4-1-1986

The effect of training on reaction time

Kurt E. Blades
Pacific University

Thomas A. Young
Pacific University

The effect of training on reaction time

Abstract
A visual enhancement training program utilizing the Eyespan was evaluated for its effect on reaction time (RT} and motor response time (MRT). The RT's and MRT's of 47 subjects were measured under identical conditions before and after a training program. Twenty four experimental subjects participated in a three week training program involving a minimum of 15 five minute sessions with the Eyespan. The other twenty three subjects served as the control for the study. After the training program, results indicated a significant improvement in RT's and MRT's of the experimental group in comparison to the control group. Since the effect of training with the Eyespan appears to be transferrable, it may be possible to improve athletic performance by improving RT's and MRT's through this type of visual enhancement therapy.

Degree Type
Thesis

THE EFFECT OF TRAINING ON REACTION TIME

THESIS BY:

KURT E. BLADES & THOMAS A. YOUNG

FACULTY ADVISORS

BRADLEY COFFEY, O.D. & ALAN W. REICHOW, O.D.

SUBMITTED TO THE FACULTY OF

PACIFIC UNIVERSITY COLLEGE OF OPTOMETRY

FOR PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

DEGREE : DOCTOR OF OPTOMETRY

SPRING 1986

TABLE OF CONTENTS

SIGNATURES

Kurt E. Blades	KURT E. BLADES
Thomas A. Young	Thomas A. Young
Alan W. Reichow	Alan W. Reichow OD
Bradley Coffey	Bradley Coffey, O.D

ABSTRACT

A visual enhancement training program utilizing the Eyespan was evaluated for its effect on reaction time (RT) and motor response time (MRT). The RT's and MRT's of 47 subjects were measured under identical conditions before and after a training program. Twenty four experimental subjects participated in a three week training program involving a minimum of 15 five minute sessions with the Eyespan. The other twenty three subjects served as the control for the study. After the training program, results indicated a significant improvement in RT's and MRT's of the experimental group in comparison to the control group. Since the effect of training with the Eyespan appears to be transferrable, it may be possible to improve athletic performance by improving RT's and MRT's through this type of visual enhancement therapy.

Key Words: Reaction time, motor response time, response time, eye-hand, Eyespan

INTRODUCTION

It is generally accepted by coaches, athletes, and sports vision specialists that a quick reaction time (RT) is crucial for many activities in sports. Sherman (1981) rates visual reaction time as important or extremely important in 16 of a brief list of 21 sporting activities. In a study related to baseball batting reaction time, Slater-Hammel and Stumpner (1950) explain that a batter must react to a pitch in approximately 0.43-0.53 seconds. In addition to baseball, one only needs to consider the various situations athletes such as hockey goalies, boxers, quarterbacks, and skiers encounter throughout the course of their activities, to understand how important RT is for optimum performance. With this understanding, those intimately involved with athletics such as coaches, trainers, or athletes themselves are concerned with the question, "Can RT be improved with training or is it strictly inherent?" The ultimate purpose of this study is to answer this question.

In a review of the literature concerning RT, many things become apparent which are relevant to our investigation. First, there is a vast amount of literature on RT, however, none to our knowledge, deals with the enhancement of athletes' performance by improving RT. Second, there are many factors which determine how fast or slow a person will react to a stimulus. Some of these include location of stimulus (Payne, 1966), foreperiod (Naatanen & Niemi, 1981), attention (Kantowitz & Roediger, 1978), anticipation (Ivanova & Kukinova, 1975), gender and general athletic training (Spirduso & Yandell, 1981), eye and hand dominance, and neural pathways (Herman, Herman & Maulucci, 1981), all of which have been studied for their effect on RT. Third, there have been a variety of uses of the various terms involved in RT type studies. To avoid any misinterpretations caused by other uses of the same terms in previous literature, <u>reaction time</u> is defined, in our study, as the time elapsed between the onset of the stimulus and the first response movement by the person. <u>Motor response time</u> is the time elapsed between the first response movement and the completion of the response or, in other words, the time of the motor movement only. <u>The response time</u> is the total time from the onset of the stimulus to the completion of the response. It is the sum of the reaction time and the motor response time.

