et al, 1984; Winstein & Schmidt, 1990; Wulf, Lee, & Schmidt, 1994). According to this hypothesis, the learner is engage in different learning processes when augmented feedback was presented with 100% frequency than with less frequency. Feedback serves as an effective guide for the learner, when they receive augmented feedback on every trial. KR especially in the stages of learning guides the learner toward the appropriate movement pattern. However, this guiding effect enables learners to perform the movement correctly; it also has a negative feature. The beneficial effects are thought to be well-known informational properties of augmented feedback, in which knowledge about the outcome is used by the learner to correct errors and improve subsequent performance. The effect of frequent augmented feedback in error identification and reduction, however, is thought to be detrimental in that it prevents or interferes with critical between-trial information processing involving encoding, storage and retrieval operations, such as problem solving, which is known to be important for learning (Bjork, 1988; Landauer and Bjork, 1978; Schmidt and Lee, 1999; Schmidt and Wrisberg, 2000). Thus, the guidance hypothesis proposes that a practice schedule with relatively infrequent augmented feedback trials would be desirable in promoting long-term learning effects.

Winstein and Schmidt (1990; Experiment 2) had tested the predictions of the guidance hypothesis by reducing the frequency of KR during acquisition. And they had revealed beneficial learning effects resulting from the lower frequency of KR. In their experiment, participants had to move a lever in an attempt to produce a goal movement pattern in 800 ms under either 100% or 50% relative frequency of KR conditions in a faded schedule. The results of the no-KR retention test indicated that the 50% KR group produced significantly smaller root mean square errors (RMSE) than the 100% KR group. Consistent with the predictions of the guidance hypothesis, Winstein and Schmidt suggested that lower relative frequencies might enhance learning because no-KR trials may cause the participants to engage in additional important cognitive processes such as those related to error detection

2.2. Self-Regulation

Self-regulation is defined as;

> Actions occurring during the actual performance of a cognitive task that allow an individual to control, govern, or direct his own activity through self-imposed rules or regulations that better adapt his performance to different circumstances or surroundings (Ferrari, Pinard, Reid, & Bouffard-Bouchard, 1991, p.139).

Zimmerman (1994) also defined self-regulation as “the degree that individuals are metacognitively, motivationally, and behaviorally active participants in their own learning process”.

Self-regulated learners are generally characterized as active learners who efficiently manage their own learning experiences in many different ways (Schunk & Zimmerman, 1994). They have a large arsenal of cognitive and metacognitive strategies that they readily deploy, when necessary, to accomplish academic tasks. Also, self-regulated learners have adaptive learning goals and are persistent in their efforts to reach those goals (Pintrich & Garcia, 1991; Schunk, 1996). In short, self-regulated learners are motivated, independent, and metacognitively active participants in their own learning (Zimmerman, 1990).

Self-regulation is an important aspect of student learning and school performance (Corno & Rohrkemper, 1985). In the academic domain there has been a long research tradition concerning the role of cognitive self-regulation for learning and achievement (Corno & Mandinach, 1983). Zimmerman and Martinez Pons (1986) found that high-achieving students use more self-regulatory behaviors than low-achieving students. In the study, high-achieving students reported that they used 13 of 14 self-regulatory behaviors identified by these researchers. Likewise, Pintrich and Dee Groot (1990) found that students who reported greater self-regulatory strategy use also reported higher levels of intrinsic motivation, self-efficacy and achievement. More generally, in a review of several recent studies, Schunk and Zimmerman (1994) concluded that self-regulated learners are likely to have more adaptive cognitive, motivational, and achievement outcomes than their classmates who fail to self regulate.

Self-regulation also is an important aspect of everyone life because a major function of education is the development of lifelong learning skills. After graduation from high school or college, young adults must learn many important skills informally. For example, in self-employment settings, both young and old must constantly self-refine their skills in order to survive. Their capability to self-regulate is especially challenged when they undertake long-term creative projects, such as works of art, literary texts, or inventions. In recreational settings, learners spend much personally regulated time learning diverse skills for self-entertainment, ranging from hobbies to sports.

The ability to self-regulate may have also advantages in the course of an individual's mental life, especially within the sporting context. For example, Vealey, Hayashi, Garner-Holman, and Giacobbi (1998) developed a questionnaire over a series of experimental trials that examined sources of sport confidence in 335 college athletes. Nine sources of sport confidence were identified among the athletes that were split into three broad domains (achievement, self-regulation and climate). The athletes rated, first, achievement (includes self-mastery and demonstration of ability), second, self-regulation (includes physical/mental preparation and physical presentation), and third, climate (includes social support, coaches' leadership, vicarious experience, environmental comfort and situational favorableness) in order of perceived priority as the most important sources of improving sport confidence.

Research within the disciplines of sports psychology and motor learning has showed that motor learning and achievement may also be affected by cognitive and motivational forms of self-regulation (Clark, 1995; Glencross, 1994; Lavisse, Deviterne, & Perrin, 2000; Lidor, Tennant, & Singer, 1996; Masson, 1990). Moreover, self-regulation has been recognized as one of the most important factors that affects success in sport participation (Hardy & Nelson, 1988; Kirschenbaum & Witrock, 1984).

2.2.1. Roles of Self-Regulation in Motor Skill

According to Newell and Barclay, "metacognition (in motor learning) relates to person's knowledge about the process of how he relates a movement to its consequences" (Newell & Barclay, 1982, pp: 198). This metacognitive activity involves two major factors, (a) sensitivity to those situations which require skilled action and (b) knowledge of variables or factors that can affect the outcome of one's actions (Newell & Barclay, 1982). These two factors refer to what Lefebvre-Pinard and Pinard (1985) call the activation of relevant metacognitive knowledge during self-regulation. In a motor skill, this may include knowledge about : (a) one's own physical capabilities and limitations, (b) the relationship between the task and its environmental context, (c) specific cognitive strategies given the objectives set for a motor performance, (d) how to plan, monitor, and verify the correct use of these strategies, and (e) the accessibility and significance of motor feedback

The relationship between the accessibility and significance of motor feedback and self-regulation has been studied in many researches. Research in educational psychology (Holt, 1982; McCombs & Marzono, 1990; Zimmerman, 1989) and motor learning (Hardy & Nelson, 1988) has indicated that actively involving learners in the skill acquisition process and giving them control over aspects of information feedback will significantly enhance their retention of crucial information. The more a learner engages in self-regulatory processes, the greater amount of learning or long-term retention will occur.

The effectiveness of self-regulation, or self-control, for learning has been discussed for a number of years (Carver & Scheier, 1990; Pinanrd, 1992;

Zimmerman, 1989). Janelle and colleagues (Janelle et al., 1997; Janelle et al., 1995) examined learner-controlled feedback schedules.

Janelle et al. (1995) implemented the notion of self-regulation to motor skill learning by engaging learners in the self-regulation of receiving augmented feedback. The purpose of this study was to assess whether a schedule based on performance feedback controlled by the learner would be a more effective means of delivering feedback than any predetermined or random schedule. In the experiment, participants were randomly assigned to one of five conditions: controlled group receiving no performance feedback, 50% relative performance feedback, summary performance feedback, subject-controlled performance feedback and yoked control group. Participants practiced on underhand ball throw to target. Data were collected during an acquisition phase (four blocks of 10 trials) and a retention phase (two blocks of 10 trials). Repeated measures analyses indicated significant main effects for the absolute error (AE). Participants in the subject controlled performance feedback condition performed significantly better on both retention trials than the other groups.

Janelle substantiated and extended these results in a later study in which videotape replay was a source of augmented feedback in addition to verbal KP (Janelle et al., 1997). In this study, participants were randomly assigned to self-controlled KP, summary KP, yoked control, or knowledge of results only conditions. Data collection consisted of an acquisition phase and a 4-day retention phase during which right-handed participants performed a left-handed ball throws. Overall, throwing form improved across trial blocks during acquisition, with the summary KP, self-controlled KP, and yoked control groups showing more improvement than the knowledge of results only group. During retention, the self-controlled KP group retained higher level of throwing form and accuracy in comparison to the other groups.

The results of Janelle's experiments suggested that a feedback schedule which is controlled by the learner may be a more effective means of delivering augmented feedback than other schedules which have been examined. In terms of augmented feedback frequency, it is interesting to note that in the Janelle et al. (1995) experiment, participants in the self-controlled condition requested KP on only 7% of the practice trials, and 11% in the Janelle et al (1997) experiment. These frequencies are very low. Therefore, it shows that there is some relationship between the self-controlled method and the reduced relative frequency of augmented feedback. Nevertheless, for the reason that the self-controlled methods in these experiments brought about better performance on retention tests, the advantage of the self-controlled condition is more than a simple frequency effect.

In another study, Chiviacowsky and Wulf (2002) examined the effects of self-controlled feedback schedules on learning. Participants practiced a sequential timing task under self-controlled or yoked feedback conditions on one day, and learning was assessed in retention and transfer tests without feedback one day later. Self-controlled group was provided with feedback whenever they requested it, whereas yoked group had no influence on the feedback schedule. After the practice phase, all participants completed a questionnaire. Self-control participants answered the questions of when and why they requested feedback and when they did not request feedback. While yoked participants answered the questions of whether they received feedback after the right trials, and, if not, when they would have preferred to receive feedback. The questionnaire results for the self-control group showed that they asked for feedback most after they thought they had a good trial (67%). Most participants (73%) in this group also reported that they did not ask for feedback after bad trials. And yoked learners also preferred to receive feedback after good trials. These results demonstrated that there is a clear preference for feedback after good trials. More importantly, the results showed the learning benefits of self-controlled group on a delayed transfer test. Analyses demonstrated that errors were lower on feedback than no-feedback trials for the self-control group but not for the yoked group. In this study, only intrinsic feedback was available for participants to determine their timing accuracy in the absence of extrinsic feedback (knowledge of results). Related with this, the frequency of feedback requests by the self-control participants was higher in this study (35%) than those in the studies by Janelle et al. (1995, 1997). At any rate, this study demonstrated the generalizability of self-controlled feedback advantages to tasks with different degrees of intrinsic feedback.

CHAPTER III

Experiment I

3.1. Introduction

Quick decision making is very important part of some of the daily life activities as well as many sport activities. One essential way people deal with long decision-making delays is to use anticipation as a strategy. Anticipating the time and place of the event helps people in reaching success (Schmidt, 1993). The ability to accurately anticipate or predict forthcoming events is a critical feature of performance in many fast ball sports and has long been identified as an essential attribute of the skilled performer (Barlett, 1947).

