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CORRELATIONS OF SELECTED PSYCHOMOTOR AND VISUOMOTOR TESTS WITH INITIAL DYNAVISION PERFORMANCE[1]

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Summary.—The current study investigated the relationship between Dynavision scores for 36 men and 52 women (*M* age = 20.5 yr.) and performance on six conventional psychomotor tests which presumably tap similar psychomotor abilities and visuomotor skills. Analysis indicated that initial Dynavision performance was significantly correlated with performance on these common psychomotor tests. These data extend findings that propose the effectiveness of the Dynavision apparatus to assess performance on basic visual-motor and visual-cognitive functions. Taken together with these new results, findings suggest that this apparatus might contribute to psychomotor assessment and may be potentially useful for effective selection and identification of individual differences in human behavioral performance.

Even in simple tasks such as reaching for a coffee cup, there is a complex orchestration of eye and hand movements (Cohen & Andersen, 2002). Disruption of eye-hand coordination after disease and injury might significantly lessen productivity and quality of life (Crawford, Medendorp, & Marotta, 2004). Specific diagnostic tests of psychomotor abilities and visuomotor skills are potentially useful in identifying individual differences in human behavioral performance. Several studies have shown incremental predictive validity of psychomotor tests for various kinds of performance (Levine, Spector, Menon, Narayanan, & Canon-Bowers, 1996; Alderton, Wolfe, & Larson, 1997; Wolfe, 1997), so prediction of good performance on such a task might have practical application (Ackerman & Cianciolo, 1999).

Some prior studies suggested that the Dynavision apparatus, a device for improving visuomotor skills of athletes and stroke patients, measures and trains visual scanning, visual attention in focal and peripheral fields, visuo-

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motor response time and coordination, and basic cognitive skills within a broad visual training environment (Klavora, Gaskovski, & Forsyth, 1994, 1995; Klavora, Gaskovski, Martin, Forsyth, Heslegrave, Young, & Quinn, 1995; Klavora & Warren, 1998; Klavora, Heslegrave, & Young, 2000; Klavora, Young, & Heslegrave, 2000; Klavora & Esposito, 2002). While empirical evidence for the verity of these claims is currently limited, its use in athletics and rehabilitation centers is growing because it is simple but diverse (Klavora & Warren, 1998; Klavora, Young, & Heslegrave, 2000; Klavora, Heslegrave, & Young, 2000). The Dynavision apparatus may be an effective tool for assessing visuomotor speed and coordination, visual scanning, and visual attention (Klavora, Young, & Heslegrave, 2000; Klavora & Esposito, 2002) and might have promise for rehabilitating visuomotor skills (Klavora, Gaskovski, Martin, Forsyth, Heslegrave, Young, & Quinn, 1995; Klavora & Warren, 1998; Klavora, Heslegrave, & Young, 2000); however, data comparing the general performance on the Dynavision apparatus with scores on more specific psychomotor tests is lacking. To address this, the association of initial Dynavision performance was examined with performance on six common psychomotor tests which may tap similar psychomotor abilities and visuomotor skills.

Method

Participants

Participants (36 men and 52 women; *M* age = 20.5 yr., *SD* = 1.3) from the School of Physical Education and Health at the University of Toronto provided written informed consent to participate. All were right-handed, as defined by the Edinburgh Inventory of Manual Preference (Oldfield, 1971), reported normal or corrected-to-normal visual acuity and being free of known sensory, perceptual, or motor disorders. None had previous experience with any of the tests to be given. All experimental procedures received ethical approval by the University of Toronto Ethics Committee.

Apparatus

Dynavision.—This multidimensional apparatus presumably tests and trains eye-hand coordination of visuomotor and visual cognitive functions within the visual training environment of the frontal plane. The testing and training surface consists of a large, wall-mounted board (165 cm × 120 cm × 20 cm) on which are positioned 64 small square buttons arranged in five concentric rings. The apparatus can be adjusted to accommodate users of different heights as well as seated persons. A light-emitting diode (LED) display is located just above the centre of the surface. The apparatus requires subjects to 'reach-to-touch' sequentially to diverse locations in visual space according to a set of programs. Briefly, subjects were tested on three tasks of graded difficulty, namely, simple, moderate, and complex. All tasks were 60 sec. in duration and used the full board. The simple task was self-paced, that is, subjects touched slots which illuminated one at a time at random locations across the board before identifying a new location. Alternatively, the moderate and complex tasks were apparatus-paced, so subjects had to touch illuminated buttons to extinguish them within a preset time at which point another target was illuminated.

