

Neurofeedback videogame ADHD technology: Results of the first concept study

Olafur S. Palsson, Psy.D.
Mindspire, LLC

Alan T. Pope, Ph.D.
NASA Langley Research Center

John D. Ball, Ph.D.
Marsha J. Turner, M.A.
Stephanie Nevin, M.S.
Eastern Virginia Medical School

Roger DeBeus, Ph.D.
Riverside EEG Biofeedback Services

Aims

- This project was a randomized and controlled technology concept study, funded by NASA's Langley Research Center
- Assessed whether a new videogame biofeedback technology developed at NASA Langley Research Center was as effective as traditional neurofeedback in treating Attention-Deficit Hyperactivity Disorder (ADHD), and whether there were significant differences in its appeal as a clinical method compared to standard neurofeedback treatment
- The study was conducted in the Behavioral Medicine Clinic at Eastern Virginia Medical School

Subjects

- 22 children with ADHD of the hyperactive-impulsive subtype (DSM-IV criteria plus physician diagnosis)
- Age range: 9-13 years, 3 girls and 19 boys
- All the children were on short-acting medications for ADHD
- The children had to be of at least normal intelligence, and have no history of affective problems or learning disabilities

Design

- The children were randomized to treatment groups: videogame (n=11) vs. standard neurofeedback (n=11)
- Children in both group completed 40 individual treatment sessions, usually seen once or twice a week.
- The children came for one test session before and after treatment, where they completed QEEG, TOVA and neuropsychological tests.
- BASC Monitor data and actigraph (physical activity) data was collected pre-and post-treatment and every ten sessions
- Children in both groups were trained with a single active Cz electrode, with reference electrode and ground attached to the earlobes

VIDEOGAME GROUP

J&J I-330 EEG hardware, NASA-built modulation unit and a modified game controller used with a standard Playstation console

Training displays were EEG influenced off-the-shelf Sony Playstation games

Training consisted of fixed-length training intervals interspersed with listening and reading



STANDARD GROUP

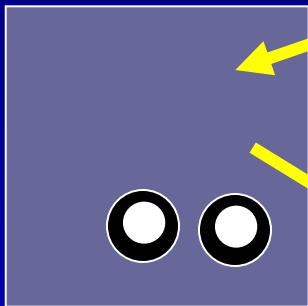
Thought Technology Procomp+ hardware and Multitrace Software

Displays were bar graphs and simple figures representing changes in SMR, beta and theta bands

Training consisted of fixed-length training intervals interspersed with listening, reading and unmodulated videogame playing