For the skilled performer, the evaluation of information is the main concern. Some psychologists explain the process of learning motor skills with a model that treats human being as an information processor similar to a computer. In such a model human beings receive signals as an input by the various sense organs at first. Then, these signals are processed through various stages and at the end; movements are produced as an output. For many psychologists, the most important goal is to understand the nature of the processing from input to output. For the analysis of human performance, it was assumed that there are three information processing stages which are called as stimulus identification, response selection and response programming (Schmidt & Wrisberg, 2000). Whenever environmental information is received, it is initially processed in the stimulus identification stage. During this stage, the individual recognizes and identifies the input. Then, in the second stage the individual decides what response should be made among many different response alternatives. At the third stage, the response programming, the individual organizes the motor system to produce the desired movement. Finally, the result of the activities of all three information-processing stages passes to the effector system which is responsible for the execution of the output.

Highly skilled individuals predict what is going to happen in the environment and when it is going to happen, and in that way are able to perform various information processing activities in advance. Researchers assume that these individuals might complete some of the information processing activities that are usually conducted during the response-selection or response-programming stages (Rosenbaum, 1980). Although, there are several advantages to anticipation, there are also some disadvantages. If correct anticipation can not be made, individuals will not found enough time to complete the task requiring quick decision making. When the individuals realize that anticipation is not correct, they have to inhibit the already prepared movement which of course, takes time, and re-plan everything from the beginning by using slow and long information processing activities. Schmidt and Gordon (1977) estimated that even for simple actions, the duration of inhibiting a planned action requires around 40 ms. After inhibiting the already prepared movement, the correct movement must be organized and initiated. Due to the nature of the fast sport like activities or daily life activities, the re-planning, organizing and initiation of an inhibited action will usually mean failure for that particular attempt.

There are many factors that affect our capability to predict. One of them is the regularity of the events. For an effective anticipation, a great deal of knowledge about the regularities of environmental events is needed. For example, if a soccer player always shoots the ball in the same way to the goalkeeper, the goalkeeper can predict this event and use it to his advantage. Obviously, if the player could perform three or four different shots, the goalkeeper's capability of doing this would be diminished considerably. This action makes the movement unpredictable, and thus the goalkeeper is prevented from anticipating.

In the literature there are some studies showing the effects of feedback on tasks which require anticipation. Studies on anticipatory timing indicated that knowledge of results was influential in developing college-aged subjects' anticipation of a moving object (Slater-Hammel, 1960; Belisle, 1963; Ramella & Wiegand, 1983). Also, in the study of Ramella (1984), knowledge of results reduced absolute errors associated with anticipatory timing in two age groups (first and third graders). The results of the study indicated that although the third graders were more consistent in reducing timing errors than first graders, both groups increased their performances by receiving knowledge of results throughout practice. This result demonstrated that the increase in performance was no longer just a function of reaction time on the contrary both groups developed stronger motor plans with less dependence on the initiation for mechanism of response. However the results of these studies have investigated the positive effect of KR on learning a coincidence-anticipation timing task, but these results are questionable with respect to measuring learning on the basis of retention and/or transfer tests. Therefore, it can be uncertain that the effect of KR during practice trials is permanent.

In some other experiments, the evidences showed that verbal KR was not critical to skill learning beyond what were caused by the use of available visual feedback (Newell, 1976). As well, in the study of Schmidt and Wrisberg (1973) in which the task were learning simple arm movement that had a criterion movement time goal, presenting verbal KR during practice in fact caused to poorer no-KR transfer performance than when no verbal KR was available during practice.

The contribution of knowledge of results to learning motor skill requiring coincidence-anticipation timing was provided in another study that KR about timing error is not needed to improve performance (Magill, Chamberlin, & Hall, 1991). The researchers had conducted four experiments that involved learning a coincidence-anticipation timing skill requiring a striking action for one stimulus speed (experiments 1 and 2) or three randomly presented stimulus speeds (experiments 3 and 4). Two learning test situations had involved either a no-KR retention test (experiments 1 and 3) or a novel stimulus speeds transfer test (experiments 2 and 4). In experiment 1 and 2, subjects had randomly assigned to one of five experimental conditions that had based on the number of practice trials after which KR had withdrawn. KR had withdrawn after 2 (KR 2), 17 (KR 17), 32 (KR 32), or 52 (KR 52) trials or it had not withdrawn at all during the practice trials (KR ALL). The five KR withdrawal conditions in the experiment 3 and had been different from experiment 1 and 2. These experiments had involved withdrawing KR after 3 (KR 3), 21 (KR 21), 39 (KR 39), or 57 (KR 57) trials, or not at all (KR ALL). This change had been made to ensure that all three speeds had been practiced an equal amount in each KR condition while KR was available. Results of these experiments demonstrated that for learning this skill, verbal KR as information was redundant. Withdrawing KR very early or very late in practice produced no retention or transfer performance differences when compared to receiving KR throughout practice for either the single or multiple goal practice situations. In three of the experiments, KR led to a practice benefit when comparisons were made among several withdrawal conditions. But these effects were temporary and disappeared on the no-KR retention and novel transfer tests, most probably due to motivational role of the KR.

To interpret the results of all these studies, the nature of the tasks should be considered cautiously. It comes into view that there are some tasks for which the addition of KR does not supply useful information, while there are other tasks for which verbal KR adds crucial information to visually detectable information. For the tasks for which visual feedback is either not the primary source or a continuous use of visual feedback is in need in order to correct error, verbal KR alongside visual feedback is useful. At this point, the addition of KR supplies beneficial information because the use of an extended length of time and multiple feedbacks determining one's actual performance is difficult.

3.1.1. The Purpose of the Study

The purpose of this experiment is to examine the effect of reduced frequency verbal KR (researcher controlled) and self-controlled (learner controlled) conditions in contrary to a control condition (100% KR) across acquisition and retention trials on the anticipation timing task.

3.1.2. The Hypotheses

1) Participants in the control condition would exhibit smaller $|CE|$ and VE scores than the relative frequency, self-controlled, and yoked conditions during the acquisition test on the anticipation timing task.

2) Participants in the self-controlled condition would exhibit smaller |CE| and VE scores than the control condition but similar |CE| and VE scores as the relative frequency, and yoked conditions during the retention test on the anticipation timing task.

3.2. Method

3.2.1. Subjects

Twenty one male and thirty five female students of Middle East Technical University participated in this study. The age range was from 19 to 30 years, with a mean of 23.8 years old (SD=2.8). None had previous experience with the task, and all were naive as to the purpose of the experiment. Table 1 represented detailed information about participants' numbers and ages.

Table 1
Descriptive Information about the Participants of Anticipation Timing Task.

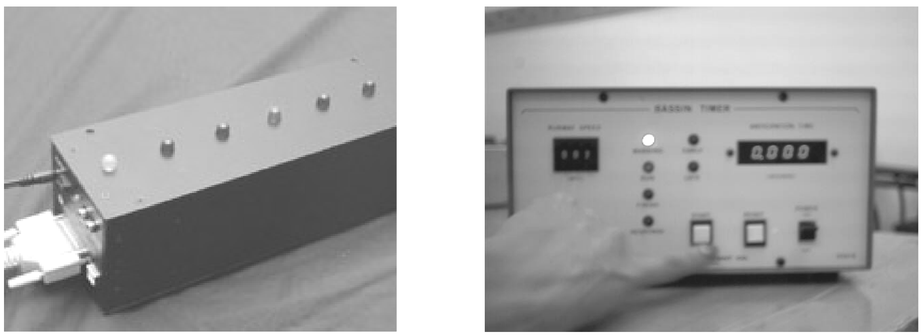
	Number of Participants		Age (years)		
Condition	Female	Male	Mean	SD	Range
Control	8	6	23.1	2.5	20-29
20% RF KR	7	7	24.6	2.4	19-29
Self-con.	8	6	24.7	3.6	19-30
Yoked	7	7	22.9	2.5	20-28

Note. Self-con=Self-controlled, RF KR= Relative Frequency Knowledge of Results

3.2.2. Apparatus and Task

A Bassin Anticipation Timer (Lafayette Instruments Co., USA) was used to measure anticipation of coincidence. The Bassin Anticipation Timer provided a task using a runway of lights (See Figure 1.a) which may be separately lit so sequential lighting of each bulb is set at a predetermined speed. The instrument was connected to a control box (See Figure 1.b) capable of (a) producing runway speeds varying from 1 to 1607 kmph (999 mph), (b) controlling delay for activation of the starting sequence from 500 to 3000 m/sec., and (c) recording the direction and magnitude of response error.

For this experiment, the task was presented as a series of 33 lights spaced 44 mm apart and lit sequentially at a speed of 3.2 kmph (2 mph). As the length of the runway was 1.45 m, the total movement time of the sequenced lighting was 1.75 sec. Each student was seated 3 m from the apparatus situated in the middle while holding a button. They were expected to anticipate the final light by simply pressing the button to correspond simultaneously with onset of the last light.



a b

Figure 1: Bassin Anticipation Timer a) Runway of Lights b) Control Box

3.2.3. Procedure and Design

Subjects were shown the Bassin Anticipation Timer as they entered the testing area. The apparatus and the subject's expected response and task goals were demonstrated prior to the test, and two practice trials were administered. The ready light signal on the runway was used as a warning cue. Then, initiation of the runway-light sequence followed.

Following subjects' timing responses, verbal knowledge of results indicating the direction and the magnitude of errors was given to the subjects within a practice test consisting of 40 trials. Two days after the practice test, the participants were administered another 20 no-KR trials in retention test.

3.2.4. Treatment Conditions

There were four treatment conditions where participants were randomly assigned to. In the first condition, subjects received knowledge of result after every trial (100% KR) throughout the practice test, while the subjects in the second condition, received only at eight times the verbal knowledge of result (20% RF KR). In the third condition, participants were informed that they have a chance to control when to ask for feedback, that is, they would not receive feedback unless they requested it. They were also instructed to request feedback only when they thought they needed it. They had to request feedback 8 times within 40 trials, that is, they received 20 % knowledge of result as the second condition with an exception where the former were in control of the feedback intervals. In order for participants to see how many times they may request feedback, numbered cards were presented to them. Participants of the last condition, the yoked group, were matched in sequence to a participant in the self-controlled condition and received the feedback at the same interval that the self-controlled condition asked for it. The main difference between these conditions were that although they were given the same amount of verbal KR, the self-controlled condition group were free to ask whenever they needed feedback but the yoked group was just a matched twin. On retention test, participants of all conditions did not receive any knowledge of result and were expected to learn using the inherent feedback of the task.

Verbal knowledge of results was given to participants according to the following classification: if timing error was 0 (zero), the participant was told that it was 0 (no error). If timing error was bigger than 0, the participant was told that s/he was "late" and the exact magnitude of error was given. And if timing error was smaller than 0, the participant was told that s/he was "early" and the exact magnitude of error was given.

