

NIH Director's Study Year One

Significant Improvements for Students with Attention Deficits

NIH Director's Award

In late 2011, Bruce Wexler, Chief C8 Scientist and Professor, Yale Medical School, received a \$4 million research award from the Director of the National Institutes of Health (NIH) for "high innovation, high impact, paradigm-changing research with the potential to transform medical practice." An anonymous expert reviewer for the NIH wrote, "The computerized training task stands out for being easily the most sophisticated ever attempted with ADHD (or any other cognitive disorder), due in particular to its ability to titrate difficulty to the individual's performance, thus maximizing its learning benefit. If any computerized program could work, this one should... Another strength is the idea of incorporating physical training... there are many reasons to think this is a good idea, yet it has scarcely been tried."

The award launched a study of the effectiveness of *C8Kids* in improving outcomes for students with attention deficits. In year one, 40 children in grades 1-3, participated in a 15 week, four times a week, 90-minute per session C8 afterschool program. Half the children screened positive for ADHD based on parent and teacher reports of attention problems and full evaluation by clinical researchers at the Yale Child Study Center. An equal number of children with ADHD served as a control group and are now receiving the program themselves. Data from the Yale Study Center and parent and teacher ratings of the treatment and control groups will not be analyzed for another year. But data is now available from NIH *Toolbox* tests of Executive Function and the Go/No-go test of response inhibition given to the

ADHD children and their typically-developing peers before and after the C8 Kids program.

Child and Parent Satisfaction

Satisfaction with C8 Kids was high. See below the "word cloud" of parent descriptions of their child's feelings about the program.



Measurable Gains on All NIH Toolbox Tests

The first test from the NIH *Toolbox* is the Flanker Test of Focused attention. Children have to indicate which way the center arrow is pointing (see below). On congruent trials this is easy because all arrows point in the same direction. Typically developing children scored 95% correct on these easy trials. Children with ADHD, however, had difficulty even on these easy trials, scoring only 87% correct. As expected, the typically developing children did not show any significant change after participating in *C8Kids* since many were at or close to 100% at the start ("ceiling effect" on easy trials). The children with ADHD, however, showed a statistically



significant improvement, “catching up” with the typically developing children and reaching 96% accuracy after *C8Kids*. Performance on more difficult incongruent trials increased significantly in both groups after participating in *C8 Kids*.

The second test from the NIH *Toolbox* is the Dimensional Change Card Sorting Task of cognitive flexibility (DCCS). Children have to match a target to one of two response options based either on similarity of shape or color. On 80% of trials they are instructed to match according to “shape. Randomly mixed in are “nondominant” trials on which they are instructed to match on the basis of “color.” The nondominant trials require cognitive flexibility as the child is required to switch sorting principals and children make more mistakes. Both groups of children showed significant gains in accuracy after participating in *C8 Kids*.

The third NIH *Toolbox* test is the Working Memory Test. In part one, children are shown a series of pictures of animals or household items. They then have to indicate which animals or items they saw, reporting them in order from smallest to largest. They start with a list of two items. Each time they respond correctly, the list length is increased by one. If they fail to accurately report two lists in a row the test is terminated. In part two, they are shown a mix of animals and furniture and have to sort them both into animals and furniture and from smallest to largest. On both parts, children with ADHD started off significantly lower than typically developing children. Importantly, both groups of children showed statistically significant gains in WM, and after *C8Kids*, children with ADHD were well within the initial range of normal performance.

The final test was a Go/No-Go Test of response inhibition. Children are instructed to push the space bar when they see the letter “P” but not when they see “R.” Halfway through, they are instructed to switch and push for R and not P. Before *C8Kids*, typically developing children were able to skip 54% of No-Go trials, but children with ADHD skipped on 36%, demonstrating the ability of the assessment tools built into *C8Kids* to identify areas of difficulty for children that can be addressed by parents and teachers in a variety of interactions. Both groups

showed small improvements which for the group as a whole approached statistical significance ($p=.08$), but gains were small. *C8* scientists are examining the relationships between performance on the brain training tasks and improvement on No-Go trials, and will make changes in *C8Kids* to increase its effects in this area of cognitive skill development.