The Videogame Neurofeedback Loop



**ADJUSTABLE
MODULATION
UNIT**



Examples of Games Played in the Study



Spyro the Dragon

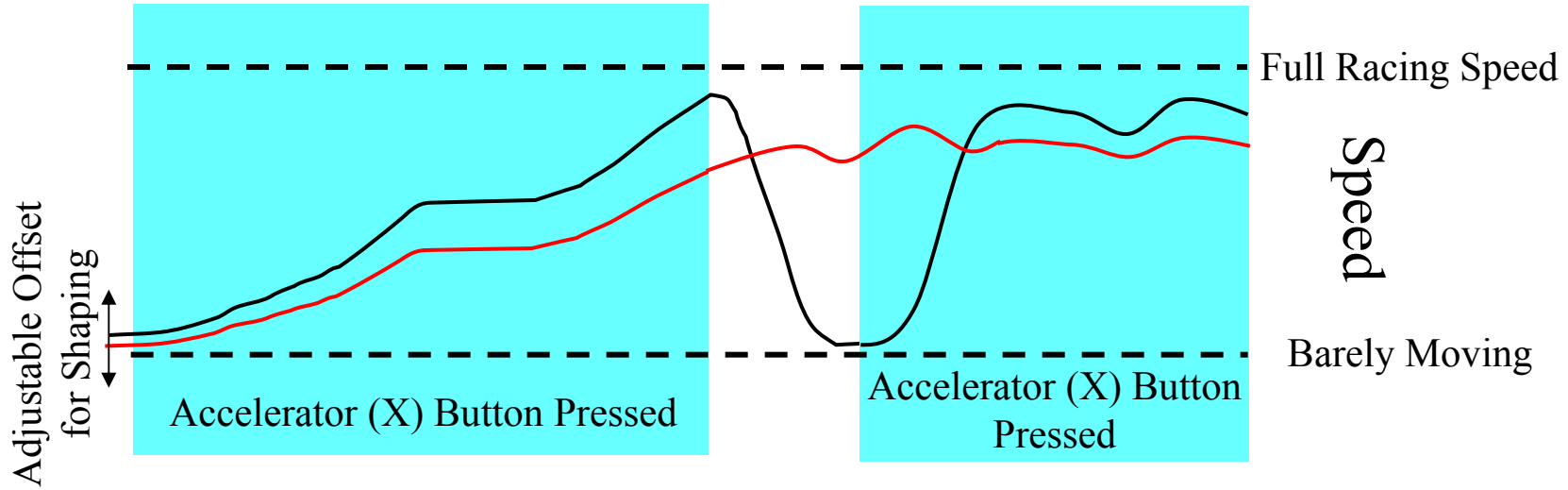


Tony Hawk

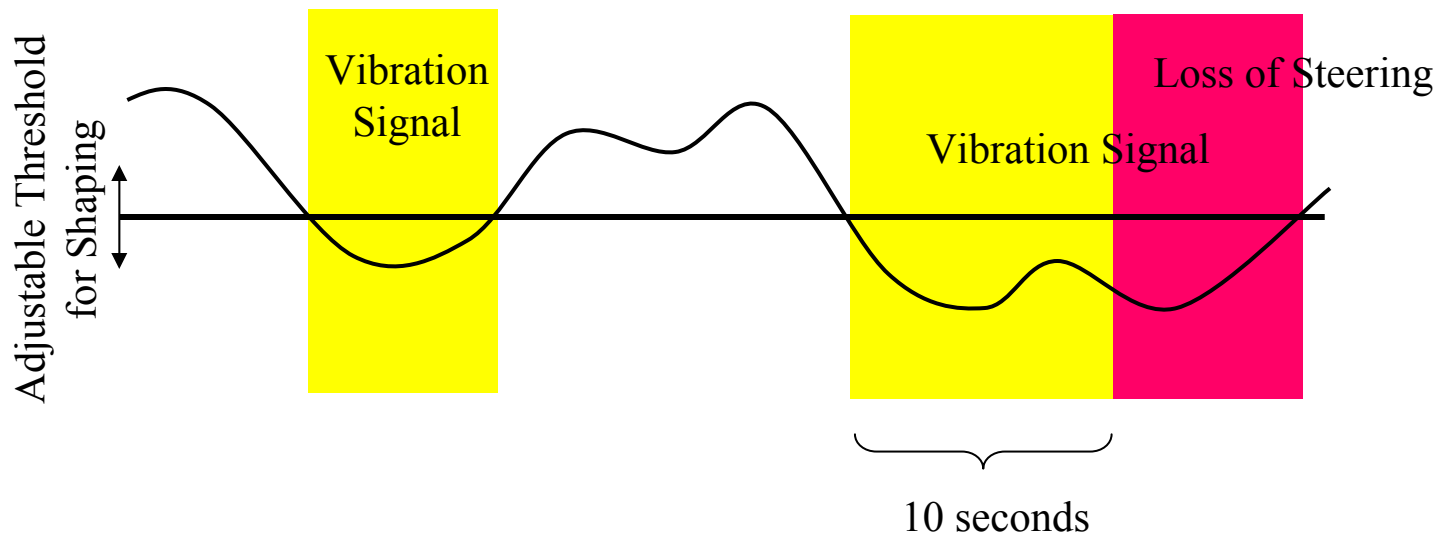


Gran Turismo

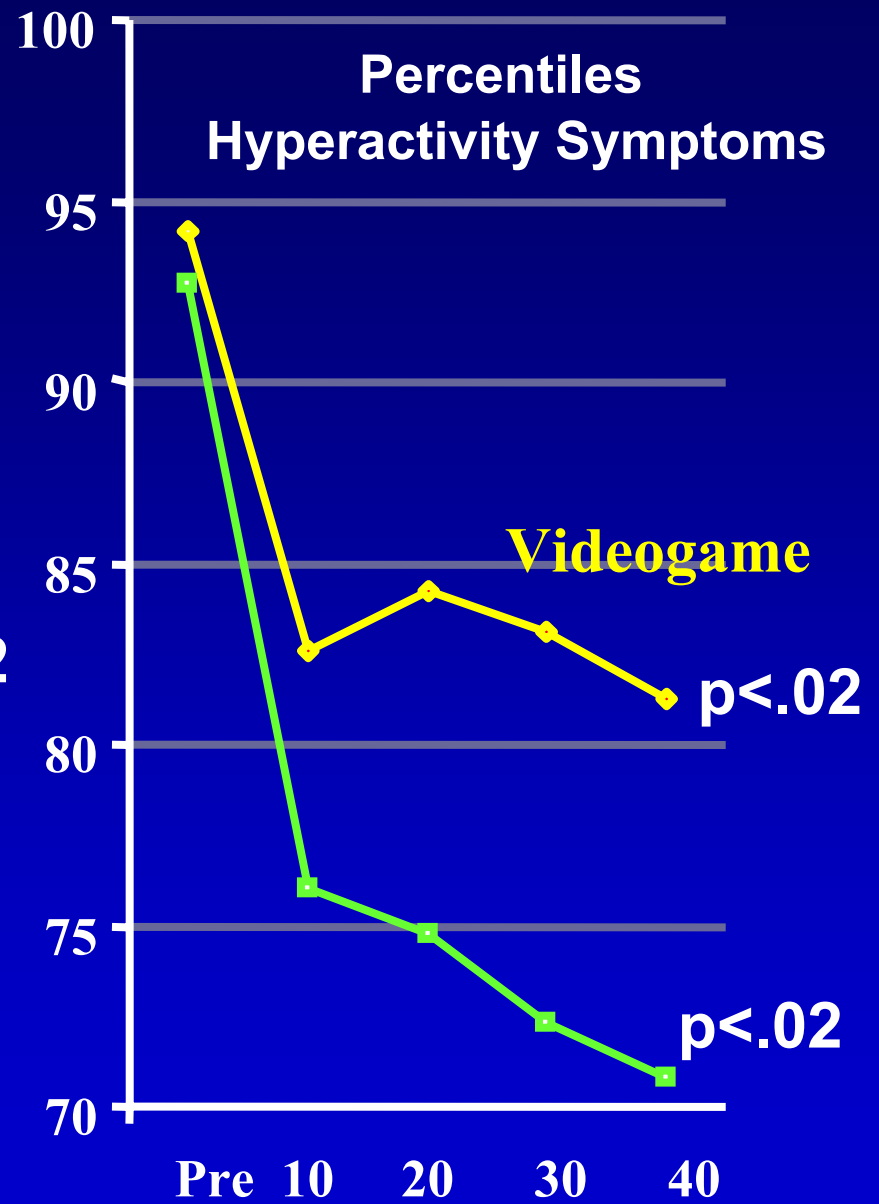
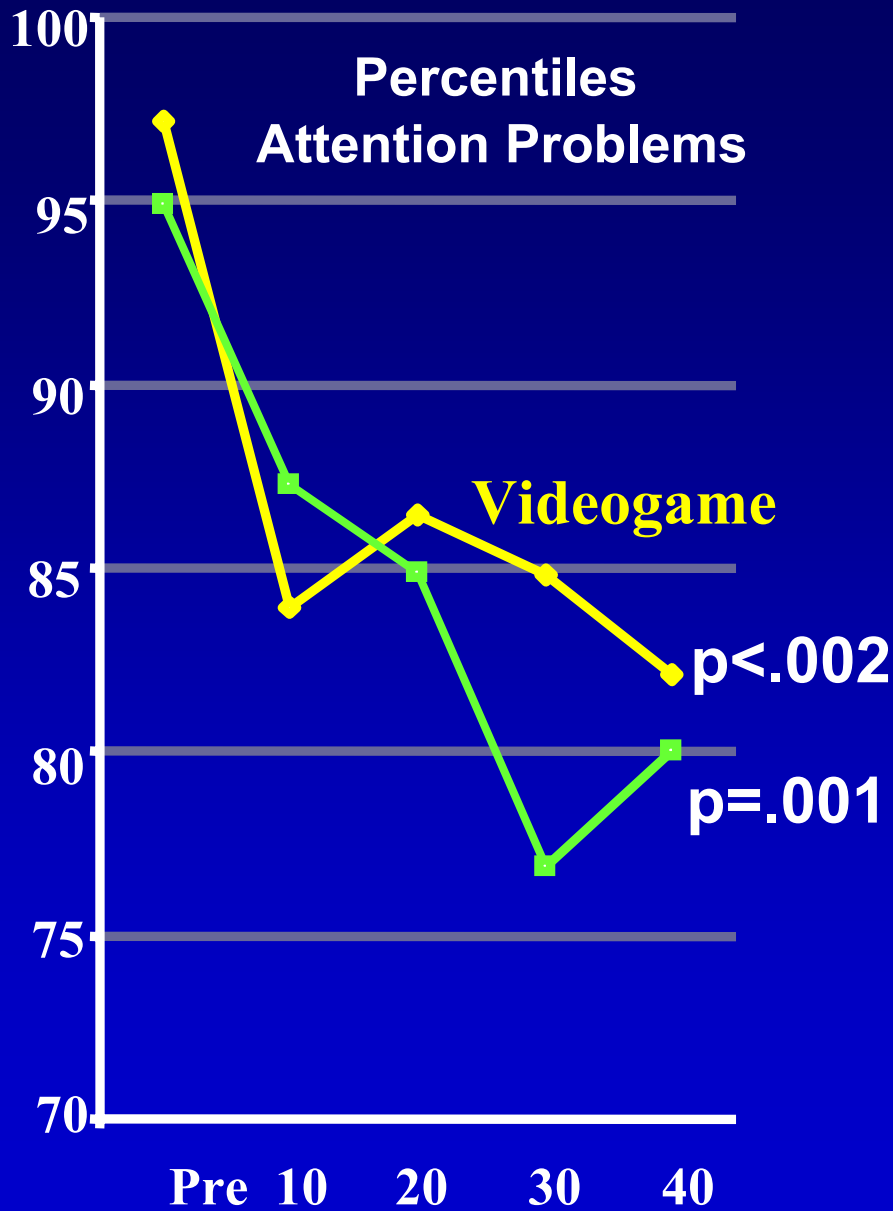
Beta/(Theta + Alpha)