Experiments involving motor behavior mostly use performance errors, as measured by the difference between a performance score and a target score, as a dependent variables (Schutz & Roy, 1973). The issues as to which error measures to use in these experiments were discussed in the early literature (Schutz & Roy, 1973; Spray, 1986; Roy, 1976). Consistent with the results of these studies and facilitating a clearer understanding, two measures of error, absolute constant error ($|$CE$|$) and variable error (VE) were used to analyze the subject's performances in this study. CE measures the amount of bias without respect to its direction and represents the average magnitude of responses. In other terms, it is a measure of the direction of the errors on average. For a single subject, $|$CE$|$ is just the absolute value of the constant error (CE). Therefore, for the group $|$CE$|$ is computed to overcome the misleading conclusion (Schmidt & Wrisberg, 2000).

It is also beneficial to compute the variable error (VE) because it measures the inconsistency in movement outcome. Important characteristic is the difference between the subject's score on each trial and his or her own average score. Thus, if one subject always moves very consistently, the VE will tend to be small. In fact, VE is the standard deviation of a set of scores about the subject's own average score.

3.2.5. Statistical Design

A schematic representation of the statistical design is given in Table 2. A significance level of $p < .05$ was set for all statistical tests.

Table 2
Statistical Design for Experiment 1

GROUPS	n	1st Acq	2nd Acq	3rd Acq	4th Acq	1st R	2nd R
Control	S1 - S14						
20% RF KR	S1 - S14						
Self-Controlled	S1 - S14						
Yoked	S1 - S14						

Note. Each block represents average mean of 10 trials. Acq = acquisition; R = retention, RF KR= Relative Frequency Knowledge of Results.

To test the hypothesis and to calculate the group differences, the acquisition data were analyzed by 4 x 4 (Group x Block) analyses of variance (ANOVA) with repeated measures on the trial block factor and the retention data were treated by separate 4 x 2 (Group x Block) ANOVA with repeated measures on the last factor. Tukey's honestly significant difference (HSD) procedure was adopted for all follow-up comparisons, when appropriate.

3.3. Results

Subjects' performance during the experiment was analyzed in blocks of 10 trials. The dependent variables for each subject and condition were absolute constant error (|CE|) and variable error (VE). |CE| and VE mean scores and standard deviations of the four conditions of trial blocks during acquisition and retention were presented in Table 3 and Table 4.

Table 3
|CE| During Acquisition and Retention of Anticipation Timing for four Experimental Conditions

		Blocks					
Groups (n=14)		1stAcq.	2ndAcq.	3rdAcq.	4thAcq.	1stRet.	2ndRet.
Control	M	47.53	40.45	38.60	39.95	46.27	41.21
	SD	7.72	13.76	9.94	11.54	11.68	14.30
20% RF KR	M	49.34	48.82	45.67	47.69	39.91	38.21
	SD	24.62	24.29	22.38	18.92	9.52	13.51
Self-controlled	M	57.49	53.01	48.36	50.61	30.81	28.09
	SD	27.82	27.64	16.47	25.67	10.18	8.08
Yoked	M	50.02	49.48	42.76	44.91	39.61	35.92
	SD	19.07	20.43	16.41	26.25	10.49	15.97

Note. Acq = Acquisition; Ret = Retention.

Table 4
VE During Acquisition and Retention of Anticipation Timing for four Experimental Conditions

		Blocks					
Groups (n=14)		1st Acq.	2nd Acq.	3rd Acq.	4th Acq.	1st Ret.	2nd Ret.
Control	M	51.14	40.07	38.53	41.43	44.64	38.94
	SD	13.67	15.91	10.54	12.31	12.30	11.46
20% RF KR	M	45.94	48.61	41.19	47.26	40.26	32.04
	SD	14.58	17.86	13.61	16.00	10.78	11.72
Self-controlled	M	52.02	53.06	46.76	46.39	29.35	28.22
	SD	16.09	34.28	16.38	17.86	10.13	10.17
Yoked	M	45.31	44.94	39.65	39.14	39.36	34.21
	SD	16.88	18.13	9.44	17.45	8.34	9.03

Note. Acq = Acquisition; Ret = Retention.

3.3.1. Acquisition Phase

3.3.1.1. Absolute Constant Error

A 4 x 4 (Group x Block) ANOVA with repeated measures on the second factor was completed on $|CE|$ mean scores. The results revealed significant main effect only for blocks, F (3,156) = 3.43, p< .05. Tukey's HSD follow-up procedure indicated that accuracy performance for the first block (M=51.10; SD=21.00) was worse than the third block (M=43.85; SD=16.82) and the fourth block (M=45.79; SD=21.22). The main effect for groups and groups by blocks interaction failed statistical significance F (3,52) = .90, p= .45 and F (9,156) = .23, p= .99, respectively. The $|CE|$ scores for each group over 4 blocks of ten trials are shown in Figure 2. The results of repeated measure ANOVA were presented in Table 5.

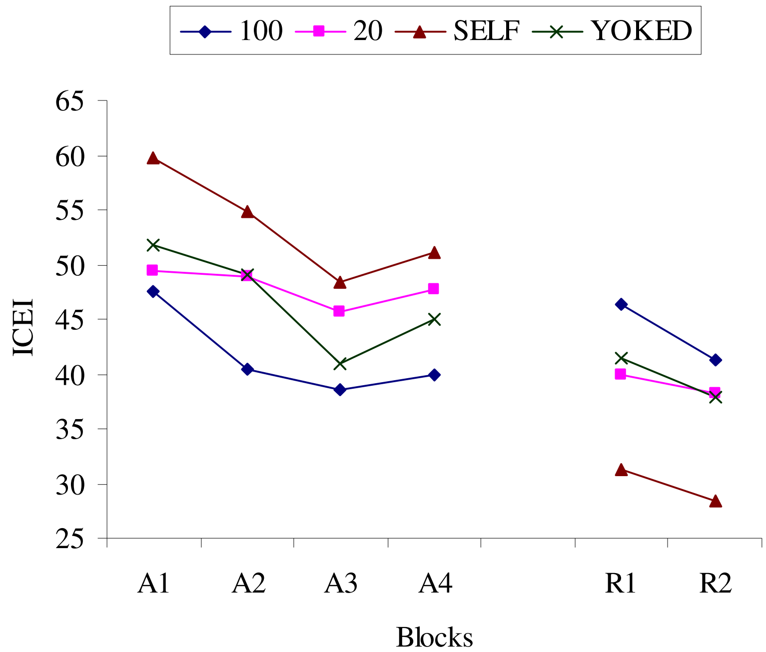


Figure 2: Absolute Constant Error for acquisition and retention phases.

Table 5
Acquisition │CE│ Repeated Measures ANOVA for Experiment I

Source of Variation	*SS*	*df*	*MS*	*F*	*Sig of F*
		Between Subjects			
Groups	3267.58	3	1089.19	.90	.449
Error Between	63127.29	52	1213.97		
		Within Subjects			
Blocks	1620.02	3	540.01	3.43	.019*
Blocks by Groups	330.61	9	36.73	.23	.989
Error Within	24540.72	156	157.31		

* Denotes significant difference at the 0.05 level of significance.
Dependent Variable: Error Score

3.3.1.2. Variable Error

The analyses of VE revealed similar results to that of │CE│. VE results showed a reliable main effect for block, F (3,156) = 2.93, p< .05. Tukey's HSD revealed that performance variability had a slight reduction from first block (M=48.60; SD=15.24) to third block (M=41.53; SD=12.83) and fourth block (M=43.55; SD=15.98). Figure 3 shows the VE for blocks of ten trials. The main effect for groups and the groups by blocks interaction failed statistical significance, *F* (3,52) = 1.04, p= .38 and *F* (9,156) = .64, p= .76, respectively. The results of repeated measure ANOVA were presented in Table 6.

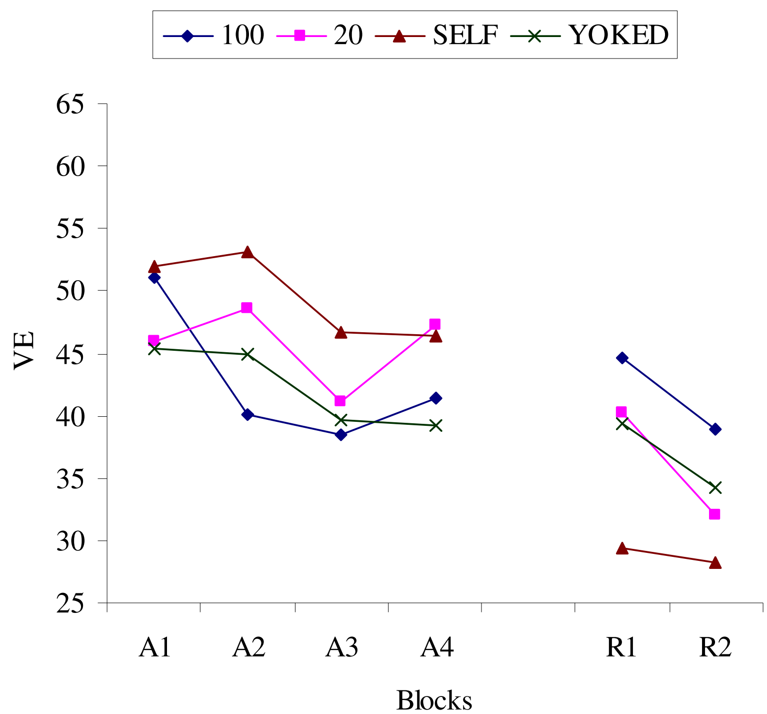


Figure 3: Variable Error for acquisition and retention phases.

Table 6:
Acquisition VE Repeated Measures ANOVA for Experiment I

Source of Variation	*SS*	*df*	*MS*	*F*	*Sig of F*
		Between Subjects			
Groups	1888.16	3	629.39	1.04	.382
Error Between	31422.86	52	604.29		
		Within Subjects			
Blocks	1671.83	3	557.28	2.93	.036*
Blocks by Groups	1094.91	9	121.66	.64	.763
Error Within	29721.68	156	190.52		

* Denotes significant difference at the 0.05 level of significance.
Dependent Variable: Error Score

3.3.2. Retention Phase

3.3.2.1. Absolute Constant Error

A 4 x 2 (Group x Block) ANOVA with repeated measures revealed significant main effect only for groups F (3, 52) = 4.89, p< .05. Tukey's HSD follow-up procedure revealed that Control group had significantly higher │CE│ score than Self-controlled group and there were no significant difference among other groups. The │CE│ scores for the four groups across the two 10-trial blocks in the retention phase are shown in Figure 2. The main effect for blocks and the groups by blocks interaction failed statistical significance, F (1,52) = 3.60, p= .06 and F (3,52) = .17, p= .92, respectively. The results of repeated measure ANOVA were presented in Table 7.