In his classical study, Donders postulated that there are three reaction-type situations. These are known as Donders A, B, and C reactions. The A reaction or simple reaction time involves only one stimulus and one response. The B and C reactions require choices between multiple stimuli and multiple responses. Donders believed that the A reaction was a strong determinant of how fast the choice reactions (B and C) took place. Although discredited for many years, Donder's study is now widely respected and more sophisticated extensions have been proposed (Kantowitz & Roediger, 1978). The key point for our consideration is that if it is possible to improve an athletes' response time to a simple visual stimulus, other responses to various situations may also be improved. The purpose of this study is not to dispute any previous research concerning the many variables, but to simply ask: Can, through a short training period on a RT-type apparatus, performance on that apparatus be improved and, if so, is that improvement transferrable to another RT measuring task? The Eyespan was utilized as the training device in our study since it allowed scoring of performance, was easy to train with, and encouraged quick responses to visual stimuli. A separate RT timing device, Reaction Plus (RP), was used to determine whether any improved performance was transferable to another activity.

METHODS

The Reaction Plus device allows specific determination of a subject's reaction time, motor response time and total response time to a visual stimulus. Reaction Plus is a two clock system used to measure reaction time (RT) and total response time (TRT) (See Figure 1). The unit was equipped with a red visual stimulus light, a ready button, and two 1/100 second chronometers mounted in a separate control console. Each trial was initiated by the experimenter from a silent switch on the control console. One clock recorded RT, the other recorded TRT. Motor response (MR) was calculated by subtracting RT from TRT. The experimental group was trained on a commercially available instrument, the Eyespan (See Figure 2). This 122 cm. square instrument is wall mounted and is comprised of 64 stimulus lights which also function as the response buttons. In mode A, the instrument presents a light stimulus and the subject responds by pushing the lighted button. Instantly, another stimulus button will light up randomly on the visual display. The sequence will continue for a preset time period, after which the instrument will stop sequencing the stimulus lights and will display the number of correct responses during the preset time period. In another mode (mode B), the Eyespan will present a stimulus for a short pre-selected time period and move on to the next stimulus regardless of a correct response. This mode continues for one minute, at which time the total number of correct responses will be displayed. Both modes were utilized in the training procedure.

PROCEDURES

Forty seven volunteer subjects, age range 20 to 36, mean age of 25 (31 males, 16 females), participated in the experiment. On the RP instrument, each subject was given 5 practice trials followed by 20 scored trials on both pre and post-testing. Three mode "A" and 1 mode "B" Eyespan scores were also recorded during pre and post-testing. The subjects were divided equally into 2 groups, experimental and control. Group assignments were made on the basis of age, gender, and capability of attending training sessions.

The following instructions were given to both experimental and control subjects during pre and post-testing of RT and MRT on the Reaction Plus:

1. This is to test your reaction time.

2. Place the palm of your dominant hand on the ready button, while keeping your entire hand behind the retaining line.

3. I will cue you by saying "ready", then sometime between 1 and 5 seconds later the stimulus light will come on.

4. Look directly at the stimulus light.

5. As soon as the light turns on, hit the lit stimulus button as quickly as you can.

6. The subject was instructed to stand comfortably with the RP apparatus directly in front of him/her in the horizontal plane.

The RP apparatus was placed on a table with the top of the apparatus 85 cm. above floor level. After the subject was cued by the word "ready", the experimenter silently counted to himself the foreperiod time before pressing the stimulus button on the control console. The foreperiod time was varied between 2 and 4 seconds and done in such a way that the subjects were unaware of the length of foreperiod. Each subject also received approximately the same variability in length of foreperiod. The experimenter stood behind the subjects in order to keep the control console and stimulus switch out of sight of the subjects. The following instructions were given to both experimental and control subjects during pre and post-testing on the Eyespan:

1. While standing relaxed, fully extend your arms so that your fingertips touch the Eyespan directly in front of you.

2. I will cue you by saying "ready begin" as I push the start button.

3. Hit the stimulus buttons as quickly as you can, as they randomly light up across the board.

4. Each trial will last for 1 minute.

Three mode "A" and one mode "B" Eyespan trials were done on pre and post-testing. No instruction to maintain fixation during the task was given. Each subject was asked if they had any questions to insure understanding of the task. The Eyespan's vertical orientation was adjusted so the fixation line was eye level with the subjects. The illumination was held constant at 7 footcandles for both instruments.

Experimental subjects participated in fifteen training sessions on the Eyespan over 3 weeks, each session lasting about 5 minutes each. The training schedule included:

Training days 1-5: 3 mode "A" and 2 mode "B" Eyespan trials. Mode "B" pre-selected time period of .75 seconds.