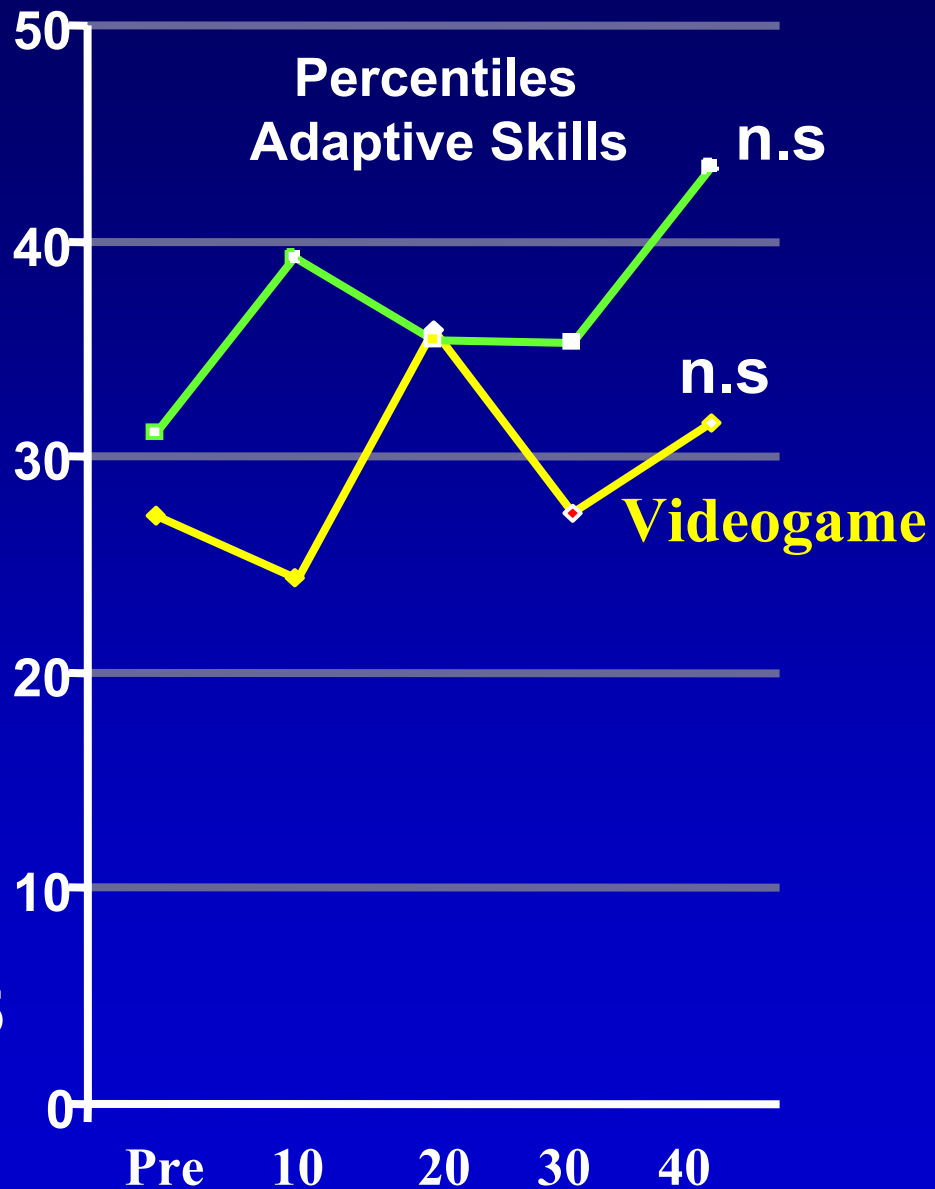
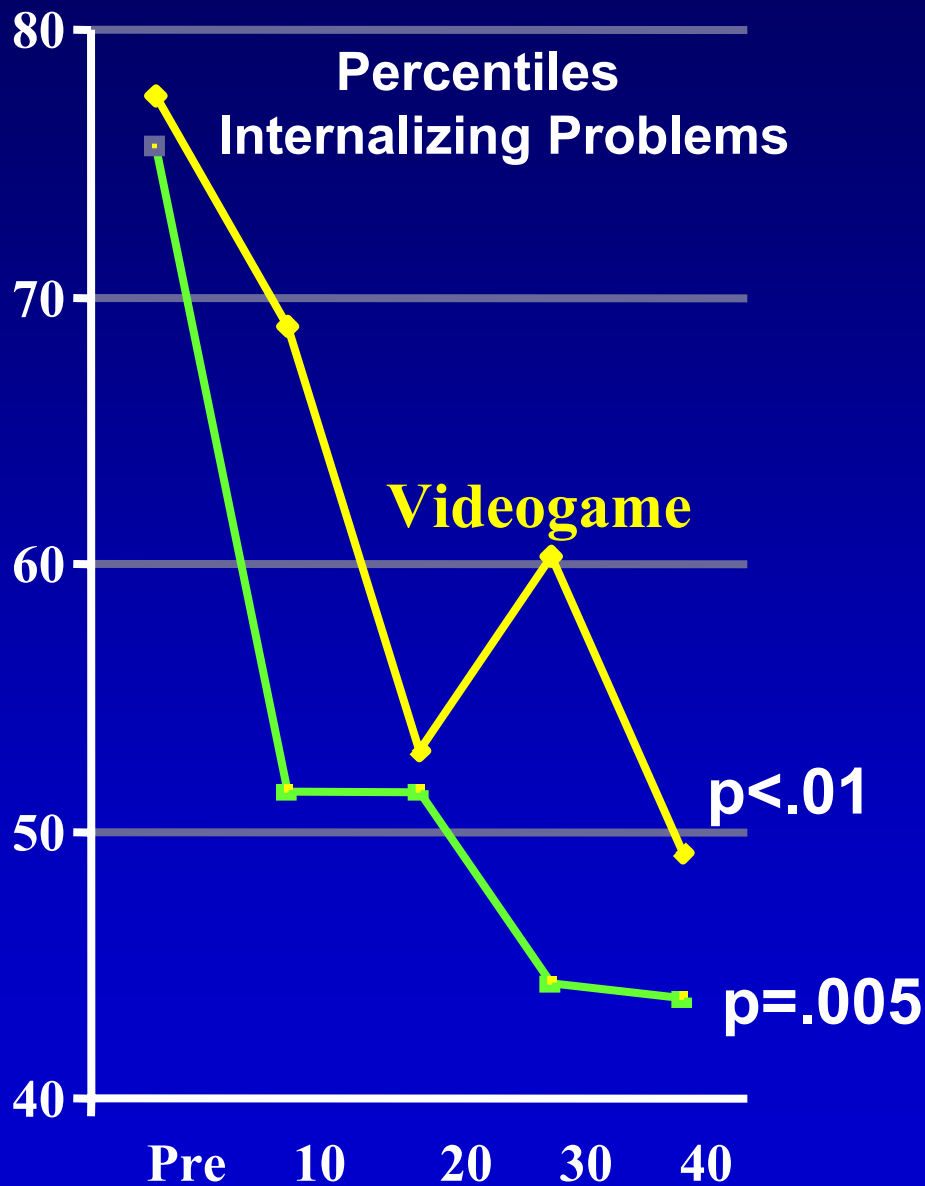
SMR