Table 7
Retention |CE| Repeated Measures ANOVA for Experiment I

Source of Variation	*SS*	*df*	*MS*	*F*	*Sig of F*
		Between Subjects			
Groups	2975.88	3	991.96	4.89	.005*
Error Between	10551.09	52	202.91		
		Within Subjects			
Blocks	302.61	1	302.61	3.60	.063
Blocks by Groups	43.13	3	14.38	.17	.916
Error Within	4372.42	52	84.09		

* Denotes significant difference at the 0.05 level of significance.
Dependent Variable: Error Score

3.3.2.2. Variable Error

A 4 x 2 (Group x Block) ANOVA with repeated measures revealed significant main effects both groups and blocks, *F* (3,52) = 4.94, p<.05 and *F* (1,52) = 11.78, p= .05, respectively. Tukey's HSD follow-up procedure revealed that Control group had significantly higher VE score than Self-controlled group and there were no significant difference among other groups. Tukey's HSD follow-up also indicated that performance variability for had a slight reduction from first block (M=38.40; SD=11.65) to second block (M=33.35; SD=11.07). This result showed an improvement in the performance by groups as they progressed through the retention trials. The main effect for the groups by blocks interaction failed statistical significance, *F* (3,52) = 1.00, p= .40. The results of repeated measure ANOVA were presented in Table 8.

Table 8
Retention VE Repeated Measures ANOVA for Experiment I

Source of Variation	*SS*	*df*	*MS*	*F*	*Sig of F*
	Between Subjects				
Groups	2411.97	3	803.99	4.94	.004*
Error Between	8460.83	52	162.71		
	Within Subjects				
Blocks	714.58	1	714.58	11.78	001*
Blocks by Groups	181.34	3	60.45	1.00	.402
Error Within	3155.02	52	60.67		

* Denotes significant difference at the 0.05 level of significance.
Dependent Variable: Error Score

3.4. Discussion

This study examined the effect of using a self-controlled feedback schedule on the retention of an anticipation timing task in comparison to 20 % RF KR, yoked, and control conditions. The first hypothesis of the experiment was that participants in the control condition would exhibit smaller error scores than the relative frequency, self-controlled, and yoked conditions during the acquisition test. The results of the study failed to support the first hypothesis that there was no statistically significance difference between the groups in the acquisition test.

Contradictory to the results of this study that indicated no group differences in acquisition test, many studies investigating the use of frequent feedback on acquisition test demonstrated improved performances in spite of the fact that this improvement is considered as transitory (Winstein & Schmidt, 1990; Wulf et al., 1994). It is not surprising that if KR is given 100% of the time, performance is more effective than if KR is provided on some lesser percentage of the trials (Bilodeau et al., 1959; Newell, 1974). Thus, it is quite clear that increasing the relative frequency increases performance in acquisition. This finding was generally explained by the informational, motivational and reinforcing properties of extrinsic feedback. Related literature emphasized that every feedback provides the learner for the nature and direction of their errors, energizes them and so increases their motivation, and also reinforces them for correct performances (Salmoni et al., 1984; Magill, 2001b). In this study, participants in the control condition received knowledge of results after every trial, and therefore they had more chance to correct their errors and increase their performances. Although the results did not reveal a difference between the groups, it was observed that the mean score of 40 trials of control condition was smaller than the other groups and during the 40 trials the error scores of control condition seemed to decrease.

Block differences were only observed for |CE| and VE across acquisition trials. Follow-up test indicated that there was a difference between the first and last blocks. During the 40 trials participants improved their anticipation on timing by using both intrinsic and extrinsic source of information. It is known that when the amount of time practicing a skill increases, individuals will be more close to an accomplished performer. All other things being equal clearly, more learning will occur if there are more practice trials. In the study of Kottke, Halpern, Eastron, Ozel & Burrill (1978), it was estimated that during their respective 15-yr professional sport careers, a typical quarterback in American football throws 1.4 million passes and a typical basketball player attempts a million shot. With the support of this result, the differences between the first and last blocks occur as the natural cause of practice.

Even if there was a significant block differences across acquisition trials, the cause that the error scores of the control condition was not significantly smaller than other groups could be accounted by floor effect which is defined as a limitation, imposed either by the scoring system or by physiological-psychological limits, that places a minimum on the score that a performer can achieve in a task (Schmidt & Lee, 1999). This effect causes a problem that leads to erroneous conclusions about learning processes from group performance curves. In this study, the task was a very simple one and that participants were just expected to anticipate the final light by simply pressing a button to correspond simultaneously with onset of the last light. For this reason, across the 40 trials almost all participants demonstrated high improvements and this might have created error scores that were very close to each other. Thus, as participants approached these floors (the limitation in score at the bottom of the scale), the changes in the performance levels of the people doing the task became increasingly insensitive to the changes in habit that might be occurring in the people as they practice (Schmidt & Lee, 1999). In fact, this effect was observed in the last two blocks of acquisition test. The error scores of the participants seemed to show little improvement in these blocks. For this reason, control condition might not show a significant different error scores than the other groups.

The results of the study also partially supported the second hypothesis that participants in the self-controlled condition would exhibit smaller $|CE|$ and VE scores than the control condition in the retention test. The result demonstrated that the members of self-controlled group learned to anticipate the time of the last light on the timer successfully. This proposed that members of the self-controlled group processed information more effectively than the other groups. Especially, the result that the self-controlled condition demonstrated better anticipation timing than the yoked condition in the retention test supplies specific information that the feedback requested when it is needed is more important than the feedback that is given at an arbitrary predetermined time.

The data obtained from this laboratory investigation confirm the findings of Janelle et al (1995; 1997) and Chen, Hendrick, and Lidor (2002) that feedback provided by the request of the learner will be more efficient for acquiring a motor skill and retaining it for a longer period of time than feedback which is provided to the learner passively.

In the study of Zimmerman (1989), it has been argued that the learners should be active throughout the learning process and employ strategies to improve metacognitive behavior. Even though the researchers underline the significance of self-regulation in academic achievement, their suggestion is usually accepted by practitioners and researchers in the motor area. For example, Singer (2001) demonstrated the use of self-regulation process for the execution of self-paced tasks.

The use of self-regulation may also indirectly have a useful effect on learning due to motivational influences on cognitive process. It was demonstrated that self-regulated learners are motivated to attain new skills (Wolters, 1998). In fact, Zimmerman (1989) defined self-regulated learners as highly motivated students because they more readily engage in, provide effort for, and persist longer at learning tasks than students who do not self-regulate. In this study, the participants of self-controlled condition were assumed to be responsible for getting feedback as well as learning a new motor skill. Thus, taking the responsibility for acquiring proficiency might lead to them to higher motivation.

The results of the study also revealed that unlike the acquisition test, $|CE|$ and VE scores of control condition in retention test was higher than the other groups. This result is consistent with the literature suggesting that practice in conditions with frequent KR is more beneficial for performance but more detrimental to the ultimate learning of motor skills than practice in conditions where KR is provided less frequently (Schmidt et al., 1989; Swinnen et al., 1990). Although, feedback served as an effective guide for the learner, when they received augmented feedback on every trial, this guiding effect created a negative feature for the learners. Receiving frequent feedback prevented the learners from some important information processing activities. This result replicated the results of previous studies showing the negative effect of frequent feedback to learning (Winstein & Schmidt, 1990; Wulf et al., 1994) and supported the guidance hypothesis.

Higher VE scores of control condition in retention test might also be explained by the participants' effort for making too much error detection and correction in acquisition. Participants of control condition were given feedback after every trial, so it unintentionally forces them to correct the next attempt even if the error is minimal. Trying to correct every attempt usually tends to larger error and performance variability due to the wrong references. Therefore in the retention test, this effort coupled with the dependency producing effect of frequent external feedback might influence learner's performances negatively. On the other hand, the participants of self-controlled condition are free to employ a feedback schedule that they find the most comfortable for themselves. Thus, this approach logically seems as a more beneficial learning strategy.

In conclusion, the findings of this study gave additional support in favor of a learning environment in which the learner has control over some features of the learning process.

CHAPTER IV

Experiment II

4.1. Introduction

Sport skills can be placed on a continuum having what are called "open" and "closed" categories (Singer, 2000). Open skills, which are at the high end of the continuum, usually take place under the conditions of a temporarily or spatially changing environment. Decisions and adjustments have to be made while "on the run". Open skills, sometimes called as externally-paced skills, require rapid anticipation, decision-making and reactions (Singer, 2000). Essentially, attending to the most meaningful yet minimal cues and information processing occur quickly (Singer, 2000). Examples of externally-paced skills are wrestling and boxing maneuvers, returning a serve in volleyball or tennis, and a batter hitting a baseball.

On the other hand, closed skills, sometimes called as self-paced skills, are at the low end of the continuum and take place under fixed, unchanging environmental conditions. They are predictable and have clearly defined beginning and ending points. In self-paced events, there is plenty of time to go through a routine, or ritual, before initiating the act. Sports such as golf, bowling and archery, or elements in sports, such as the serve in tennis, the foul shot in basketball or the serve in volleyball, allow time for the athlete to prepare and to execute when ready (within reasonable time limitations).

Research in educational psychology, sport psychology, and motor learning has showed that achievement in cognitive and motor tasks may be affected positively by using task relevant learning strategies (Singer, Lidor & Cauraugh, 1993). The term “learning strategy” generally refers to the behaviors and thoughts that a learner uses during purposeful learning (Singer, 1988). For self-paced activities, the 'Five-step Strategy' which are readying, imaging, focusing, executing, and evaluating (Singer 1988), seems to be particularly helpful in the learning process as well as for the production of high levels of skill. For over a decade published research under laboratory and field conditions indicates the effectiveness of the Five-step Strategy and similar strategies in contributing to achievement (Singer & Suwanthada 1986, Singer et al., 1989, Lidor et al. 1996).

Singer and Chen (1994) classified the cognitive strategies as externally imposed and self-generated on the base of source. They emphasized that there would be some problems when using the externally imposed strategies. For example, learners may forget to use, or forget how to use, an externally imposed strategy when needed. On the other hand, self-initiated strategies are generally applied more effectively after sufficient experiences with the task and situation because self-produced feedback and continual self-evaluation cause the ability to make better decisions about which strategies work best for particular circumstances.

In addition to the notion of learning strategy, there is also one important notion that an instructor or a teacher should consider intensely in learning situations. This is the notion of transfer. As Seigler (1988) suggested that the major goals of educational programs should be assisting learners to learn, learn how to learn, attain self-evaluation and self-management skills, and transfer previous knowledge to new learning situations.