Training days 6-10: 2 mode "A" and 3 mode "B" Eyespan trials. Mode"B" pre-selected time period of .50 seconds.

Training days 11-15: 1 mode "A" and 4 mode"B" Eyespan trials. Mode "B" pre-selected time period of .50 seconds.

Each experimental subject recorded his/her own scores from the training sessions. The experimental subjects were paid $15.00 on the sole basis of completing 15 training sessions (all 24 experimental subjects met the criterion for payment). The subjects were paid regardless of improvement.

RESULTS

The data obtained during pre and post-testing were analyzed using matched sample T tests. The experimental and control groups were compared on the basis of their performance on the Eyespan and the RT apparatus.

Analysis of the performance on the RT device was divided into its component parts; reaction time, motor response time, and total response time. This was necessary to determine which aspect of the total response time was responsible for any change found in the post-testing vs. pre-testing data.

The results summarized in Table 1 indicate that the total response time for both the experimental and control groups improved on the post-testing session. This improvement in total response time was due to improvement of both motor response time and reaction time for both groups. It is significant to note, however, that the improvement of the control group was small in comparison to the experimental group. In fact, the experimental group's improvement in reaction time was more than three times that of the control group. Both total response time and motor response time were also bettered by approximately three to one in comparison of the experimental group to the control group. Adjusting for the improvement of the control group, further analysis indicated that the experimental group still improved significantly more than the control group ($p<.001$) for RT, MRT, and TRT.

The Eyespan data, summarized in Table 2, primarily indicates the same trend. Both experimental and control groups improved their scores in both modes "A" and "B" on the post-test. Again, the improvement of the experimental group far exceeded that of the control group ($p<.001$).

It is noteworthy to examine the raw data of the individual subjects (See Figure 3). Twenty three of the twenty four (96%) experimental subjects showed an improvement in their total response time while only fourteen (60%) of the control subjects improved. Furthermore, nineteen (79%) of the experimental subjects improved by more than 0.03 seconds, four of these improving by more than 0.12 seconds. In comparison, only six (26%) of the control group members bettered their time by more than 0.03. Out of the six, no one improved by as much as 0.07 seconds.

Individual Eyespan data revealed that 20 of the 24 experimental subjects averaged at least 100 correct responses in less than 1 minute on the post-test. No one had averaged 100 on the pre-test. In comparison, only one person in the control group reached 100 on the post-test.

DISCUSSION

From the overall analysis of the data, the results indicate a definite improvement in the experimental group's total response time vs. the control group's. This improvement in TRT was due to improvement in both the reaction time and motor response time of the subjects. These results support our hypothesis that a person's RT and MRT can be enhanced through training with the Eyespan. However, a complete discussion of the results must include a closer investigation of several factors involved in this study.

The analysis of the data shows that the control group improved in their performance on the Eyespan and the Reaction Plus. Although improvement was less than 1/3 of the experimental group's, a significant difference between pre and post-testing was obtained, and hence, must be considered. The cause of the control group improvement is believed to be a practice effect. With an instrument such as the Eyespan, a practice effect was expected, especially since most of the subjects had no familiarity with the instrument prior to testing. Improvement, due to this same "practice effect", was also expected on the Reaction Plus apparatus, since a large number of trials (20 recorded + 5 practice) were used during pre and post-testing. One may argue that the experimental group's improvement on RP and the Eyespan was strictly due to a practice effect. Yet, analysis of the experimental vs. control group, with the "practice effect" factored out, still indicates significant experimental group improvement ($p < .001$) over that of the control group (see Table 3). Also, over 1/3 of the of the control group did not show a practice effect, as they did not improve on post-testing.

As mentioned earlier, to our knowledge there have been no visual enhancement studies attempting to improve RT. However, the large number of RT studies previously done were valuable in determining the control factors for this study. A brief mention of those especially relevant to this investigation follows.

1- Illumination: Changes in illumination and resulting contrast may have a significant effect on performance on instruments similar to the Eyespan or Reaction Plus (Appler & Quimby, 1984). The illumination was held at a constant 7 footcandles for both groups during pre and post-testing.

2- Time of day: To control for any possible effects on RT, all pre and post-testing was performed in the afternoon or early evening hours.