BASC Monitor

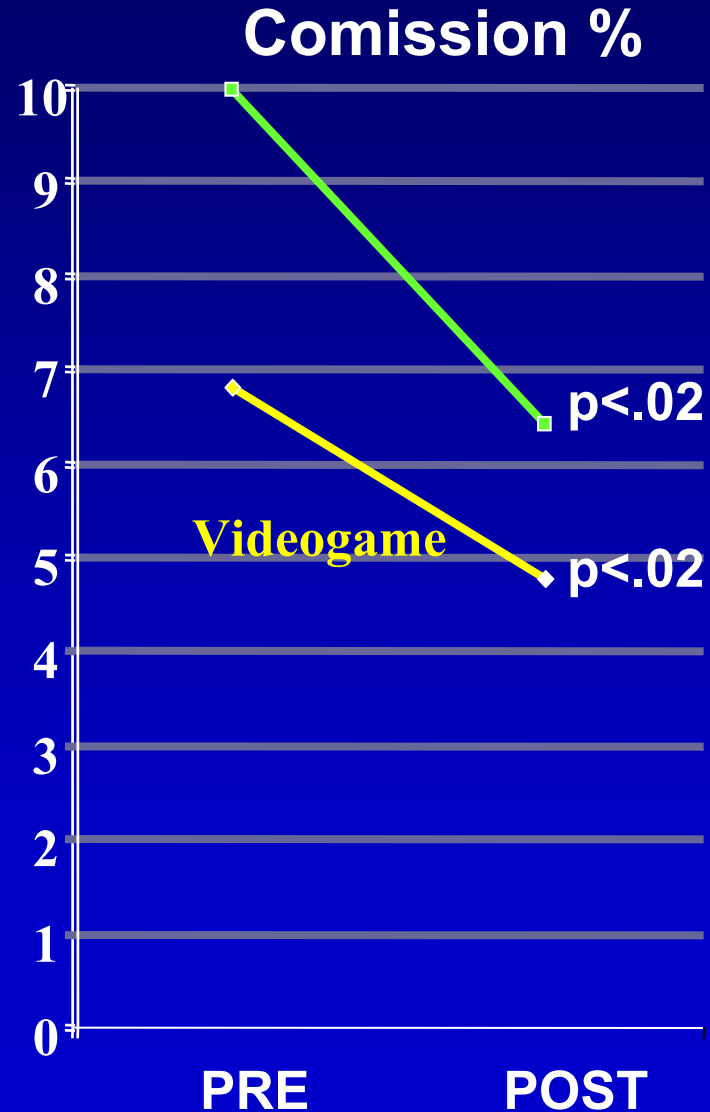
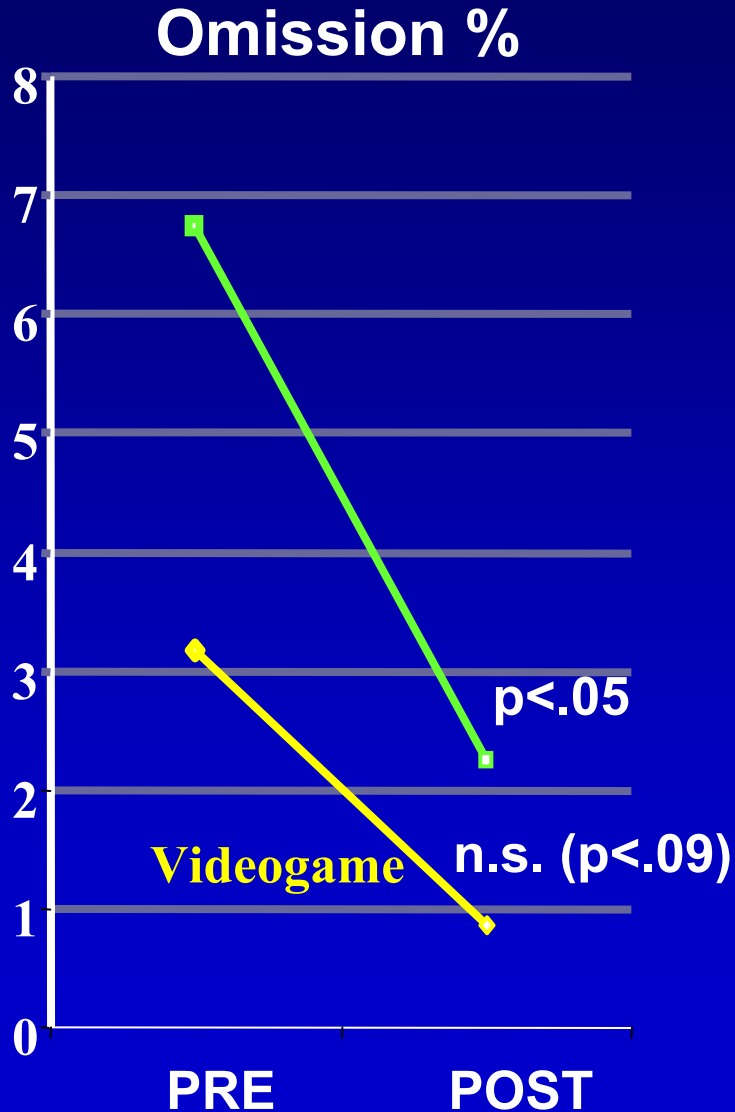