The amount of influence the learning of one skill has on the learning of another skill is generally called as transfer. It can have a positive, negative or neutral impact on learning (Schmidt & Wrisberg, 2000). Positive transfer the learning of a skill facilitates the learning of another skill. For example, learning the overhand throwing pattern should positively influence the subsequent learning of more complex actions, such as the overhand serve in tennis. Unlike positive transfer, in negative transfer the learning of one skill interferes with the learning of another. If practicing a forehand stroke in badminton produces losses for a forehand stroke in tennis, this effect of the practice occurs due to negative transfer. In his example, negative transfer may be triggered by the changes in the pattern of coordination, or by the altered force, necessary to hit a forehand in badminton relative to the forehand tennis stroke. However, the research indicates that negative transfer effects are temporary and can be quickly upgraded with additional practice of the transfer skill. There is also one type of transfer too. This is neutral transfer which occurs when one learned skill has no influence on the learning of another skill.

Understanding the relationship between transfer and learning is important for the instructors for three major reasons (Schmidt &Young, 1987). First, it provides the instructors to develop a better understanding of how certain skills contribute to other skills being practiced in a particular training situation. Second, it provides them to structure an optimal learning environment with the use of various instructional strategies. Third, understanding this relationship helps instructors when designing a practice requiring simulation.

The first theoretical model of transfer was constructed by Thorndike and Woodworth (1901, as cited in Kluka, 1999)**.** The basis of their identical-elements theory was that in order for the transfer of learning between skills and/or movement contexts to occur, the elements which are fundamental for the two skills or situations must be identical. Therefore, a main assumption of this theory was that transfer of learning was not based on any general extraction of knowledge, but rather, was very specific in nature. Later, Osgood (1949) and Holding (1976) extended and modified the ideas by investigating the relationship between the stimulus prompting an action and the action itself. According to Holding, in situations where much similarity existed between the stimulus and the response of the first task learned and those of the task currently being practiced, high levels of positive transfer would occur. Conversely, as the degree of similarity between the stimuli and response associated with the two tasks declined, any transfer would grow less likely.

More recently Bransford (1979), who focused on mostly verbal skills, proposed a new view of transfer which is known as transfer-appropriate processing. This view claims that although similarity in skill and context components explains some transfer effects, it can not explain all transfer effects. According to the model, the more similar the cognitive processing characteristics of the initially learned skill to the one being learned, the more positive the transfer occurs. Lee (1988) has lately adapted the transfer-appropriate processing model to motor skills. As indicated by Lee positive transfer should occur by practicing skills that are cognitively similar, even though they are not physically similar.

In the light of all these studies, it can be said that there are two main hypotheses that explain why transfer of learning occur. One hypothesis proposes that it occurs for the reason that the components of the skills and/or the context in which skills are performed are similar. The other proposes that it occurs mainly due to similarities between the amounts and types of learning processes required. Although much remains unknown about the cause of transfer of learning, evidence indicates the value of both hypotheses. Nevertheless, the conclusion from viewing this literature is that motor transfer is not well understood at all (Schmidt & Young, 1987).

To successfully execute the wide variety of motor skills that individuals use in everyday life, they have to coordinate various muscles and joints to work together. There are some theories about how individual's control coordinated movements. Motor program theory is the one that emphasize that for many actions, specifically those that are brief in duration and produced in stable and predictable environments, individuals generally plan the movement in advance, and then trigger the action in such a way that it runs its course without much modification (Schmidt & Wrisberg, 2000).

Although the theory has some important evidences for believing that movements are controlled by motor programs, there are two important problems that limit the theory. The problems were associated with the requirement for storage of many different motor programs as well as with the means by which the motor program could create a novel action. For these reasons, Schmidt (1988) hypothesized the generalized motor program theory. He proposed that a generalized motor program controls a class of actions, rather than a specific movement or sequence. A class of actions is defined as a set of different actions having a common but unique set of features. According to Schmidt, these features, which he called invariant features, are the “signature” of a generalized motor program, and form the basis of what is stored in memory. In order to identify how the movement is expressed, these generalized motor programs require parameters. These parameters are the modifiable features of a generalized motor program, such as speed or amplitude of the movement or the muscle that is used to make the movements. Thus, many different movements can be made with the same program and novel movements can be generated through selection of parameters that have not been used previously.

On the base of generalized motor program theory, it can be said that our capability to perform a task like throwing is not depend on one particular throwing movement. More exactly, for a variety of throwing tasks, a generalized throwing program is used, but with the selection of proper parameters for the kind of object to be thrown as well as the distance and trajectory. Therefore, the effectiveness of a practice session is measured not only by how well the particular skills practiced are acquired, but also by how well other similar skills are acquired. This would include measuring performance on other similar skills in a transfer test.

The transfer experiments are a type of learning experiments which give evidences about the persistence of the acquired capability for performance. Researchers use variety of experimental designs for the transfer experiments. According to Schmidt and Lee (1999) transfer designs are critical to the study of motor learning, as they supply a way of studying several independent variables with respect to their effects on the learning of motor tasks. These designs provide for the separation of the relatively permanent effects which is due to learning and temporary effects of the independent variable.

In this experiment, different than experiment 1, the experimental design includes a transfer test. The inclusion of a transfer test in this experiment allowed us to replicate the first experiment with a more novel movement as a throwing task and to test the generalizability of self control and the knowledge of results scheduling to a somewhat novel situation. In the transfer test, the groups of subjects will practice different levels of the independent variable namely the amplitude (distance). If the acquisition condition produces effective performance on transfer test, then it would be concluded as having generalizability of the learning task.

4.1.1. The Purpose of the Study

The purpose of this experiment is to examine the effect of reduced frequency KR (researcher controlled) and self-controlled (learner controlled) conditions in contrary to a control condition (100% KR) across acquisition and retention as well as transfer trials on the ball throwing task.

4.1.2. The Hypotheses

1) Participants in the control condition would exhibit smaller $|CE|$ and VE scores than the relative frequency, self-controlled, and yoked conditions during the acquisition test on the ball throwing task.
2) Participants in the self-controlled condition would exhibit smaller $|CE|$ and VE scores than the control condition but similar $|CE|$ and VE scores as the relative frequency, and yoked conditions during the retention test on the ball throwing task.

3) Participants in the self-controlled condition would exhibit smaller $|CE|$ and VE scores than the control condition but similar $|CE|$ and VE scores as the relative frequency, and yoked conditions during the transfer test on the ball throwing task.

4.2. Method

4.2.1. Subjects

The participants were 56 students from Ülkü Akın Elementary School. They ranged in age from 13 to 14 years, with a mean of 13.04 yr. (SD=0.19). None had previous experience with the task, and all were naive as to the purpose of the experiment. In each of the four conditions, a total of 14 students (seven boys and seven girls) participated. Table 9 represented the detailed information about participants' numbers and ages.

Table 9
Descriptive Information about the Participants of Ball Throwing Task.

	Age (years)		
Condition	Mean	SD	Range
Control	13.07	0.27	13-14
20% RF	13	0	13-13
Self-con.	13	0	13-13
Yoked	13.07	0.27	13-14

Note. Self-con. denotes self-controlled condition.

4.2.2. Instruments and Task

The setting was a target area for an underhand ball throwing and consisted of an artificial turf lane measuring 200x200 cm. The target area consisted of 40 lines with an invariant width of 5 cm. The center of the target was a line in the middle, representing the ideal resting place for the thrown ball. The setting rested at a horizontal angle on a level plane of the floor (See Figure 4).

The experimental task was to throw a ball (5 cm in diameter) to the target with the non-dominant hand. As the throw action is a fundamental movement and is likely to be performed and practiced by the children many times, to make the movement a novel one, all the children were asked to use their non-dominant hand for the throw action while sitting on a chair. While on both acquisition and retention tests the chair was placed on 3 m away from the center of the target, on transfer test it was placed on 4,5 m away from the center of the target. Participants were blind folded with a piece of cloth during the whole test. Therefore, the need for the feedback from an outside source increased. The ball is covered with a Velcro so that the ball sticks to fallen place on the target and scorers will enable to get the exact score of the throw. The scores were later used for calculating throwing error to assess the accuracy and consistency of the throws.

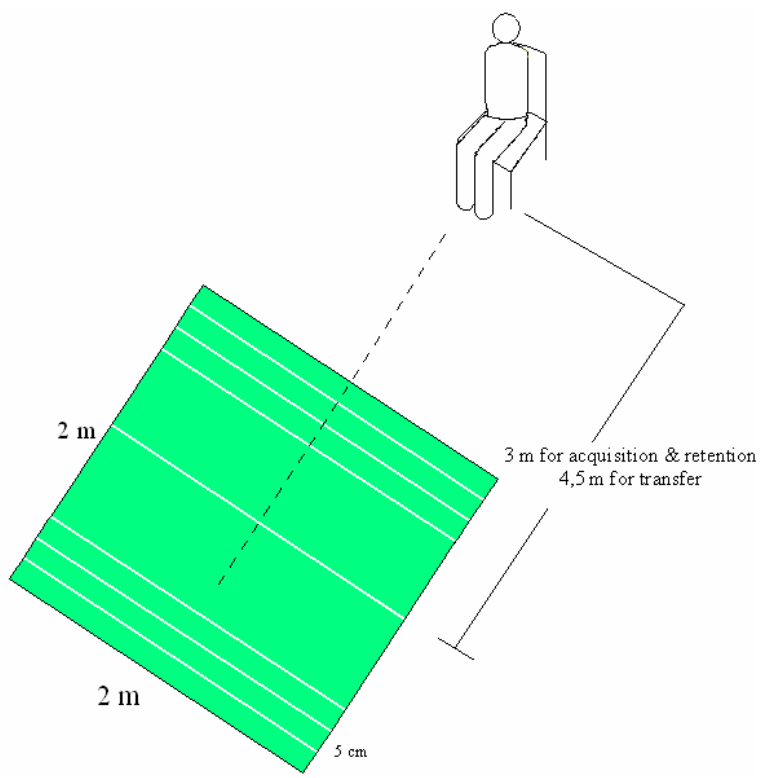


Figure 4: Diagram for the Ball Throwing Task

4.2.3. Procedure and Design

Upon arriving at the laboratory, participants were provided with general instructions for the ball throw. Prior to data collection, two practice trials were administered.

Following subjects' ball throw, verbal knowledge of results indicating the direction and the magnitude of errors was given to the subjects within a practice test consisting of 40 trials. Two days after the practice test, the subjects were administered another 20 no-KR trials in retention test. One day after retention test, this time the subjects were administered 20 no-KR trials in transfer test.

