Application of the Dynavision 2000 to Rehabilitation of Soldiers With Traumatic Brain Injury

Written Statement Prepared by
Mary Warren MS, OTR/L, SCLV, FAOTA
On behalf of
Performance Enterprises
For
House Committee on Veteran's Affairs Hearing
on
Traumatic Brain Injury Related Issues
April 2, 2008

Name: Mary Warren MS, OTR/L, SCLV, FAOTA
Company: Performance Enterprises
Hearing: "TBI Related Vision Issues"
Date: April 2, 2008

Biography

Mary Warren is an associate professor of occupational therapy at the University of Alabama at Birmingham and director of the Graduate Certificate in Low Vision Rehabilitation Program. She was asked to represent Performance Enterprises, the manufacturer of the Dynavision, because she has used the Dynavision extensively in clinical practice and co-authored a manual on how to use in rehabilitation of persons with visual and physical deficits. Her area of expertise is rehabilitation of adults with visual and visual perceptual deficits from acquired brain injury. She has lectured extensively on this topic to occupational and physical therapists nationally and internationally; has published research, and contributed chapters to rehabilitation textbooks. Before joining the UAB faculty, she provided direct clinical services for 25 years to adults with visual impairments from acquired brain injuries. For nearly 20 years of that time, she used the Dynavision apparatus as part of her treatment to remediate visual impairments in my clients.

Background Information

Persons with acquired brain injuries often experience significant changes in vision and visual perceptual processing that affect the ability to take in and use visual information to complete daily activities.[1-4] Visual search, defined as the ability to scan the environment to locate targets and information, is a critical component of visual processing that is often impaired even in mild brain injuries.[1-4] Visual search can be disrupted by deficits in the visual field (hemianopsias and other field deficits), impairment of visual attention (neglect and hemi inattention), oculomotor impairment (double or blurry vision), or loss of vision in one eye (altering depth perception).[4] Disruption of visual search creates asymmetry and gaps in the visual information the person gathers from the environment. The quality of the person's decision making decreases because the brain is not receiving complete visual information in an organized fashion and therefore unable to effectively use this information to make appropriate decisions. Visual scanning speed also slows significantly, making it difficult for the person to acquire information from the environment in a timely fashion.[1] Deficient visual search can affect all aspects daily living however, the impairment is greatest for activities completed in dynamic environments where the person must be able to rapidly process visual information from a variety of sources.[4] As a result driving and participation in community environments for work, shopping, leisure or social participation are often most affected.

Therapists, faced with the responsibility of rehabilitating clients with brain injuries so that they can drive and successfully engage in dynamic community activities, have looked for devices that will enable them to reestablish efficient and fast search strategies in their clients. The Dynavision, originally designed to improve the visuomotor skills of athletes, is one of the devices adopted and modified by rehabilitation specialists to provide that same training benefit to clients. Occupational therapists have used the device in rehabilitation since 1986 to address visual, cognitive and motor impairment in persons with acquired brain injuries. For persons with visual and visuomotor impairment the apparatus is used to train compensatory search strategies, increase visual search speed and efficiency, improve oculomotor skills such

as localization, fixation, gaze shift, and tracking, increase peripheral visual awareness, visual attention and anticipation, and improve eye-hand coordination and visuomotor reaction time. For persons with motor impairment it is used to increase active upper extremity range of motion and coordination, muscular and physical endurance and motor planning. It has been successfully used to improve function in adults with limitations from stroke, head injury, amputation, spinal cord injury and orthopedic injury.[5] Currently there are over 300 Dynavision units in rehabilitation clinics in the United States and 16 units have been added to VA programs within the last two years.

Description of the Dynavision Apparatus

The Dynavision (Figure 1) is an approximately 5 foot by 4 foot board containing 64 small red square target buttons arranged in five nested rings. Each button covers a single small light bulb that illuminates randomly when the device is in use. An L.E.D. (light emitting diode) display is situated just above the center of the training surface. The board is wall mounted and adjustable to accommodate users of different heights. A computerized display panel, printer, and membrane control panel are situated on the left side of the board. The control panel has 37 operating keys that control four modes, six light speeds, three working areas, four quadrants, 1-7 digits with displays of 1 to .1 second and run times of 30, 60 or 240 seconds.

With these numerous options, a variety of training and testing tasks can be generated using either self-paced or apparatus-paced modes. In the self-paced training mode, (mode A) a target button illuminates in a random location on the board. The user must locate the light and strike it with the hand as quickly as possible. When struck, the light beeps and extinguishes and another target light appears in a random location on the board. The user proceeds to strike the target lights for the duration of the exercise. The numbers of light "hits" are recorded and displayed at the end of the run. In the apparatus-paced mode, the light is illuminated for a pre-selected period of time of 5, 3, 2, 1, .75 or .5 seconds. The user must strike the target within the pre-selected time to score a "hit." Apparatus-paced exercises are more challenging than self-paced exercises.

