



AOTA Evidence Briefs

Brain Injury

**A product of the American Occupational Therapy Association's Evidence-Based Literature Review Project*

BI #13

Virtual exercise may improve cognitive function in clients with brain injury

Grealy, M. A., Johnson, D. A., & Rushton, S. K. (1999). Improving cognitive function after brain injury: The use of exercise and virtual reality. *Archives of Physical Medicine and Rehabilitation, 80*, 661–667.

Level: IIB2b

Nonrandomized controlled trial, 2 groups, fewer than 20 participants per condition, moderate internal validity, moderate external validity

Why research this topic?

For people who experience traumatic brain injury, rehabilitation during the first 6 to 9 months after the injury is probably crucial to recovering as much cognitive function as possible. The researchers hypothesized that exercise would play an important role in the rehabilitation of such persons. The literature suggests that exercise in natural and virtual-reality environments can be used to train people in cognitive functions. A virtual-reality environment is a three-dimensional computer program that immerses the user in the context.

What did the researchers do?

The researchers, variously of the University of Glasgow (Scotland) and Astley Ainslie Hospital (Edinburgh, Scotland), tested the effects of exercise in a virtual environment on the cognitive function of patients with brain injury.

For the first part of their study, the researchers recruited 13 participants (8 men and 5 women) for the experimental group, all of whom were from the same hospital. The average age of the participants was 32.4 years. They met the following criteria for using the virtual-reality system: they were ambulatory, they had good sitting balance, and they had no perceptual disabilities that would prevent them from viewing the computer monitor. They also met criteria related to verbal learning capacity. Further, they passed a medical examination.

The experimental group exercised three times a week, for up to 25 minutes at a time, for 4 weeks. For the exercise, the participants sat on a virtual-reality exercise bicycle and steered a course around a virtual world or raced against other virtual riders. They operated in three virtual environments: a Caribbean island, a town and countryside, and snowy mountains with ski runs.

For comparison, the researchers constituted 12 control groups from a database of 320 persons who had been admitted to the hospital over the previous 2 years. All met the criteria for inclusion in the study, but they did not undergo the medical examination. Each group consisted of at least 25 participants who were similar to members of the experimental group in age, severity of injury, and time since injury.

For the second part of their study, the researchers recruited 13 patients with moderate brain injury (7 men and 6 women), whose average age was 32.1 years. Each of these patients participated in an experimental and a control trial, in random order. In both trials, participants responded to 40 stimuli via a keyboard while their response and movement times were recorded. In the experimental trial, the researchers measured the participants' reaction and movement times before and after a single bout of exercise on the virtual reality bicycle. In the control trial, the

participants rested quietly between the tests.

The outcome areas of interest in the two parts of the study were *attention* and *information processing* (as measured by the Digit Span test, the Digit Symbol subtest of the Wechsler Adult Intelligence Scale—Revised, and the Trails A and B tests); *learning* and *memory* (as measured by the Rey Auditory Verbal Learning and Complex Figure tests, and the Visual Learning and Logical Memory tests of the Adult Memory and Information Processing Battery [AMIPB]); *distance cycled* (as measured by the computer software); a *workout index* (as measured by the computer software); and *reaction time* and *movement time* (as measured by a computerized program).

What did the researchers find?

In the first part of the study, the experimental group improved **significantly** (*see Glossary*) in the digit symbol task (which requires making associations between shapes and figures), verbal learning, visual learning, immediate retention of visual memory, the workout index, and distance cycled.

Compared with the control participants, the experimental group showed a significant overall improvement in attention and information processing and performance on the digit symbol task.

In the second part of the study, the experimental group improved significantly in reaction time and movement time. The control group did not.

What do the findings mean?

- For *therapists and other providers*, the findings suggest that virtual-reality exercise can improve some aspects of cognitive function in clients with brain injury. Computer-generated virtual-reality environments represent a simulated environment for training such clients in cognitive functions and can be used as a supplement to traditional rehabilitation.
- The findings suggest a direction for research: replication of the study with a larger population and comparing exercise in different simulated and natural environments.

What are the study's limitations?

The researchers' method of selecting study participants was systematic; that is, they selected the participants randomly. This feature raises confidence that the results of the study can be attributed to the intervention.

The study provides useful information. However, it has limited generalizability for the population of persons with traumatic brain injury across settings because the participants did not represent all age ranges and all types of head injuries.

Glossary

significance (or significant)—A statistical term, this refers to the probability that the results obtained in the study are not due to chance, but to some other factor (such as the treatment of interest). A significant result is one that is likely to be generalizable to populations outside the study.

Significance should not be confused with clinical effect. A study can be statistically significant without having a very large clinical effect on the sample. For example, a study that examines the effect of a treatment on a client's ability to walk, may report that the participants in the treatment group were able to walk significantly longer distances than the control. However, if you read the study you may find that the treatment group was able to walk, on average, six feet, while the control group was able to walk, on average, five feet. While the outcome may be statistically significant, a clinician may not feel that a one foot increase will make his or her client functional.

■ Terminology used in this document is based on two systems of classification current at the time the evidence-based literature reviews were completed: *Uniform Terminology for Occupational Therapy Practice—Third Edition* (AOTA, 1994) and *International Classification of Functioning, Disability and Health (ICIDH-2)* (World Health Organization [WHO], 1999). More recently, the *Uniform Terminology* document was replaced by *Occupational Therapy Practice Framework: Domain and Process* (AOTA, 2002), and modifications to *ICIDH-2* were finalized in the *International Classification of Functioning, Disability and Health* (WHO, 2001).

This work is based on the evidence-based literature review completed by Beatriz C. Abreu, PhD, OTR, FAOTA, and colleagues.

For more information about the Evidence-Based Literature Review Project, contact the Practice Department at the American Occupational Therapy Association, 301-652-6611, x 2040.



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