3- Foreperiod: An important factor in the consideration of RT is attention. It has been found that the length of the foreperiod has an effect on attention and anticipation thereby affecting the RT measured (Naatanen & Niemi, 1981). These factors were controlled by varying the foreperiod between 2-4 seconds as previously described and by using a large number of trials to determine the RT.

4- Foveal stimulus: Payne (1966) determined that RT varies with retinal location of the stimulus; therefore the subjects were instructed to look directly at the stimulus light, thereby keeping the stimulus foveal.

5- Hawthorne effect: The Hawthorne effect was minimized by allowing the experimental group to train without supervision. Instruction sheets were posted and the subjects recorded their own Eyespan training scores. The control group was not given any training activity and was instructed not to use the Eyespan between pre and post-testing sessions.

There are several implications that can be drawn as a result of this study. First, an athlete's response to a simple visual stimulus may be quickened. This is highly significant when one considers the tasks involved in many "reaction" type sports such as baseball, football, volleyball, hockey etc. It logically follows that if an athlete has the ability to react faster, his/her performance may subsequently be enhanced.

Secondly, even though the experimental group TRT mean change of 0.07 seconds seems to be small, it is actually close to a 15% improvement. Relative to the amount of time needed to react to a baseball pitched at 90 mph or a tennis serve at 100 mph, 0.07 seconds becomes highly significant. In an article on baseball batting, Allman (1985) states that a 90 mph pitched ball reaches the catchers mitt in only 0.41 seconds and that the average major league batter takes 0.28 seconds from the start of the swing to impact with the ball. With this in consideration, a fraction of a second becomes extremely critical.

Thirdly, athletes and coaches are ultimately seeking the "winning edge" in order to maximize athletic performance. Countless hours of training via weightlifting, running, etc. are spent attempting to achieve this edge. In contrast, the total amount of time spent in these 15 training sessions was approximately 75 minutes per subject, and yet profound effects were yielded. The training was non-fatiguing, offered a competetive atmosphere, and was enjoyable according to most of the subjects. A more rigorous program and an in-season maintenance program could easily be established to insure that the athlete's RT would be at her/his peak. Finally, there are probably other benefits to the athlete with this type of training other than a decreased RT to a central stimulus. We tested only the reactions to central stimuli, when in essence the Eyespan is a peripheral training device. It is our belief that other visual abilities such as peripheral localization, awareness, and eye movement skills may have been enhanced also.

CONCLUSION

In summary, we found that a person's reaction time, motor response time, and total response time can be significantly improved with visual enhancement training on the Eyespan. This improvement is very meaningful, especially considering the short amount of time athletes have to react to various situations. As a result, it is our contention that an athlete may enhance his/her performance through this simple method of visual training.

REFERENCES

Allman, W.F. The swing's the thing. Science, April,1985, 86-87.

Appler, D.V., Quimby, C.A. The effect of ambient room illumination upon Wayne Saccadic Fixator performance. Journal of the AOA, Nov. 1984, 55(11):818-821.

Herman, Richard, Herman, Ruth, Maulucci, R. Visually triggered eye-arm movements in man. Experimental Brain Research, 1981, 42:392-398.

Ivanova, M.P., Kukinova, L.P. (USSR Scientific Research Inst. of Physical Culture, Moscow) Readiness potential and reaction time in man. Abstract. Voprosy Psikhologii, Jan-Feb,1975, No. 1:122-12.

Kantowitz, B.H., Roediger III, H.L. Experimental Psychology. Chicago: Rand McNally College Publishing,1978.

Naatanen, R., Niemi, P. Foreperiod and simple reaction time. Psychological Bulletin, 1981, Vol. 89, No. 1:133-162.

Payne, W.H. Reaction time as a function of retinal location. Vision Research, 1966, 6:729-732.

Slater-Hammel, A.T., Stumpner, R.L. Batting reaction-time. Research Quarterly: Am. Assoc. Health & Phys. Ed. 1950, 21:353-356.

Sherman, A. Prescribing for patients who play. Optometric Management, November 1981, pp.67-68.

Spirduso, W.W., Yandell, K.M. Sex and athletic status as factors in reaction latency and movement time. Research Quarterly for Exercise and Sport, 1981, 52(4):495-504.