The therapist selects different options to accompany the two modes depending on the needs of the user. Exercises can be pre-selected to run 30, 60, or 240 seconds. Longer durations are useful for working on maintaining sustained attention; shorter durations for exercises requiring high intensity performance. The board can be programmed so that lights appear within only one quadrant to challenge the user who may have difficulty scanning or reaching in a certain direction. The training surface can also be adjusted between use of the full board (lights in all five rings illuminate) the middle board (the inner 4 rings of the board illuminate) or the inner board (the central three rings illuminate). The middle and inner board surfaces are suitable persons with limited upper extremity range of motion or strength. When the flash option mode is used, the L.E.D. display in the center of the board can be programmed to display from one to seven digits periodically during the exercise run. The user must call out the numbers while striking the target buttons, a task that requires the ability to monitor and shift visual attention smoothly between the central and peripheral visual field. This program option significantly increases the cognitive demands on the user. Other instructional variations can be used to increase the cognitive requirements of the training tasks. For example, the user may be asked to multiply or add the digits in the L.E.D. display while striking the lights on the board. Or, on B mode, the user may be required to refrain from

hitting lights when they appear in certain areas of the board or to strike lights with a certain hand only.

On completion of an exercise run, the Dynavision prints outs an analysis of the user's performance, including a comparison of reaction time and accuracy in the four quadrants of board. This provides the clinician with objective data on the user's strengths and weaknesses in performance and assists in evaluation, treatment planning and documentation.

Application of the Dynavision in Rehabilitation

The design of the Dynavision board in terms of size, button configuration, and number of program options enables the device to be used to treat persons with a range of capabilities and medical conditions. The simplicity and straightforwardness of the response required (striking the button) enables persons with limited comprehension to understand the demands of the task. The ability to limit presentation to the inner ring of lights, coupled with the ability to lower the position of the board permits use by persons with restricted upper body mobility and wheelchair users. Although precision in the striking the button is required, the button can be struck with any part of the hand such as the palm, fingers, or back of the hand. This allows persons with limited prehension from conditions such as quadriplegia, hemiplegia or amputation to successfully work the board.

Ability to select different speeds of stimulus presentation from the self-pacing of mode A to the automatic presentation of mode B enables use with persons with varying speeds of information processing. The Board in mode A can be used to facilitate visual scanning and increase visual reaction time in persons who have difficulty executing adequate search patterns due to oculomotor impairment, hemi-inattention and neglect, and hemianopsia. Mode B and the digit flash option can be used to challenge high functioning persons who must demonstrate rapid information processing and mental flexibility in order to resume demanding tasks such as driving, engaging in sports activities and work. Varying the length of the presentation from 30 seconds to 240 seconds allows the therapist to prevent fatigue in persons with limited endurance and also challenge sustained attention in persons who have difficulty maintaining vigilance. Both modes A and B can be used with persons with upper extremity limitations to increase active range of motion and coordination.

The most unique and important contribution of the Dynavision to rehabilitation is its capacity to challenge the efficiency and speed of visual search. The size of the Dynavision board automatically elicits a combination of head turning and eye movement, which is the natural scanning strategy used when searching the environment. The light buttons are identical which eliminates the need for discrete identification and elicits a more automatic visual search response. This capacity enables the Dynavision to develop the attention skills needed for driving, and orientation to and negotiation of the environment. One of the great advantages of the device as a tool specifically for the rehabilitation of wounded soldiers is its competitive nature. Dynavision drills are presented as games of skill by instructing the persons to strike as many lighted buttons as possible within the allotted time. This challenges the client to give their best effort each time. The device records and analyzes performance showing the client where deficiencies exist to enable the client to improve performance on the board. Clients can compare their performance and compete with each other. Because the device was designed for athletes, the lights can be programmed to move at very high speeds and it is impossible to beat the board, which draws out the competitive nature of young men

who use it. Also because it is used to train athletes, less stigma is attached to the exercises as using the board is regarded as athletic training.

Evidence

Published research supports the validity and reliability of the device in rehabilitation.[5-10] Most notably, Dr. Peter Klavora and his collaborators at the University of Toronto have published several studies on the ability of the Dynavision to predict driving performance in persons with brain injury and to rehabilitate driving performance in persons post stroke.[7-8]

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Figure 1: The Dynavision Apparatus