4.2.4. Treatment Conditions

There were four treatment conditions where participants were randomly assigned to. In the first condition, subjects received knowledge of result after every trial (100% Control) throughout the practice test, while the subjects in the second condition, received only at eight times the verbal knowledge of result (20% RF KR). In the third condition, participants were informed that they have a chance to control when to ask for feedback, that is, they would not receive feedback unless they requested it. They were also instructed to request feedback only when they thought they needed it. They had to request feedback 8 times within 40 trials, that is, they received 20 % knowledge of result as the second condition with an exception where the former were in control of the feedback intervals. In order for participants to understand how many times more they might request feedback, the experimenter stated the number of feedback received verbally after each request. Participants of the last condition, the yoked group, were matched in sequence to a participant in the self-controlled condition and received the feedback at the same interval that the self-controlled condition asked for it. The main difference between these conditions were that although they were given the same amount of verbal KR, the self-controlled condition group were free to ask whenever they needed feedback but the yoked group was just a matched twin. On retention and transfer test participants did not receive any knowledge of result and were expected to learn using the inherent feedback of the task.

Verbal knowledge of results was given to subjects according to the direction and magnitude of the error. The direction and magnitude of the error were determined according to the center of the target. While the direction could be either "near" or "far", the magnitude could be 21 different scores. If the ball is on the center line, the magnitude of error will be zero. But, if the ball sticks to a place between the first and second line close to you, the magnitude of error is "near 5" but if it is away from the target line, the magnitude of error is "far 5". And these scores will increase up to 100 in both directions, progressing outward from the center.

In the study, two measures of error, absolute constant error (|CE|) and variable error (VE) were used to analyze the subject's performances.

4.2.5. Statistical Design

A schematic representation of the statistical design is given in Table 10. A significance level of $p < .05$ was set for all statistical tests.

Table 10
Statistical Design for Experiment II

GROUPS	n	1st Acq	2nd Acq	3rd Acq	4th Acq	1st R	2nd R	1st Tran.	2nd Tran
Control	S1 - S15								
20%RF KR	S1 - S15								
Self-Controlled	S1 - S15								
Yoked	S1 - S15								

Note. Each block represents average mean of 10 trials. Acq = Acquisition; R = Retention; Tran = Transfer.

To test the hypothesis and to calculate the group differences, the acquisition data were analyzed by 4 (Group) x 4 (Trial Block) analyses of variance with repeated measures on the trial block factor and the retention and transfer data were treated by separate 4 (Group) x 2 (Trial Block) analyses of variance with repeated measures on the last factor. Tukey's honestly significant difference (HSD) procedure was adopted for all follow-up comparisons, when appropriate.

4.3. Results

Subjects' performance during the experiment was analyzed in blocks of 10 trials. The dependent variables for each subject and condition were absolute constant error (│CE│) and variable error (VE).

The acquisition data were analyzed by 4 x 4 (Group x Block) ANOVA with repeated measures on the last factor on both dependent measures. The retention and transfer data were treated by 4 x 2 (Group x Block) ANOVA with repeated measures on the last factor on both dependent measures. Tukey's honestly significant difference (HSD) procedure was adopted for all follow-up comparisons, when appropriate. │CE│ and VE mean scores and standard deviations of the four conditions of trial blocks during acquisition, retention and transfer were presented in Table 11 and Table 12.

Table 11
│CE│ During Acquisition, Retention, and Transfer of Ball Throwing for four Experimental Conditions

Groups (n=14)		Blocks							
		1st Acq	2nd Acq	3rd Acq	4th Acq	1st Ret	2nd Ret	1st Tr.	2nd Tr.
Control	M	36.64	35.39	27.75	30.54	38.18	37.36	47.21	50.46
	SD	3.43	2.52	2.96	4.24	4.11	4.22	4.93	5.60
20% RF KR	M	34.04	36.29	37.32	31.18	39.90	43.93	44.50	49.64
	SD	2.97	3.75	3.72	2.56	2.66	3.84	3.09	3.05
Self-controlled	M	40.64	36.29	32.54	30.57	38.32	32.14	45.61	43.93
	SD	2.84	2.89	2.02	2.72	2.67	2.52	4.55	3.66
Yoked	M	35.54	30.71	26.32	29.57	37.86	37.86	42.54	41.18
	SD	4.47	3.22	2.00	3.50	4.34	4.69	3.24	5.11

Note. Acq. = Acquisition, Ret. = Retention, Tr .= transfer

Table 12
VE During Acquisition, Retention, and Transfer of Ball Throwing for four Experimental Conditions

Groups (n=14)		Blocks							
		1st Acq	2nd Acq	3rd Acq	4th Acq	1st Ret	2nd Ret	1st Tr.	2nd Tr.
Control	M	36.01	36.68	32.82	34.96	31.93	32.41	37.53	32.86
	SD	2.76	2.01	3.46	4.24	2.51	2.80	3.87	2.58
20% RF KR	M	36.42	34.91	35.27	28.34	35.42	32.77	39.40	42.06
	SD	2.84	2.56	3.55	2.32	3.05	3.65	2.67	3.50
Self-controlled	M	39.36	38.60	32.43	31.42	35.11	28.93	36.65	32.40
	SD	3.21	3.36	2.35	3.06	1.76	2.22	4.70	3.38
Yoked	M	32.24	29.62	28.66	29.34	29.61	28.66	33.16	27.65
	SD	3.39	2.35	1.96	2.04	3.24	3.92	2.72	2.42

Note. Acq. = Acquisition, Ret. = Retention, Tr .= transfer

4.3.1. Acquisition Phase

4.3.1.1. Absolute Constant Error

A 4 x 4 (Group x Block) ANOVA with repeated measures on the second factor revealed significant main effect only for blocks, F (3,156) = 5.16, p< .05. Tukey's HSD follow-up procedure indicated that accuracy performance for the first block (M=37; SD=12.92) was worse than the third block (M=31; SD=10.98) and the fourth block (M=30; SD=12.11), and for the second block (M=35; SD=11.62) was worse than the third and fourth blocks. The main effect for groups and groups by blocks interaction failed statistical significance F (3,52) = .88, p= .46 and F (9,156) = 1.11, p= .36, respectively. The │CE│ scores for each group over 4 blocks of ten trials are shown in Figure 5. The results of two-way ANOVA with repeated measures analyses were presented in Table 13.

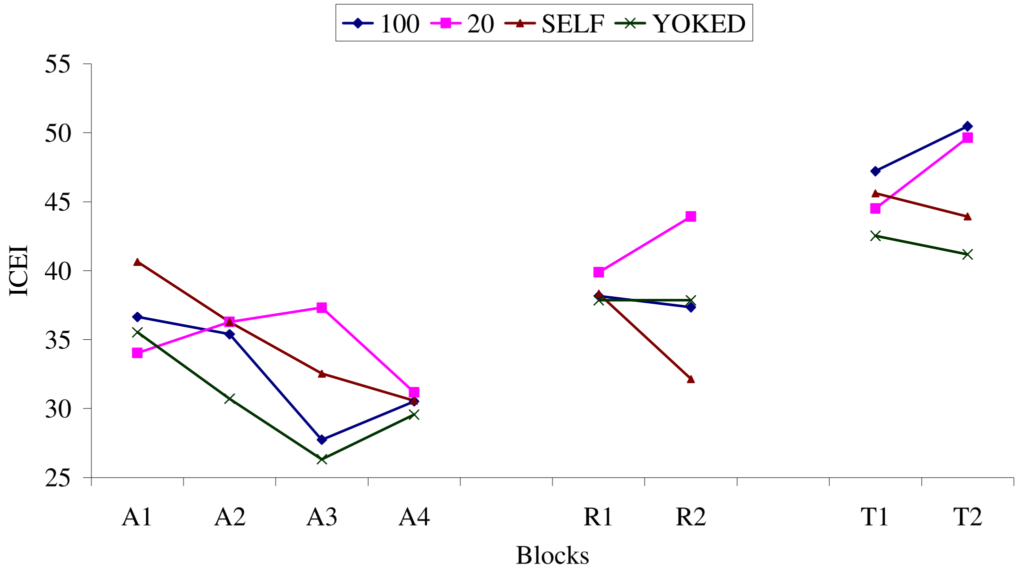


Figure 5: Absolute Constant Error for acquisition, retention and transfer phases.

Table 13
Acquisition │CE│ Repeated Measures ANOVA for Experiment II

Source of Variation	*SS*	*df*	*MS*	*F*	*Sig of F*
		Between Subjects			
Groups	729.15	3	243.05	.88	.459
Error Between	14415.26	52	277.22		
		Within Subjects			
Blocks	1507.12	3	502.37	5.16	.002*
Blocks by Groups	971.67	9	107.96	1.11	.359
Error Within	15181.90	156	97.32		

* Denotes significant difference at the 0.05 level of significance.
Dependent Variable: Error Score

4.3.1.2. Variable Error

The analyses of VE revealed similar results to that of │CE│. VE results showed a reliable main effect for block, F (3,156) = 3.09, p< .05. Tukey's HSD revealed that performance variability had a slight reduction from first block (M=36; SD=11.43) to third block (M=32; SD=10.87) and fourth block (M=31; SD=11.34).

Figure 6 shows the VE for blocks of ten trials. The main effect for groups and the groups by blocks interaction failed statistical significance, F (3,52) = 1.91, p= .14 and F (9,156) = .69, p= .72, respectively. The results of two-way ANOVA with repeated measures analyses were presented in Table 14.

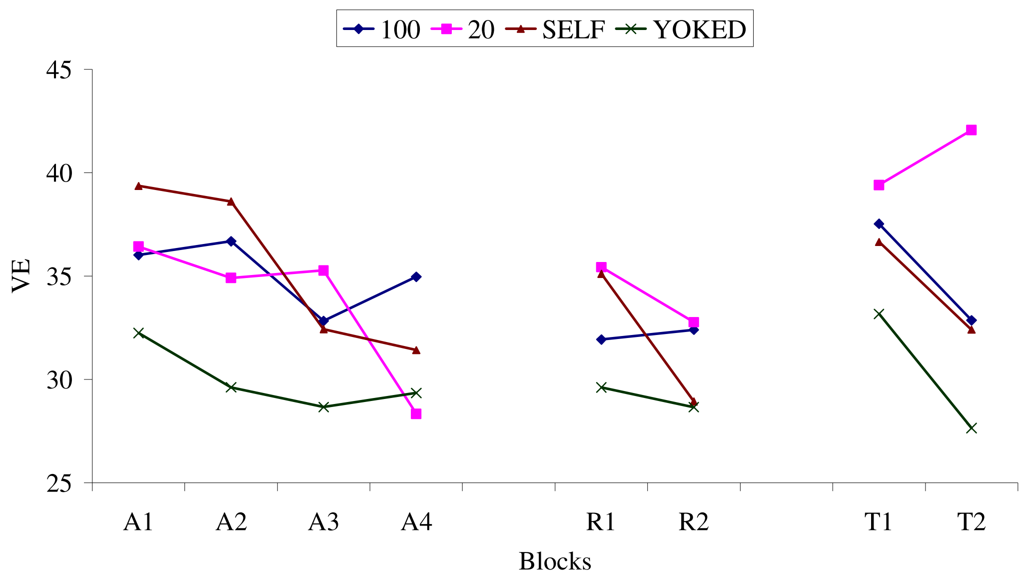


Figure 6: Variable Error for acquisition, retention and transfer phases.