FIGURE 1

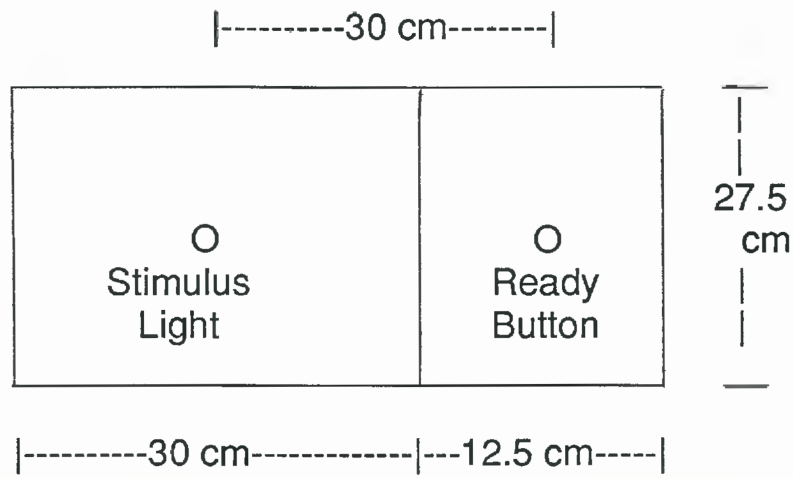

Fig. 1a-Schematic drawing of the Reaction Plus apparatus.

Fig.1b- The Reaction Plus was used in testing to measure the reaction, motor response, and total response times of the subjects.

FIGURE 2

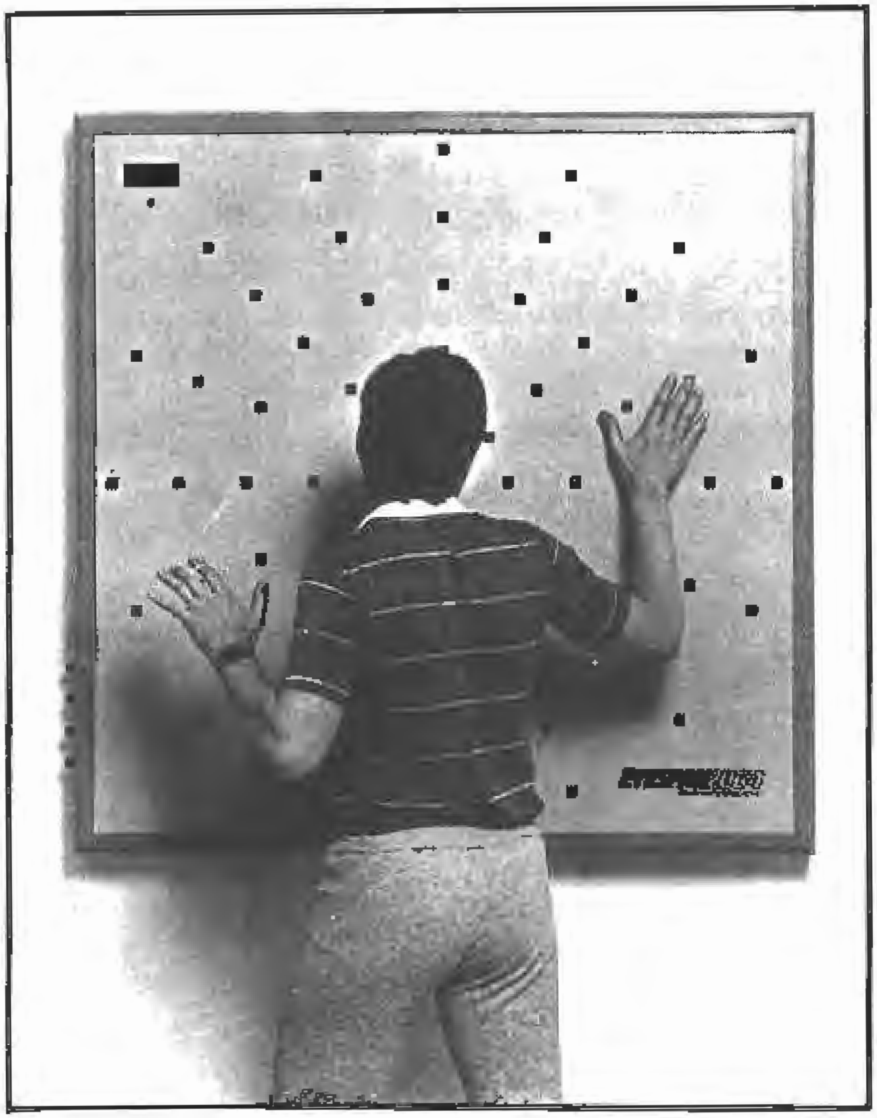

Fig.2 The Eyespan was utilized as the training device by the experimental group. All subjects were tested on this instrument before and after the training period.