For both the moderate and complex tasks, subjects were instructed to read and call out random four-digit numbers displayed on the LED screen, in addition to touching illuminated target buttons. These numbers were displayed for 1.0 sec. at 5.0-sec. intervals for a total of 12 four-digit numbers in 60 sec. Target buttons remained illuminated for 1.0 sec. during the moderate task and for 0.5 sec. for the complex task. All tasks were performed in the dark to improve visibility of the illuminated buttons. To emphasize peripheral visual attention, subjects were instructed to fix the eyes directly forward on the LED display and to use peripheral vision to locate target buttons. To ensure central fixation was maintained throughout the task, the researcher monitored subjects' eye movements. Buttons which lit to the right and left of the centre of the board were to be touched with the right and left hands, respectively, while those which lit directly above or below the centre could be touched with either hand. A hit was considered invalid if made with the incorrect hand. A beep signaled a successful hit, and the apparatus recorded the total number of hits. In general, more hits reflected faster visuomotor responses and better performance (Klavora, *et al.*, 1994; Klavora, Gaskovski, & Forsyth, 1995).

Psychomotor test battery.—Six tests were used to assess how well scores on the Dynavision apparatus predicted performance. These particular tests were selected because they likely measure some of the abilities and skills considered to be trainable on the Dynavision apparatus.

For simple response time subjects held down one telegraph key and were required to strike another telegraph key 30 cm away when a lightbulb lighted. Three practice and five test trials were performed for both dominant and nondominant hands (order randomized). Response time (msec.) of the five test trials was measured.

To measure choice response time subjects held down one telegraph key and were required to strike one of four distinct telegraph keys 30 cm away when a lightbulb lighted. Three practice and five test trials were performed by both dominant and nondominant hands (order randomized). Response time (msec.) of the five test trials was measured.

Pursuit-rotor performance required subjects pursue a target (approximately 19 mm in diameter) located 10 cm from the centre of the disc on the edge of a rotating platform with the tip of a stylus (3 mm). The stylus rested on the target when the trial started, and the platform rotated at a rate of 30 or 60 rpm for 60 sec. (order randomized). Total time (sec.) the stylus was held on target was measured for each platform rotation rate and for both dominant and nondominant hands (order randomized).

To assess ring replacement subjects were required to move 20 rings (approximately 3 mm in thickness and 15 mm in diameter) placed 30 cm from a set of five pegs located on the opposite side of a screen. The corresponding set and hand movement could only be viewed through a mirror. Time (sec.) to replace the rings was measured for dominant and nondominant hands (order randomized).

Minnesota Manual Dexterity Test–Placing used a board (23 cm wide × 86 cm long × .5 cm thick) containing 60 holes, 3.9 cm in diameter and .5 cm thick. It was placed lengthwise on a table 30 cm from the participant. There were 60 cylindrical blocks measuring 3.7 cm in diameter and .5 cm high. The blocks were red on one side and black on the other side. Standard instructions for two boards were administered. The participant faced the empty board placed 2.5 cm from the end of the table. The board containing the blocks was aligned directly behind the empty board. Subjects were instructed to place the bottom wooden block into the top hole of the empty board at the right edge and the block second from the bottom into the second hole from the top at the right, and so on, right down the line until all four rows had been filled. Time (sec.) to complete two test runs was measured to obtain a total raw score.

Minnesota Manual Dexterity Test—Turning was performed on a board placed 2.5 cm from the edge of a table located 30 cm from the participant. Subjects were instructed to pick up wooden cylindrical blocks from their individual slots, turn them, and place them into the same hole with the other hand as quickly as possible in both directions (right to left and left to right; order randomized). Time (sec.) to complete two test runs was measured to obtain a total raw score.