BASC Monitor



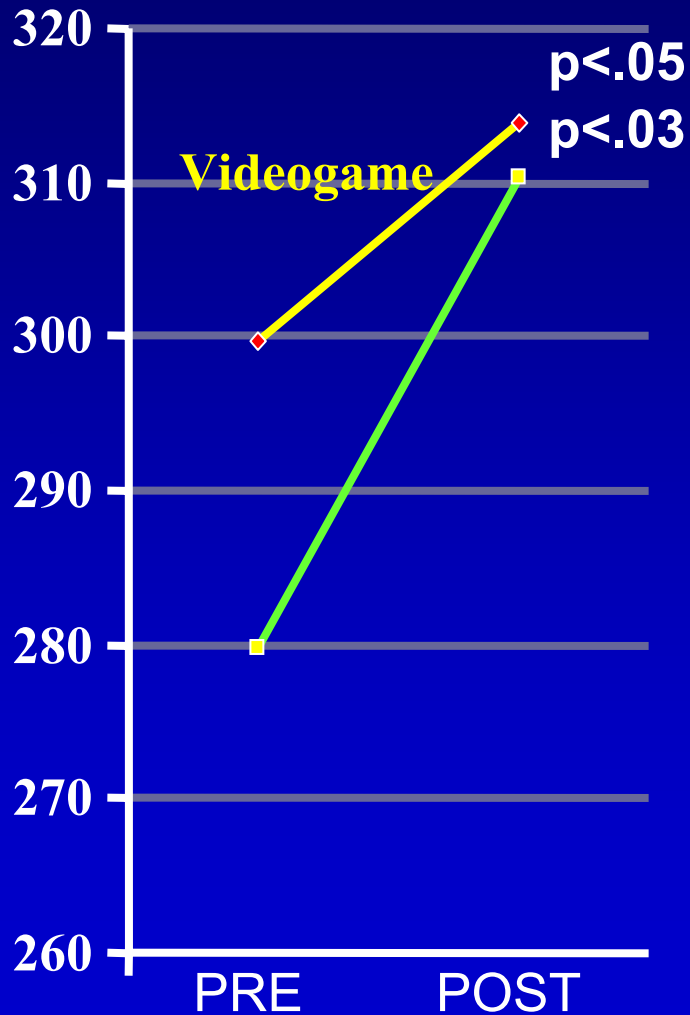
TOVA:

TOTAL PERCENTAGE OMISSION AND COMMISSION ERRORS

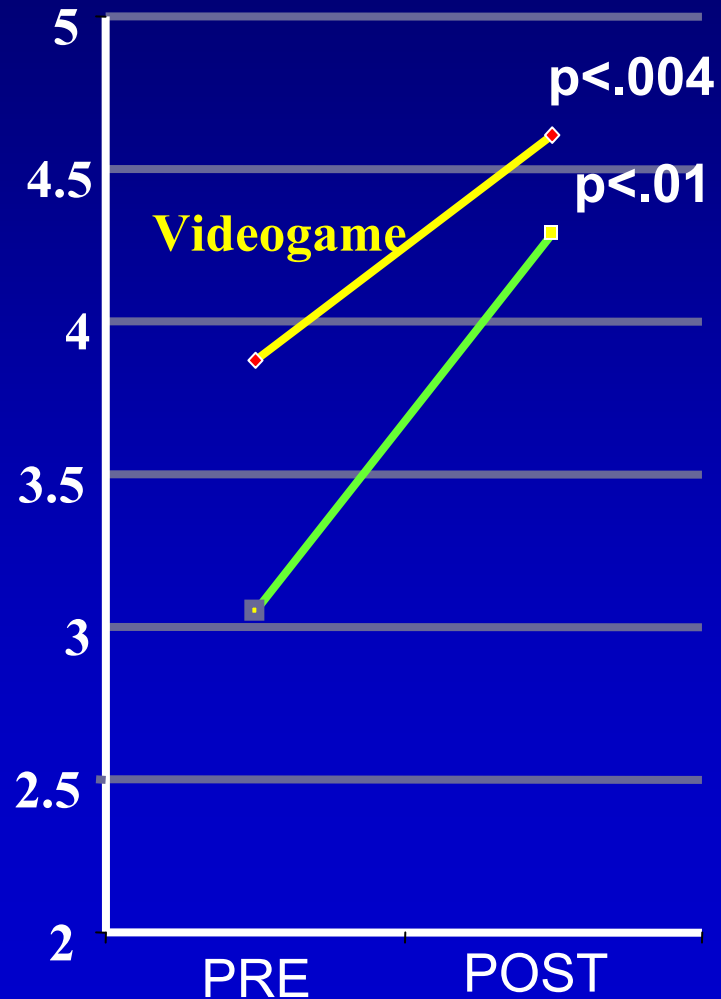


TOVA: TOTAL CORRECT RESPONSES AND D PRIME

Total # of correct responses



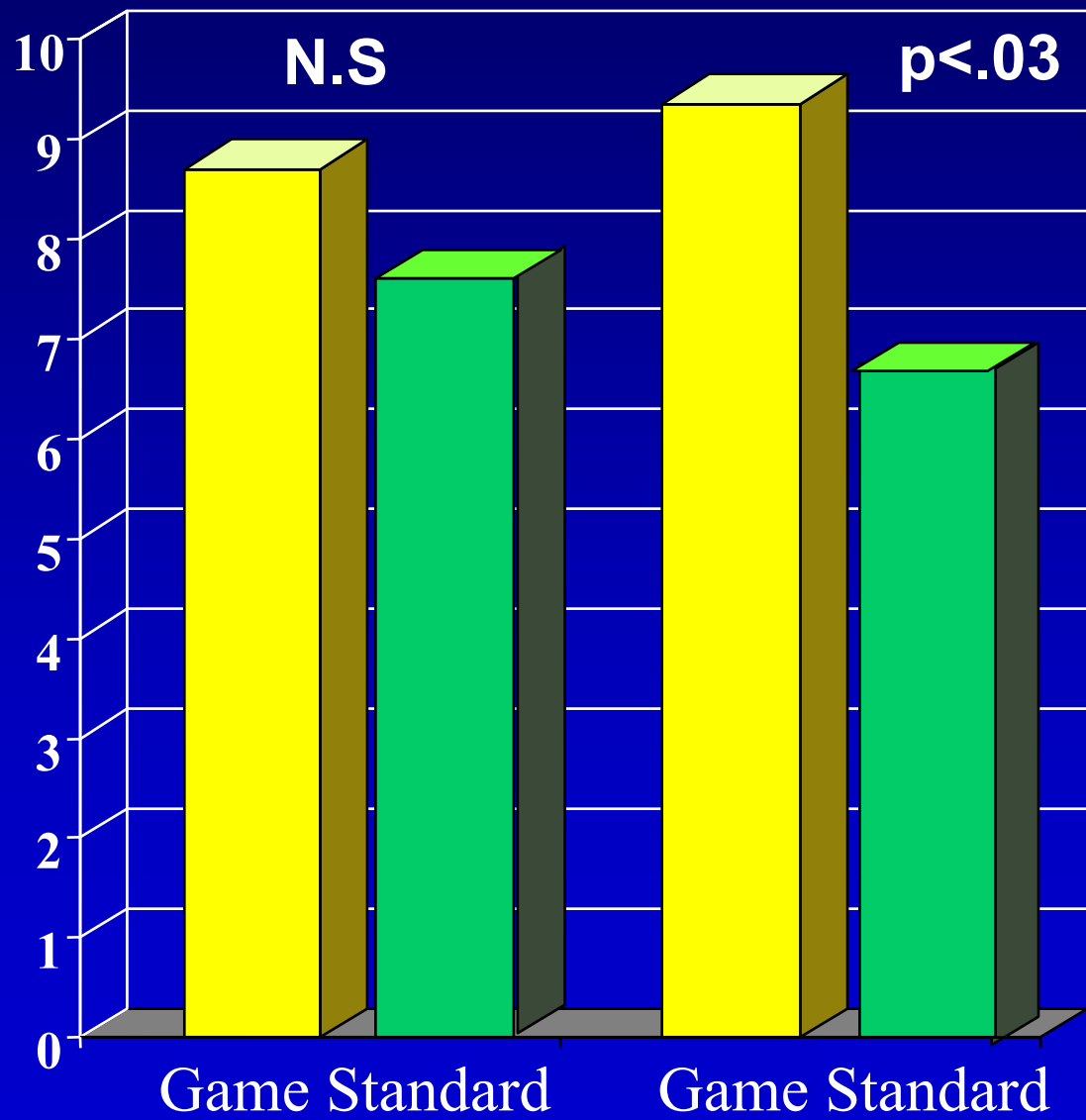
D prime



**PARENT
POST-TREATM.
SATISFACTION
SURVEY**

**Satisfaction
with results**

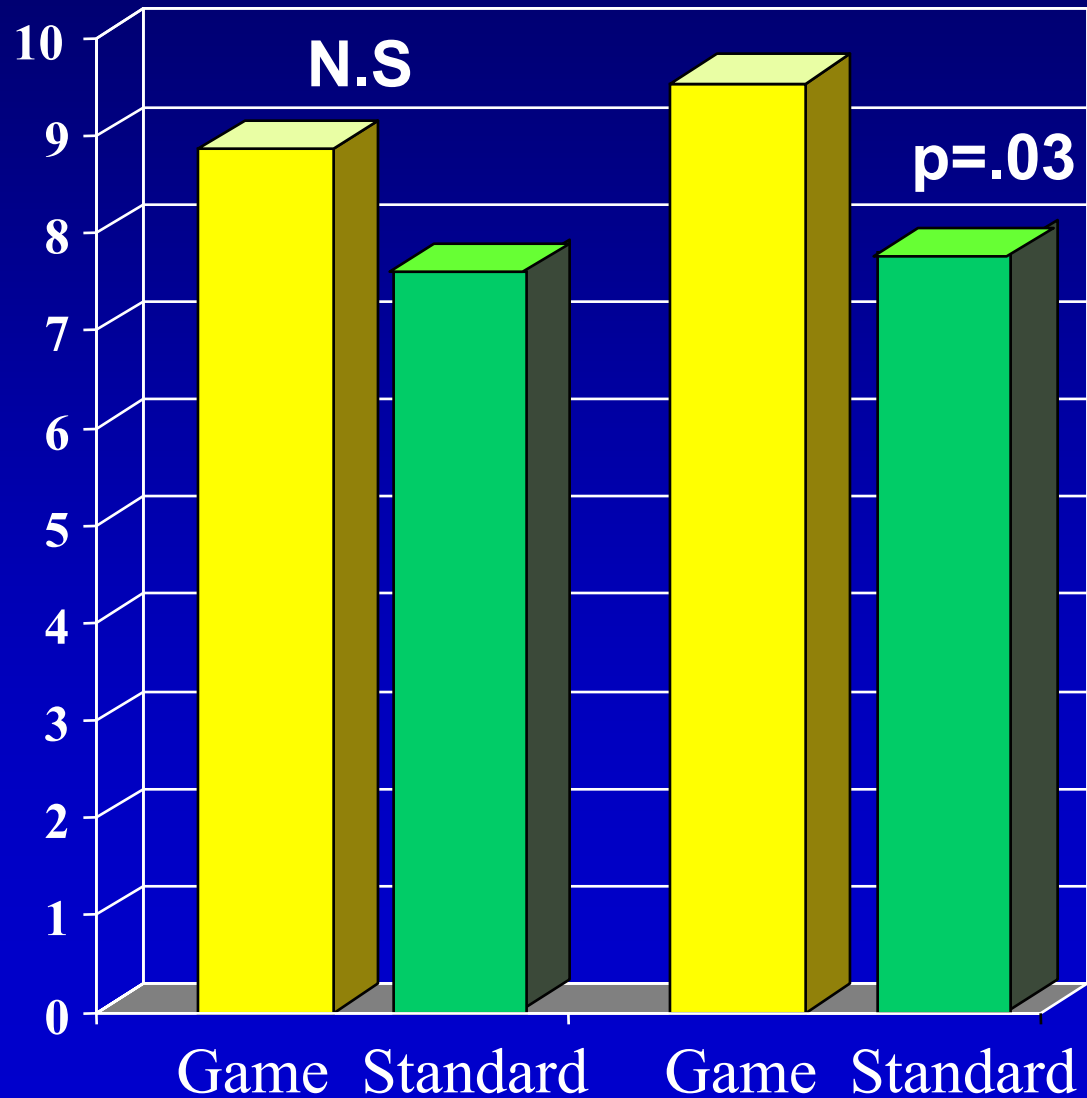
**How much their
children enjoyed
coming for treatment**



