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The effects of training on eye-body reaction/response time

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Abstract
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THE EFFECTS OF TRAINING ON EYE-BODY REACTION /RESPONSE TIME

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ABSTRACT

Reaction/response times are important in most sporting activities. It is hypothesized that by enhancing eye/hand abilities there will be a corresponding change in specific visual and visually-guided skills related to peak athletic performance. A visual enhancement training program utilizing the EyeSpan, an eye-hand coordination training device, was evaluated for its effect on eye/body reaction time (RX), motor response time (MR) and total response time (RP). The RX's, MR's and RP's of 48 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 fifteen 5-minute sessions with the EyeSpan. The other twenty-four subjects served as the control for the study. After the training program, results indicated a significant difference (p< .003) between control and experimental groups in eye/body response time (a measure of overall quickness). This corresponds to a 4% improvement in experimental subjects' response time following training. It appears that by enhancing eye/hand abilities there is to some degree a transference to another visually guided process, eye/body response time.

KEY WORDS: response time, motor response time, reaction time, eye/hand, eye/body and EyeSpan
INTRODUCTION

Since the beginning of competitive sports, coaches and trainers have been in search of the "edge", that one small advantage which would place an athlete above his opponent. Many aspects of sport training such as weight lifting, running, breathing techniques, and visualization training have been utilized in an effort to enhance athletic ability. Perhaps an obvious option has been overlooked ... the eyes. "In most sports nothing affects performance more than the ability to see clearly and correctly whether an athlete is tracking a fly ball, returning a serve, or throwing a pass, it is his eyes that lead his body," (Schechter 1987).

In virtually all sports there is a component of speed involved with a visual stimulus. The athlete with the ability to react to the stimulus in the shortest amount of time, while giving the appropriate response, has the advantage. Sherman (1981), in 16 of 21 sports, rated visual reaction time (RX) as a crucial factor. An example of the critical role reaction time plays in sports was shown in a study by Slater-Hammel and Stumpner (1950). They showed a batter has only 0.43-0.53 seconds to react to a pitch. In this time span the batter must decide the appropriate response and initiate a motor movement.

In the past, most research concentrated on measuring reaction time and the components thereof. Donder explained the various reaction types. Donder postulated that there were three reaction types, known as Donder's A, B, and C reactions. The A reaction was a single stimulus - single response interaction. The B and C reactions contained both multiple stimuli and responses. Donder felt that the A reaction was the determinant factor for both type B
and C reactions (Kantowitz and Roediger, 1978). A recent study by Blades and Young (1986) dealt with improving RX and RP times. The Blades and Young study showed that "it is possible to improve an athlete's response time to a simple visual stimulus" , which is Donder's A reaction type.

The measurement and enhancement of RX becomes difficult because of the many independent variables involved. Each athlete will react differently to a stimulus according to its location (Payne, 1966). The attention (Kantowitz and Roediger, 1978), anticipation (Ivanova and Kukinova, 1975), gender, and amount of training (Spirduso and Yandell, 1981) all have an effect on RX. The physiological components of the neurological pathways (Herman, Herman and Maulucii, 1981) also play a role in RX.

For clarification, this study will refer to RX as the time elapsed between the onset of a visual stimulus and the subject's first motor response movement. Motor response time (MR) is the time elapsed between the first response movement and the completion of the response movement. The response time (RP) is the total time from the onset of the stimulus to the completion of the response. The RP is the sum of the reaction and motor response times.

METHODS

Subjects

Subjects were 48 optometry students, (12 women, 36 men) ranging in age from 22 to 32 years with a mean of 24 years, all of whom had 20/20 visual acuity or better at near and far. None of
the subjects had participated in prior visual training or visual enhancement procedures.

**Instrumentation**

A computer along with three photosensors and a light stimulus allowed specific determinations of a subject's RX, MR, and RP.

The subjects stood behind the first photosensor and were told to look at a light stimulus 10 meters away (Figure 1). The subject was told to get ready and the stimulus would then light 2-4 seconds after the command. The computer would record the time from the light stimulus to when the subject made his/her first motor movement, which would break the beam of the first sensor. This time was recorded as the RX. The subject then ran 3 meters past a second photosensor. The total elapsed time from the onset of the stimulus until the subject crossed the second sensor was measured and recorded as RP. From these measurements MR could be calculated by subtracting RX from RP. A third photosensor was placed 1 meter past the second photosensor to insure that the subjects did not slow down before breaking the second photosensor.