Table 14
Acquisition VE Repeated Measures ANOVA for Experiment II

Source of Variation	*SS*	*df*	*MS*	*F*	*Sig of F*
		Between Subjects			
Groups	1061.03	3	353.68	1.91	.139
Error Between	9625.08	52	185.10		
		Within Subjects			
Blocks	895.80	3	298.60	3.09	.029*
Blocks by Groups	596.04	9	66.23	.69	.722
Error Within	15078.98	156	96.66		

* Denotes significant difference at the 0.05 level of significance.
Dependent Variable: Error Score

4.3.2. Retention Phase

4.3.2.1. Absolute Constant Error

A 4 x 2 (Group x Block) ANOVA with repeated measures revealed that the main effect for groups, blocks and the groups by blocks interaction failed statistical significance, F (3,52) = .66, p= .58, F (1,52) = .24, p= .63 and F (3,52) = 1.91, p= .14, respectively. The │CE│ scores for the four groups across the two 10-trial blocks in the retention phase are shown in Figure 5. The results of two-way ANOVA with repeated measures analyses were presented in Table 15.

Table 15
Retention │CE│ Repeated Measures ANOVA for Experiment II

Source of Variation	*SS*	*df*	*MS*	*F*	*Sig of F*
		Between Subjects			
Groups	640.69	3	213.56	.66	.580
Error Between	16789.56	52	322.88		
		Within Subjects			
Blocks	15.38	1	15.38	.24	.628
Blocks by Groups	370.58	3	123.53	1.91	.139
Error Within	3358.42	52	64.59		

Dependent Variable: Error Score

4.3.2.2. Variable Error

A 4 x 2 (Group x Block) ANOVA with repeated measures revealed that the main effect for groups, blocks and the groups by blocks interaction failed statistical significance, F (3,52) = .71, p= .55, F (1,52) = 1.82, p= .18 and F (3,52) = .69, p= .56, respectively. The VE scores for the four groups across the two 10-trial blocks in the retention phase are shown in Figure 6. The results of two-way ANOVA with repeated measures analyses were presented in Table 16.

Table 16
Retention VE Repeated Measures ANOVA for Experiment II

Source of Variation	*SS*	*df*	*MS*	*F*	*Sig of F*
		Between Subjects			
Groups	351.36	3	117.12	.71	.548
Error Between	8532.27	52	164.08		
		Within Subjects			
Blocks	151.57	1	151.57	1.82	.184
Blocks by Groups	173.07	3	57.69	.69	.561
Error Within	4338.35	52	83.43		

Dependent Variable: Error Score

4.3.3. Transfer Phase

4.3.3.1. Absolute Constant Error

A 4 x 2 (Group x Block) ANOVA with repeated measures revealed that the main effect for groups, blocks and the groups by blocks interaction failed statistical significance, F (3,52) = .63, p= .60, F (1,52) = .49, p= .49 and F (3,52) = .79, p= .51, respectively. The $|CE|$ scores for the four groups across the two 10-trial blocks in the transfer phase are shown in Figure 5. The results of two-way ANOVA with repeated measures analyses were presented in Table 17.

Table 17
Transfer |CE| Repeated Measures ANOVA for Experiment II

Source of Variation	*SS*	*df*	*MS*	*F*	*Sig of F*
		Between Subjects			
Groups	765.94	3	255.31	.63	.599
Error Between	21089.05	52	405.56		
		Within Subjects			
Blocks	50.22	1	50.22	.49	.487
Blocks by Groups	241.47	3	80.49	.79	.507
Error Within	5325.80	52	102.42		

Dependent Variable: Error Score

4.3.3.2. Variable Error

A 4 x 2 (Group x Block) ANOVA with repeated measures revealed significant main effect only for groups *F* (3, 52) = 2.97, p< .05. The follow up Tukey's test revealed that 20% RF KR group had significantly higher VE score than Yoked group and there were no significant difference among other groups. The main effect for blocks and the groups by blocks interaction failed statistical significance, *F* (1,52) = 1.76, p= .19 and *F* (3,52) = .72, p= .54, respectively. The VE scores for the four groups across the two 10-trial blocks in the transfer phase are shown in Figure 6. The results of two-way ANOVA with repeated measures analyses were presented in Table 18.

Table 18
Transfer VE Repeated Measures ANOVA for Experiment II

Source of Variation	*SS*	*df*	*MS*	*F*	*Sig of F*
		Between Subjects			
Groups	1514.52	3	504.84	2.97	.040*
Error Between	8826.87	52	169.75		
		Within Subjects			
Blocks	242.29	1	242.29	1.76	.190
Blocks by Groups	298.73	3	99.58	.72	.543
Error Within	7156.54	52	137.63		

* Denotes significant difference at the 0.05 level of significance.
Dependent Variable: Error Score

4.4. Discussion

This study examined the effect of using a self-controlled feedback schedule on the retention and transfer of a ball throwing task in comparison to 20 % RF KR, yoked, and control conditions. The first hypothesis of the experiment was that participants in the control condition would exhibit smaller error scores than the relative frequency, self-controlled, and yoked conditions during the acquisition test. The results of the study failed to support the first hypothesis that there was no statistically significance difference between the groups in the acquisition test. The result of the first experiment is inline with this second experiment. As the related literature and the reasons of these findings were discussed in detail in chapter 3, no further discussion was provided in this section of the discussion.

The results of the study also failed to support the second hypothesis that there was no statistically significance difference between the groups in the retention test. This result was contradictory to literature illustrating the negative effect of frequent feedback to learning and supporting the guidance hypothesis. As mentioned, the guidance hypothesis suggests that increased frequency of feedback helps to guide the participant to the correct movement during the acquisition period but may lead to a dependence on feedback (Salmoni et al., 1984; Wulf & Schmidt, 1989). This dependency results in a decline of performance during retention trials owing to lack of processing other important sources of information (i.e. proprioceptive sources) (Salmoni et al., 1984). The results demonstrated that the mean score of 40 trials of control condition was smaller than the 20% RF KR condition in the retention test.

In the study, the most surprising finding was that there were no group differences in the retention test contradictory to the hypothesized expectation. It was expected that due to the effect of self regulation, participants in the self-controlled condition would exhibit smaller error scores than the control condition. This result is inconsistent with the literature emphasizing the significance of self-regulation and experiment one.

The third hypothesis of the study was that participants in the self-controlled condition would exhibit smaller error scores than the control condition but similar error scores as the relative frequency, and yoked conditions during the transfer test. The results demonstrated a group difference in transfer test. However this finding is very extraordinary that there was a difference between 20% RF KR and Yoked groups. The results revealed that 20% RF KR group were inconsistent throughout the transfer test compared to Yoked group.

In the light of these surprising findings, it appears that participants of self-controlled condition were unable to use self-regulation as a strategy for some reasons. It is indicated that for self-regulation, some form of planning and decision making is required. Kirschenbaum and Witrock (1984) identified five stages for an effective self-regulation. These stages are (a) problem identification (isolating performance variables that may be optimized), (b) commitment (self-motivation, in particular, formulating an effective plan and not focusing on aversive aspects of the situation), (c) execution (making changes based on self-monitoring and evaluation of performance as well as on positive and negative self-consequation concerning its results), (d) environment (arranging one's social and physical environment to encourage goal achievement), and (e) generalization to other situations. To be a self regulated learners, individuals have to set personal goals, perform strategically, monitor their progress, and adapt their approach to better accomplish their goals.

Consequently, it can be said that the use of self-regulation as a strategy is an effortful process and the degree to which learners are motivated to self-regulate depends in part on their commitment to their personal goals (Zimmerman, 1989).

The shortcomings of this experiment might have been related with the following factors; (a) the commitment and motivation of the participants, (b) the age of the participants (compared to the first experiment), and (c) the use of non-dominant hand for the throwing task.

The results of the study also revealed that almost all participants seemed to throw the ball less accurately and less consistently during the 20 trials of the transfer test. In this experiment, transfer test added to test the generalizability of self control and the knowledge of results scheduling to a somewhat novel situation. In the test one parameter (amplitude) of the movement was modified (the target was settled 4,5m away from the participant) and the participants supposed to use same motor program. By increasing the movement amplitude, the complexity of the movement increased too. This relation had a support in literature that Fitts (1954) described it as "Fitts' Law". According to this law, as the distance becomes longer the index difficulty (a quantitative measure of the difficulty of performing a skill involving both speed and accuracy requirements) of the movement increases. Therefore, in the transfer test the participant's accuracy and consistency decreased.

In conclusion, the result of the study demonstrated that the participants' performance progressed during training. It was also expected that the different feedback schedules have an imperative effect on learning; however, the findings of this experiment compared to first one did not reveal this learning effect. It appears that the reasons for this failure might be related with the psychological condition, the demographic and psycho-motor features of the participants.

CHAPTER V

CONCLUSION

It was known that actively involving learners in the skill acquisition process and giving them control over aspects of information feedback will significantly enhance their retention of crucial information (Zimmerman, 1989; Hardy &Nelson, 1988). That is to say, the more a learner engages in self-regulatory processes, the greater amount of learning or long-term retention will occur.

Although the first experiment support the assumption that feedback delivered at the request of the learner will be more effective for acquiring a motor skill and retaining it for a longer period of time than feedback delivered to the learner passively, the second experiment did not support it. The failure of the second experiment might be explained by the ineffectiveness of participants for using self-generated strategies. Derry and Murphy (1986) stated that the effectiveness of self-generated strategies depends on the experiences, abilities, and initiatives of the person. Additionally, ineffective learners do not produce necessary self-monitoring strategies (Garner, 1990). What is more, Singer and Chen (1994) proposed that if learners do not know how to determine how well they are progressing, they will not see any need to make use of potentially effective strategies. In this experiment, although the use of self-generated strategies is important for mastering the learning task, the participants most probably avoided using them.

Watkins (1984, as cited in Janelle et al., 1997) has suggested that deeper information processing may occur in the self-controlled learning environment because it leads to a more active involvement of the learner in the learning process. As the central aim of education is to make people active and critical thinkers, promoting active learning is very important in all learning environments. Our highest endeavor in education process must be to develop individuals who are independent and able to search for information and use it for the enhancement of their progress.

The first experiment has shown that the use of self-regulation positively influence learning. The second experiment aimed to apply this result in a more actual learning context with a fundamental movement task; unfortunately it did not reveal same results. If the use of self-regulation is an effective tool for learning, it is recommended that new experiments in the motor area should be designed to elaborate these contradictory results.