CHILDREN'S POST-TREATM. SATISFACTION SURVEY

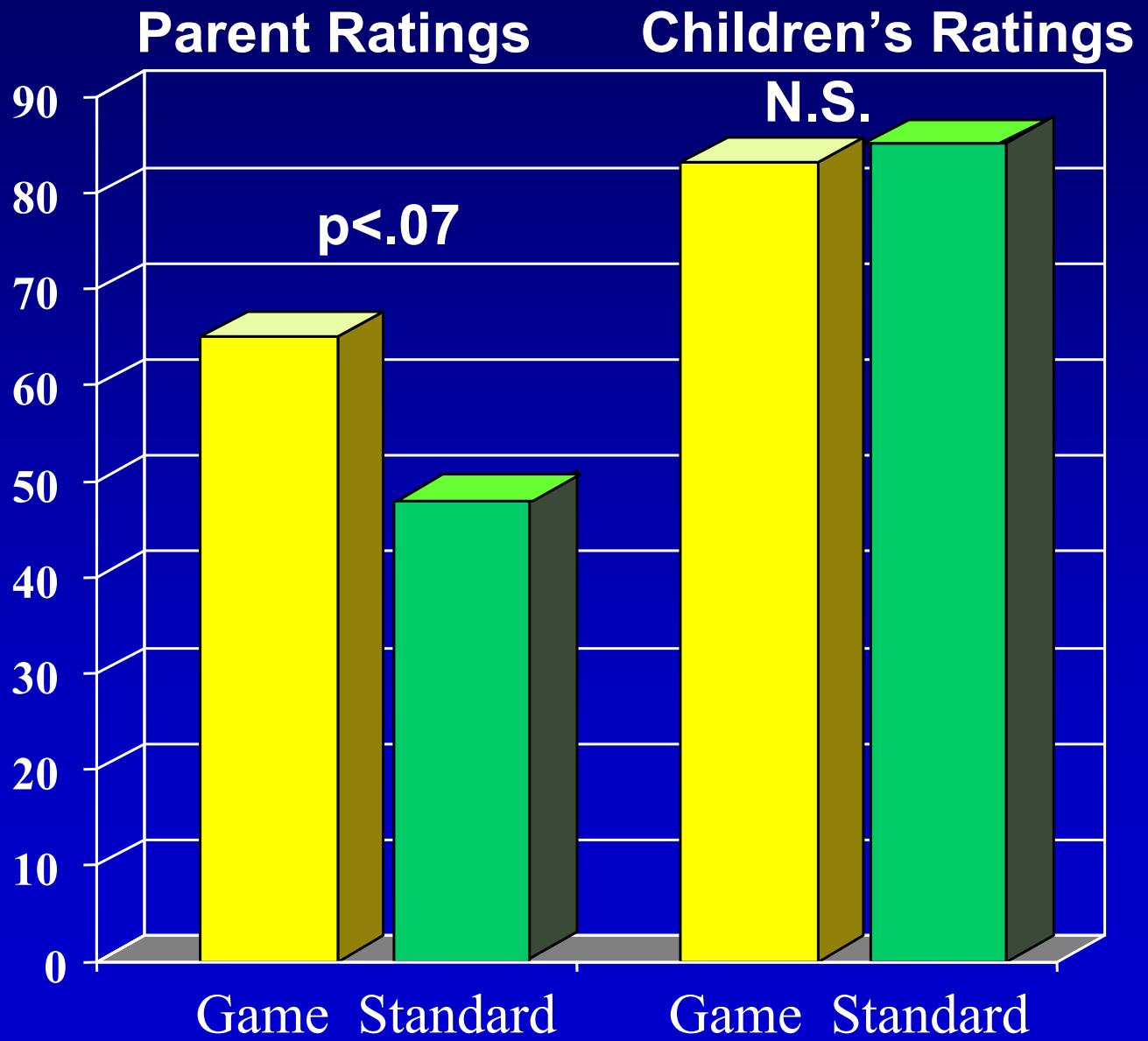
Satisfaction
with results

How much they
enjoyed coming
for treatment

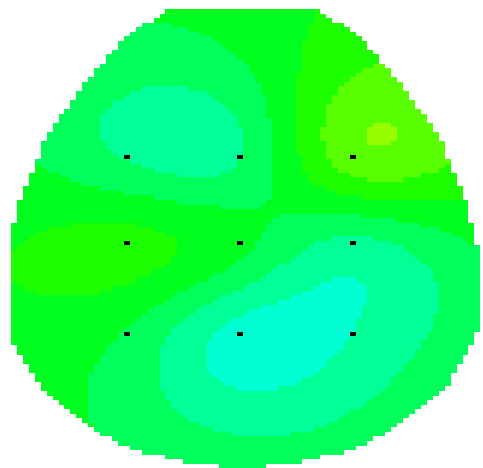


**POST-TREATM.
SATISFACTION
SURVEY**

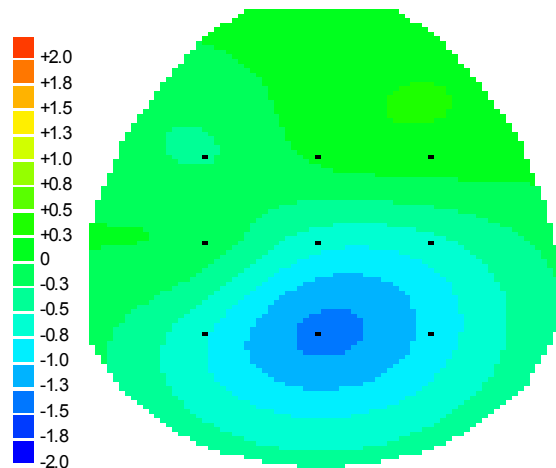
**ESTIMATES OF HOW MUCH
(0-100%) ADHD PROBLEMS HAVE IMPROVED
FOLLOWING TREATMENT**



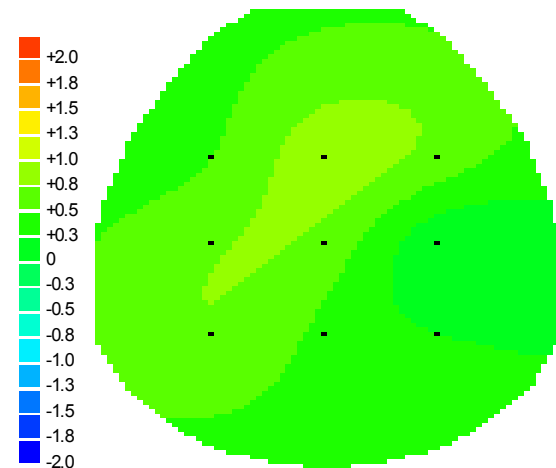
Videogame Group: QEEG Treatment Changes



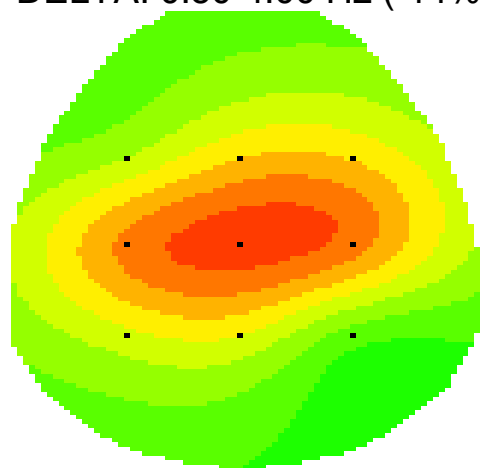
DELTA: 0.50-4.00 Hz (-14%)



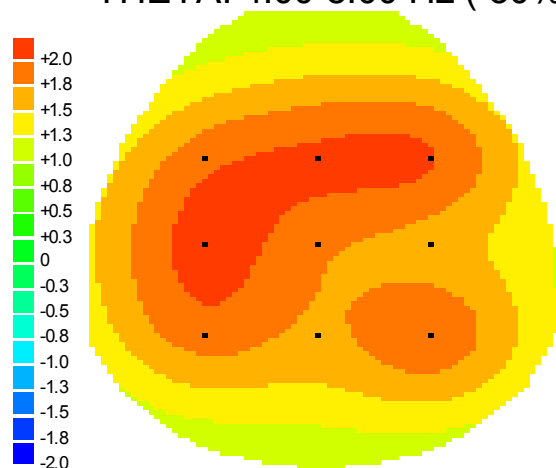
THETA: 4.00-8.00 Hz (-30%)



ALPHA: 8.00-13.00 Hz (15.02%)

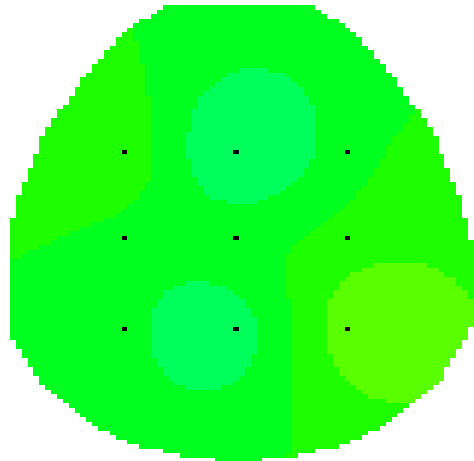


SMR: 13.00-14.00 Hz (12.04%)

