

Cognitive Games as Therapy for Children with FAS

David Bartle*
Sam Rossoff†
David Whittaker‡
Bruce Gooch§

Department of Computer Science
University of Victoria

Kim Kerns¶
Jenny MacSween||
Department of Psychology
University of Victoria

Abstract

Therapies that help restore abilities in individuals with brain damage are being investigated to help individuals with FAS. These methods focus on rehabilitation and exercises for the brain which improve specific cognitive capacities. We present *Cognitive Carnival*, a computer game therapy based on cognitive exercises, designed to improve the child's motivation and engagement of the tasks. Three minigames were developed, each based on improving one of three cognitive principles: executive function, continuous performance, and working memory. These minigames will be used in controlled therapy sessions with neuropsychologists for children with FAS to determine their effectiveness as a rehabilitative tool.

Fetal Alcohol Syndrome (FAS) is a disorder that is caused by the ingestion of alcohol during pregnancy. Alcohol is a teratogen (substance that is toxic to the developing brain) and can result in abnormal brain development (brain damage). Children with FAS are faced with numerous obstacles, including significant problems with executive functions, attention, memory, and language. These conditions impede children with FAS from succeeding in school and living normal lives.

There is estimated to be 0.5 to 2.0 children diagnosed with FAS per 1,000 births in the United States during the 1980's and 1990's [May and Gossage 2001]. It especially prevalent in remote communities. There is no cure. However, therapies that help restore abilities in individuals with brain damage are being explored to help individuals with FAS. These methods focus on rehabilitation by means of an intervention by psychological professionals. The therapies are able to leverage the brain's plasticity to improve cognitive function [Neu 2002]. While adult brains show low levels of plasticity, children have more neurons and their brains continue to grow into their early 20's. Consequently, neurogenesis can be leveraged by supervised mental exercise.

Classical therapy involves a trained therapist visiting local school, often times for a single child, to administer the therapy. The therapy itself consists of a set of exercises which the child preforms. This model of therapy, while effective, is inefficient and often times impractical for many areas. Additionally, the therapy has no built-in reward system and often times the therapist will offer the child candy or a small prize which provides little engagement with the tasks themselves.

The minigames are intended for a controlled environment where a child with FAS is supervised by a neuroscientist. Over a course of weeks, the child will play each minigame, progressing through the difficulty levels as their abilities increase.

A game-based therapy has multiple advantages over traditional exercises. Games tend to be more engaging than paper exercises. They also can accommodate built-in reward and motivation systems, instead of requiring the alternative of real-world incentives as the sole motivation for completing the tasks. Possibly the the most significant advantage is the ability to easily distribute the system using the Internet. This allows it to easily reach remote areas, where FAS is prevalent.

Our therapy targeted three cognitive abilities: continuous performance, working memory, and executive function. Four minigames were created, each embodying at least one of the fundamental cognitive abilities affected by FAS. We decided to divide the therapy into minigames as each minigame could focus primarily on a single cognitive principle. This narrowed focus allowed neuropsychologists to measure progress on particular abilities. This also allowed for separate starting ability parameters for the children.

The minigames focused on three cognitive principles typically impaired by FAS: continuous performance, working memory, and executive function. Continuous performance is the ability to sustain a consistent focus to an ongoing task continuing over an extended time period. Children without this ability may be at a major disadvantage in learning settings to their healthy counterparts. Working memory is the ability to temporarily store and manipulate information. It is an important basis for complex cognitive processes. Executive function is the ability to plan, problem solve, and make decisions.

Each minigame has built-in difficulty levels, and the ability to manually adjust parameters for an individually-tailored therapy. Levels are then subdivided into repeated trials of the same parameters. The user progresses through each trial, receiving positive and negative feedback as appropriate, according to his or her performance. Upon the completion of a session, the user is presented with his or her results and a progress plot of their recent trials.

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*e-mail: dwbartle@uvic.ca

†e-mail: tzenes@gmail.com

‡greytone@gmail.com

§brucegooch@gmail.com

¶e-mail: kkerns@uvic.ca

||e-mail: macsween@uvic.ca