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APPENDICES

APPENDIX A

INSTRUCTIONS TO PARTICIPANTS IN EXPERIMENT I

Instructions to Participants during Acquisition Test

Instructions for all Groups

As a participant you are asked to press the button while anticipating the onset of the last light that travels 2mph. from a distance of 1.5 meter. Prior to test, you will have an opportunity to make two practice trials. The ready light signal on the runway will be used as a warning cue. You will be given to 40 trials for the acquisition test.

Following your timing responses, verbal feedback indicating the direction and the magnitude of errors will be given after each or specific trials depending on your group. If your timing error is 0 (zero), you will be told that it is 0 (no error). If your timing error is bigger than 0, you will be told that you are “late” and the exact magnitude of error will be given. And if your timing error is smaller than 0, you will be told that you are “early” and the exact magnitude of error will be given.

The following sentence(s) are specific to the groups.

Control Group: You will receive verbal feedback after every trial and by using this information you are expected to minimize the errors.

20% RF Group: You will receive verbal feedback after every five trials. It means that you will receive feedback 8 times within the total of 40 trials. By using this information you are expected to minimize the errors.

Self-Controlled Group: You will have a chance to control when to ask for feedback, that is, you will not receive feedback unless you will request it. You will try to request feedback only when you think you need it. You can only request feedback 8 times within 40 trials. You will be shown a numbered card in order for you to see how many more times you may request feedback. By using this information you are expected to minimize the errors.

Yoked Group: You will receive verbal feedback after some trials. You will receive feedback 8 times within the total of 40 trials but the interval of the feedback is not fixed.

<u>Instructions to Participants during Retention Test</u>

Instructions for all Groups

As a participant you are asked to press the button while anticipating the onset of the last light that travels 2mph. from a distance of 1.5 meter. Prior to test, you will have an opportunity to make two practice trials. The ready light signal on the runway will be used as a warning cue. You will be given to 20 trials for the retention test.

Following your timing responses, you will not receive any verbal feedback during the test.

APPENDIX B

INSTRUCTIONS TO PARTICIPANTS IN EXPERIMENT II

Instructions to Participants during Acquisition Test

Instructions for all Groups

As a participant you are asked to throw a ball to a target that is 3m away from you, with your non-dominant hand. You will be blind folded with a piece of cloth during the whole test. The ball is covered with a Velcro to enable us to get the exact score of your throw. Prior to test, you will have an opportunity to make two practice trials. You will be given to 40 trials for the acquisition test.

Following your timing responses, verbal feedback indicating the direction and the magnitude of errors will be given after each or specific trials depending on your group. The direction and magnitude of the error will be determined according to the center of the target. While the direction could be either "near" or "far", the magnitude could be 21 different scores. If the ball is on the target line, the magnitude of error will be zero. But, if the ball sticks to a place between the first and second line close to you, the magnitude of error is 5 and the direction is near. So, the feedback you will receive will be "near 5". But if it is away from the target line, the magnitude of error is 5 and the direction is far. So, the feedback you will receive will be "near 5". And these scores will increase up to 100 in both directions, progressing outward from the center.

The following sentence(s) are specific to the groups.

Control Group: You will receive verbal feedback after every trial and by using this information you are expected to minimize the errors.

20% RF Group: You will receive verbal feedback after every five trials. It means that you will receive feedback 8 times within the total of 40 trials. By using this information you are expected to minimize the errors.

Self-Controlled Group: You will have a chance to control when to ask for feedback, that is, you will not receive feedback unless you will request it. You will try to request feedback only when you think you need it. You can only request feedback 8 times within 40 trials. In order for you to understand how many times you may request feedback, the experimenter will state the number of taken feedback verbally after each request. By using this information you are expected to minimize the errors.

Yoked Group: You will receive verbal feedback after some trials. You will receive feedback 8 times within the total of 40 trials but the interval of the feedback is not fixed.

<u>Instructions to Participants during Retention Test</u>

Instructions for all Groups

As a participant you are asked to throw a ball to a target that is 3m away from you, with your non-dominant hand. You will be blind folded with a piece of cloth during the whole test. The ball is covered with a Velcro to enable us to get the exact score of your throw. Prior to test, you will have an opportunity to make two practice trials. You will be given to 20 trials for the retention test.

Following your responses, you will not receive any verbal feedback during the test.

Instructions to Participants during Transfer Test

Instructions for all Groups

As a participant you are asked to throw a ball to a target that is 4,5m away from you, with your non-dominant hand. You will be blind folded with a piece of cloth during the whole test. The ball is covered with a Velcro to enable us to get the exact score of your throw. Prior to test, you will have an opportunity to make two practice trials. You will be given to 20 trials for the transfer test.

Following your responses, you will not receive any verbal feedback during the test.

APPENDIX C

FORMAL CORRESPONDENCES

E.ĞİTİM FAKÜLTESİ DEKANLIĞI
Ev. Arş. Md. Saat :

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

BÖLÜM : Kültür.
SAYI : B.08.4.MEM.4.06.00.11.070/ 337
KONU : Uygulama.

05.02.2004

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
EĞİTİM FAKÜLTESİ DEKANLIĞINA
(BEDEN EĞİTİMİ VE SPOR BÖLÜMÜ)

İLGİ: 23.1.2004 tarih ve BESB./2004/19 sayılı yazınız.

Üniversitenizin , Eğitim Fakültesi Beden Eğitimi ve Spor Bölümü Araştırma Görevlisi Güler ARSAL'ın, İlimiz Çankaya İlçesine bağlı Ülkü Akın İlköğretim Okulu'nda uygulama yapabilmesine ilişkin 28.1.2004 tarih ve 293 sayılı Valilik oluru ilişikte gönderilmiştir.

Bilgilerinize arz ederim.

Erol ORTAKAYA
Müdür a.
Milli Eğitim Müdür Yardımcısı

EKLER:
Eki : 1- Valilik oluru.

11.02.04 001930

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Milli Eğitim Müdürlüğü

BÖLÜM: Kültür
SAYI : B.08.4.MEM.4.06.00.11.070/293
KONU : Uygulama yapılması

28/01/2004

VALİLİK MAKAMINA
ANKARA

İLGİ: Orta Doğu Teknik Üniversitesi Eğitim Fakültesi'nin 23.01.2004 tarih ve 19 sayılı yazısı.

Orta Doğu Teknik Üniversitesi, Eğitim Fakültesi Beden Eğitimi ve Spor Bölümü Araştırma Görevlisi Güler ARSAL'ın, "Geri Bildirim Motor Becerilerinin Öğrenimine Etkisi" konulu bilimsel araştırma projesi kapsamında, ilköğretim seviyesindeki öğrencilere performans ve hatırlama ölçümleri yapılması nedeniyle, İlimiz Çankaya Ülkü Akın İlköğretim Okulu öğrencilerinin kapalı motor becerilerinin ölçülebilmesi için ilgi yazı ile izin istenmektedir.

Kamu Kurum ve Kuruluşlarında uygulanan Devlet Memurları Kılık-Kıyafet Yönetmeliği ve Okullarda uyulması gereken usul ve esaslara özen gösterilmesi, 2003-2004 öğretim yılında olması kaydıyla, söz konusu istek Müdürlüğümüzce uygun görülmektedir.

Makamlarınızca da uygun görüldüğü takdirde olurlarınıza arz ederim.

Erol ORTAKAYA
Müdür a.
Milli Eğitim Müdür Yardımcısı

OLUR
28/01/2004
Hakkı LOĞOĞLU
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İL MİLLİ EĞİTİM MÜDÜRLÜĞÜ'NE,

ANKARA

Bölümümüz araştırma görevlilerinden Güler Arsal'ın "Geri Bildirim Motor Becerilerinin Öğrenimine Etkisi" konulu bilimsel araştırma projesi kapsamında, ilköğretim seviyesindeki öğrencilere performans ve hatırlama ölçümleri yapılması gerekmektedir. Bu çalışmanın gerçekleştirilebilmesi için Çankaya İlçe Milli Eğitim Müdürlüğü'ne bağlı olan Ülkü Akın İlköğretim Okulu öğrencilerinin kapalı motor becerileri ölçülecektir. Ek 1'de sunulan ölçümlerin uygulanabilmesi için gereğinin yapılmasını bilgilerinize arz ederim.

Saygılarımla

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EK 1:

Çalışmada Kullanılacak Ölçüm Aracı:

Çalışmada ölçüm aracı olarak $4m^2$ büyüklüğünde ve üzerinde 5 cm aralıklı çizgiler bulunan halı biçiminde bir alan kullanılacaktır. Bu alana öğrenciler belli bir uzaklıktan baskın olmayan elleriyle top atacaklardır.

Ölçüm Süreci:

Öğrenciler top atılan alanın tam karşısında ve alıştırma ve hatırlama testinde 3 m aktarma testinde ise 4,5 m uzaklığa yerleştirilen bir sandalyeye oturtulup gözleri bağlanacaktır. Öğrencilerin yapmaları gereken halının tam ortasında belirlenmiş olan hedefe topu atmalarıdır.

Ölçümlerden önce her öğrenci için yapmaları gerekenler anlatılacak ve iki tane deneme yapmaları sağlanacaktır. Alıştırma testlerinde öğrenciler 40 defa deneme yapacaklar ve sonuç hakkındaki bilgiyi alacaklardır. Bu ölçüm bir öğrenci için yaklaşık 5 dakika sürecektir. Alıştırma testinden bir gün sonra yapılan hatırlama ölçümlerinde kişiler herhangi bir geri bildirim almazlar. Kişilerin ne kadar öğrendiklerini ölçmek için yapılan bu testte öğrenciler 20 tekrar yapacaklardır. Bu ölçüm ise bir öğrenci için yaklaşık 3 dakika sürecektir.

Hatırlama testinden bir gün sonra ise aktarma testi yine 20 tekrarlı fakat farklı bir mesafeden yapılacaktır. Bu ölçüm ise yine bir öğrenci için yaklaşık 3 dakika sürecektir.

Çalışmaya ilköğretim öğrencilerinden rasgele seçilecek olan 56 denek katılacaktır ve bu öğrenciler rasgele olarak dört tane gruba dağıtılacaklardır. Bu gruplar;

1. Kontrol grubu
2. % 20 oranlı sıklıkta geri bildirim alan grup
3. Kendi isteğine bağlı olarak geri bildirim alan grup
4. 3. gruptaki eşine göre geri bildirim alan gruplardır.

Sonuç hakkında verilen geri bildirimler aşağıdaki kriterlere göre verilecektir:

- Eğer atış hedef çizgisini geçtiyse deneğe uzağa attığı ve hatanın büyüklüğü cm olarak söylenecektir.
- Eğer atış hedefe düştüyse deneğe sıfır hata yaptığı söylenecektir.
- Eğer atış hedef çizgisine ulaşmadıysa deneğe yakına attığı ve hatanın büyüklüğü cm olarak söylenecektir.