The Monark America EyeSpan Eye-Hand Coordinator, model 2064(Figure 2) was the instrument used to train the experimental group. The EyeSpan is a commercially available instrument which can be mounted on the wall or placed on a portable stand. It measures 122 cm square and has 64 radially arranged response buttons on its face. These buttons are used as both the light stimulus and response button. There are two modes (A and B) and two levels (adult and child) of operation on the EyeSpan.
adult mode uses all 64 stimulus buttons, while the child's mode
does not utilize the outer two circles of lights. Mode A randomly
displays the light stimuli, which remain illuminated until
depressed. Once the button is depressed another instantly
illuminates. This cycle will continue for a preselected time. At
the end of the time interval, the lights will remain off and a
display of the correct number of responses will be shown. In mode
B, the light stimulus is displayed for a short preselected time
period and moves to another stimulus regardless of response.
Again, the sequencing occurs for a predetermined time interval and
the total number of correct responses are displayed. Both modes
at the adult setting were utilized in this study for training.

Procedure

Pre and post-test data were taken on all 48 subjects for
eye/body RX's, RP's, and MR's with the previously described
photosensor/computer timing device. The following instructions
were given to both experimental and control subjects during pre
and post-testing with the photosensor device: "This is to test
your eye/body reaction time. I will call you to your mark, at which
time you will align your body just behind the first photosensor. I
will cue you by saying "set"; then, sometime between one and three
seconds later the stimulus light will come on. Look directly at the
stimulus light. As soon as you see the light come on, run as fast
as you can until you have passed the third photosensor" (approx 4
meters).

The computer apparatus that randomly activated the stimulus
light was controlled by a work-study student who was located out
of the subject's field of view. The stimulus light apparatus was located 10 meters directly in front of the subject at a height of one meter. An ambient light level of sixty foot candles was utilized for all measurements. Subjects were given two practice trials, followed by twenty test trials. Each subject's twenty trials were staggered so that they would have a minimum one-minute rest between runs.

EyeSpan data were also recorded for each subject during pre and post-testing. Scores for two 1-minute Mode A and two 1-minute Mode B trials were recorded. A .75 second interval between stimuli was used in the Mode B pre and post-testing. Subjects were instructed to stand relaxed directly in front of the EyeSpan instrument, at a distance such that, if their arms were fully extended, their fingertips would just touch the most distal response buttons on the EyeSpan. The vertical height of the EyeSpan was adjusted so that the subject could easily touch all four corners.

Subjects were told that the object of the test was to depress the lighted stimulus buttons as quickly as possible, as they randomly flashed across the board. The subjects could use either hand and no instruction was given regarding visual fixation. The differences between Mode A and B were explained to insure understanding before the subjects began their trials. Illumination of seven footcandles was held constant throughout EyeSpan testing and training.

After all pre-test Mode A EyeSpan scores were recorded, the subjects were ranked from fastest to slowest. Experimental and control group assignments were made by putting every other subject in the ranking in each group. This system of dividing the
subjects into groups allowed for essentially equally matched
groups based on pre-test EyeSpan scores.

The twenty-four subjects assigned to the experimental group
participated in an EyeSpan training program, which consisted of
fifteen 5 minute sessions. Training was conducted over a three
week period, with each subject completing one session per day.
The training program was not supervised and each subject was
responsible for recording his or her own EyeSpan scores in the
training log. Researchers checked the training log daily to insure
that training was being completed.

Each training session consisted of three Mode A and two Mode B
trials, all one minute in length. Two of the Mode A trials were
completed with the subject touching the stimulus lights with any
part of their hand and the third Mode A trial was performed with
the subject touching the stimulus with an index finger only. In the
first six training sessions the stimulus lights were set at a .75
second interval during Mode B training. In sessions seven through
fifteen the stimulus lights were set at a .50 second interval.

Both experimental and control subjects were paid $25 for their
participation in the experiment. Subjects were paid regardless of
improvement, with the only requirement being that all the
subjects perform pre and post-tests and that experimental
subjects complete their fifteen training sessions.

RESULTS

In the within subjects analysis the data from both pre and
post-testing were analyzed by matched sample t-tests. The
between groups analysis was analyzed by the unmatched sample
T-test. Means for each subject's 20 trials were derived and used in the analysis. Performance on the EyeSpan and the eye/body apparatus were compared both within and between the experimental and control groups. The eye/body timing apparatus divided the timed events into three parts: RX, MR, and RP. This enabled us to assess changes within the all three times and to determine which was responsible for any experimental differences.