FIGURE 3

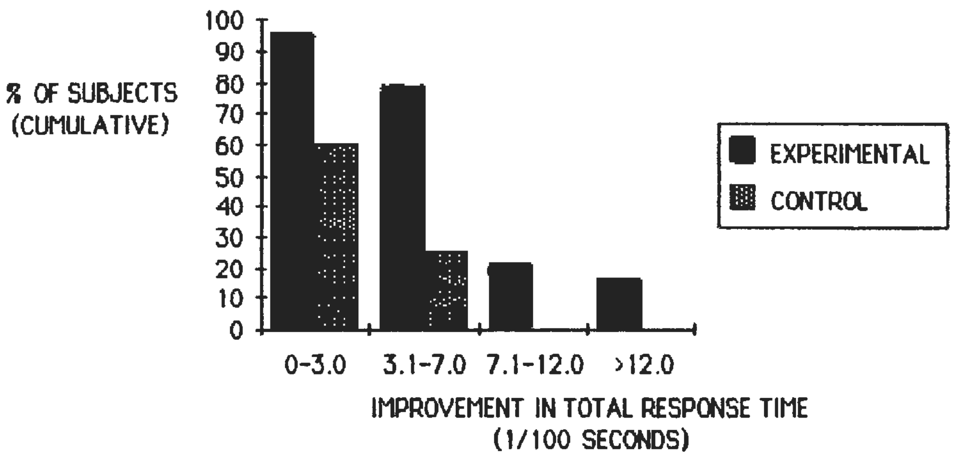

FIG. 3 Comparison of control and experimental group total TRT improvement on post-testing. Bars denote total % of subjects improving at least "X" amount of time.

*Note 40% of control group and 4% of experimental group showed no improvement and are not represented on the graph.

TABLE 1

	Mean	S.D.	Mean	S.D.	(Post-Pre)	P value
REACTION TIME*						
Control	26.8	2.1	26.0	2.1	0.8	$p = .015$
Experimental	27.9	4.1	24.7	2.4	3.2	$p < .001$
MOTOR RESPONSE TIME*						
Control	17.2	3.6	15.4	3.5	1.8	$p = .048$
Experimental	17.5	4.6	13.4	3.3	4.1	$p < .001$
TOTAL RESPONSE TIME*						
Control	44.0	4.2	41.3	4.6	2.7	$p = .013$
Experimental	45.4	7.0	38.0	4.2	7.4	$p < .001$

Table 1. Comparison of group reaction time data.

* Times are expressed in 1/100 seconds.

TABLE 2

	Mean	S.D.	Mean	S.D.	(Post-Pre)	P value
EYESPAN: MODE "A"						
Control	76.4	10.8	86.6	11.5	10.2	p < .001
Experimental	77.5	9.7	110.8	12.2	33.3	p < .001
EYESPAN: MODE "B" *						
Control	49.4	16.1	63.1	14.2	13.7	p < .001
Experimental	50.9	14.7	98.7	15.7	47.8	p < .001

Table 2. Comparison of group Eyespan data.
Mean values represent score obtained in one minute on Eyespan.

* Mode B was performed at the .75 second setting.

TABLE 3

	"PRACTICE EFFECT"	EXPERIMENTAL IMPROVEMENT	SIGNIFICANCE P LEVEL
REACTION TIME*	0.8	3.2	$p < .001$
MOTOR RESPONSE TIME*	1.8	4.1	$p < .001$
TOTAL RESPONSE TIME*	2.7	7.4	$p < .001$

Table 3. The analysis of experimental data assuming control group improvement is due to "practice effect". The significance level applies to the experimental effect after the practice effect has been factored out.

* Times are given in 1/100 seconds.

ACKNOWLEDGEMENTS

We would like to express our gratitude to Monark America, the company that provided funding for our study. We would also like to thank Kent Fronk and Robin Lindauer for their help in data collecting and computer work. Finally, we would especially like to thank our advisors, Alan Reichow and Bradley Coffey, for their help and guidance.