Procedure

Three weeks prior to testing, subjects participated in a single orientation session with all tasks (i.e., the Dynavision apparatus and six psychomotor tests). Subjects listened to a prerecorded set of instructions on the specific performance details of the tasks and how to maximize performance on the Dynavision apparatus (i.e., optimal stance and distance from the board, button-striking technique, and the importance of fixating the eyes on the centre of the board and using peripheral vision). Prior to testing, the order of the tasks was randomized for each subject. Only the researcher was present during the testing. To ensure that all subjects were given uniform instruction, the same prerecorded message was played for each subject before each task during testing.

RESULTS

Mean Performance and Handedness

The primary goal was to assess whether Dynavision performance predicted performance on the selected psychomotor tasks. First, the overall performance on each task was analyzed. Mean scores for each psychomotor task and Dynavision task are listed in Table 1. Surprisingly, there was no significant effect of handedness on comparison of scores for dominant and nondominant hands on psychomotor tasks that included handedness as a factor:

TABLE 1
MEANS AND STANDARD DEVIATIONS FOR PSYCHOMOTOR AND DYNAVISION TASK SCORES AND PEARSON CORRELATIONS

Task	*M*	*SD*	*r* With Dynavision		
			Simple	Moderate	Complex
Simple Response Time, sec.			–.71	–.63	–.70
Dominant Hand	.50	.09			
Nondominant Hand	.50	.09			
Choice Response Time, sec.			–.65	–.60	–.64
Dominant Hand	.54	.08			
Nondominant Hand	.55	.09			
Pursuit-Rotor Task at 30 rpm, sec.					
Dominant Hand	56.1	3.4	.56	.32	.39
Nondominant Hand	53.2	4.5	.57	.39	.53
Pursuit-Rotor Task at 60 rpm, sec.					
Dominant Hand	12.3	3.7	.44	.29	.37
Nondominant Hand	7.6	3.2	.42	.21	.36
Minnesota Manual Dexterity Test					
Placing, sec.	233.1	14.3	–.64	–.50	–.63
Turning, sec.	165.5	13.7	–.66	–.45	–.62
Ring Replacement, sec.			–.75	–.56	–.63
Dominant Hand	57.5	4.4			
Nondominant Hand	58.5	4.3			
Dynavision					
Simple Task, no. hits	81.6	8.7			
Moderate Task, no. hits	74.5	11.4			
Complex Task, no. hits	29.1	18.3			

simple response time ($t_{174}=.16$, $p=.87$), complex response time ($t_{174}=-.53$, $p=.59$), ring replacement ($t_{174}=-1.53$, $p=.13$), with the exception of the response time on the pursuit-rotor task. Accordingly, data for dominant and nondominant hands were pooled for each task to simplify the subsequent analysis. On the pursuit-rotor task, however, an effect of handedness was found for both speeds, 30 rpm ($t_{174}=4.88$, $p<.001$) and 60 rpm ($t_{174}=8.92$, $p<.001$). Consequently, on the pursuit-rotor task, time by each hand was correlated with Dynavision scores.

Correlations

To describe statistically the relation of performance on the Dynavision apparatus with scores on the other six psychomotor tests, Pearson correlations within subjects on the averaged data for each task are listed in Table 1. Overall, performance on all psychomotor tasks was significantly correlated ($p < .05$) with each Dynavision task.

Note that the pursuit-rotor tasks were the only tasks having positive correlations with the Dynavision task scores. Although these values were significant they were weaker than correlations for the other psychomotor tasks. For example, the moderate Dynavision task only correlated with the 60-rpm pursuit task (.29 with dominant hand and .21 with the nondominant hand). Psychomotor tasks involving both simple and choice response times yielded the strongest correlations with each Dynavision task (approximately –.70). These negative correlations show that the faster response times correlated with more hits on the Dynavision task. Similarly, the ring-replacement task and the Minnesota Manual Dexterity Test–Placing and Turning tasks yielded negative correlations with the Dynavision task.

This study was a first step in exploring use of the Dynavision apparatus in the assessment of basic psychomotor abilities and visuomotor skills. Present results provide a basis for further study of Dynavision scores and some conventional psychomotor tests (Klavora, Heslegrave, & Young, 2000; Klavora & Esposito, 2002). Although use of the Dynavision apparatus has increased in the study of human performance and rehabilitation, further work must focus on its validity in assessing skills specifically related to standard protocols in these environments.

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