In order to infer transference from training eye/hand response time to another visually guided task (eye/body), a significant training effect must first be established associated with the EyeSpan training. Our EyeSpan data reveal a significantly greater ($p < .001$) improvement in both Mode A and Mode B scores for experimental subjects as compared to the controls.

Within groups comparison of pre vs. post-test data revealed that the control group’s post-test RX, MR, and RP all were slightly slower, with the RP being significantly slower ($p < .003$). Analysis of the experimental group pre vs. post data revealed that RX, MR, and RP all slightly improved, but none significantly (Figure 4).

Between groups analysis of pre vs. post-testing data revealed that there was a significant ($p < .003$) difference in RP of 37 milliseconds. RX and MR differences were not significant. Table 1 shows mean and standard deviation values for both pre and post-testing.

**DISCUSSION**

Our findings on the EyeSpan essentially replicate those of the Blades and Young study (1986). Both studies reveal that training
on the EyeSpan effects reduction in eye/hand response times, though the magnitude of improvement in the current study was much less (Figure 3).

The second aspect of the study was to show a transference of this enhancement to a separate effector system (eye/body) RX, MR and RP. We postulated that after the EyeSpan enhancement program, eye/body RX and/or RP would be improved for the trained subjects. RP did show a significant change in between groups analysis, though this change must be fairly attributed to the slowing of RP among the control subjects.

Besides the RP improvement, the data revealed a 4% improvement in RX in the experimental group. At the elite level of competition 4% improvement in RX could easily make the difference between winning and losing.

We feel these improvements were meaningful based on the specificity and the short time spent on enhancement training. Only eye-hand visual abilities were trained and only a total of 75 minutes were spent on enhancement training by the experimental group. Private sports vision practitioners often provide enhancement training programs of 25 to 50 hours which entail activities involving several areas of visual ability.

The significant difference in RP between groups was primarily due to the slowing of the controls. The other two components making up RP were not significantly better after training, though both did improve slightly. All three times (RX, MR, & RP) improved for the experimental group pre to post while the control group's times all showed a slower performance. We feel the slower performance exhibited by the control group may have been due to the fact post testing was done during final exams. Had it not been
for the training, the experimental group may have also exhibited a similar decrease in performance.

The difference between EyeSpan results in our study and the Blades and Young study might be explained by the differing training protocol we utilized. Specifically, our protocol dedicated more training time to the precision aspect rather than the speed of response. We instructed subjects to utilize one finger-tip, during some of the training, when depressing the EyeSpan stimulus buttons rather than using the entire hand. Our study also placed less emphasis upon training in Mode B, which requires a quicker response to the stimulus.

We recommend further studies incorporating increased length of training sessions and increased length of overall training time.

CONCLUSION

Our data show significant difference between groups (p < .001) in eye/hand abilities following Eye Span training.

By enhancing eye/hand abilities there is to some degree a transference of this enhancement to other visually guided activities, such as eye/body response time.

It appears that by improving Donders A type reaction through EyeSpan training there is a transference to B and C type reactions.
REFERENCES


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**

**EYESPAN MODES A & B**

**1985 STUDY**

- *Mode A*
- *Mode B*

* E vs. C differ (p<.05)

Pre-to-Post Improvement (%)

**FIG. 3a** The Eyespan score differences expressed as percentage change.

**EYESPAN MODES A & B**

**1986 STUDY**

- *Mode A*
- *Mode B*

* E vs. C differ (p<.05)

Pre-to-Post Improvement (%)

**FIG. 3b** The Eyespan score differences expressed as percentage change.

Note the smaller percentage improvement in the 1986 experimental group relative to the 1985 results.
Eye/Body Reaction Time

- Experimental 3.947
- Control 4.776

% Change

Eye/body reaction time differences expressed as percentage change.

Eye/Body Motor Response Time

- Experimental 0.192
- Control 0.699

% Change

Eye/body motor response time differences expressed as percentage change.

Eye/Body Response Time

- Experimental 1.042
- Control 1.720

% Change

Eye/body response time expressed as percentage change.
# TABLE 1

**Eye/Body Reaction Time**

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<td><strong>Control Group</strong></td>
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<td>.335/.227</td>
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**Eye/Body Motor Response Time**

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<td><strong>Control Group</strong></td>
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**Eye/Body Response Time**

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