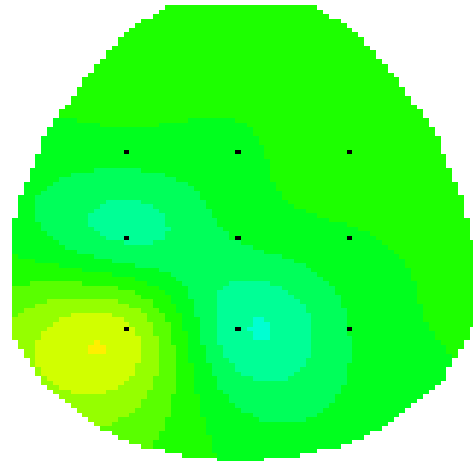


BETA: 14.00-21.00 Hz (117.17%)

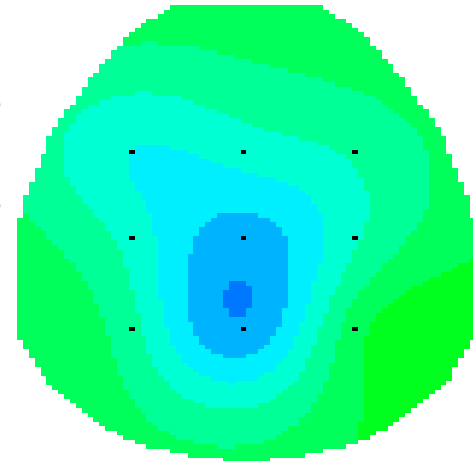
Standard Group: QEEG Treatment Changes



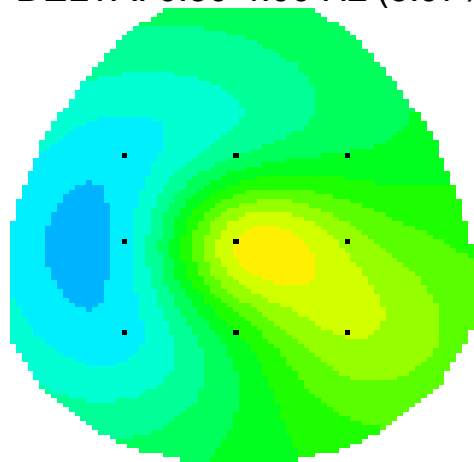
DELTA: 0.50-4.00 Hz (3.97%)



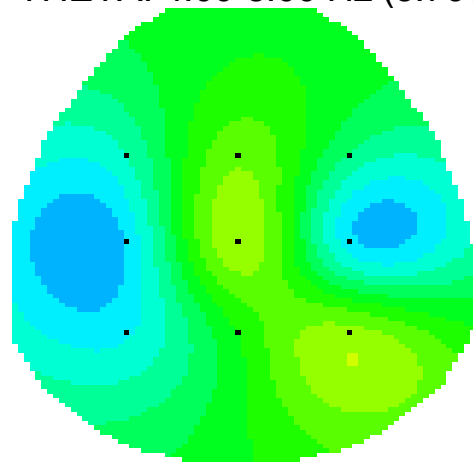
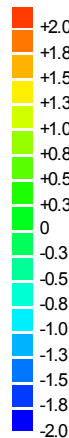
THETA: 4.00-8.00 Hz (5.76%)



ALPHA: 8.00-13.00 Hz (58.36%)



SMR: 13.00-14.00 Hz (2.40%)

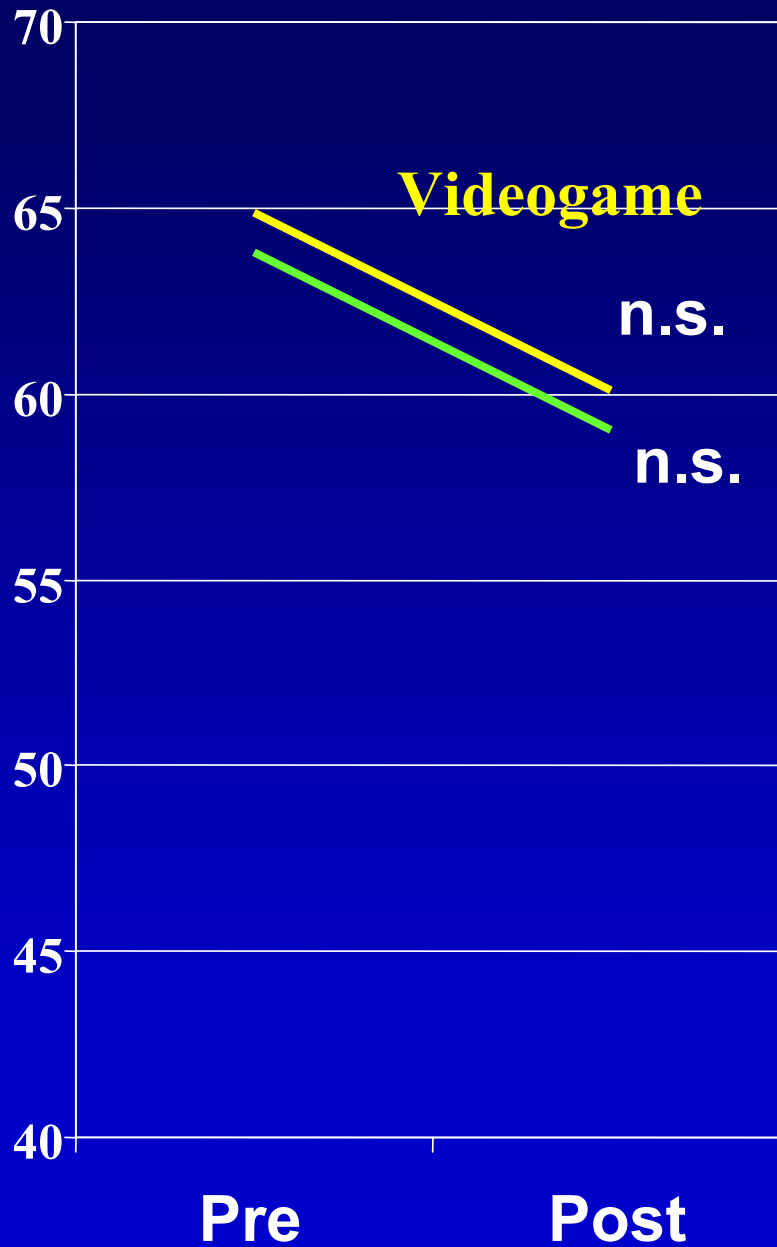


BETA: 14.00-21.00 Hz (29.51%)



Personality Inventory for Children (PIC)

Hyperactivity



Summary of Findings

- Both the videogame and standard neurofeedback groups improved significantly on most main ADHD outcome measures. No significant difference in treatment change was seen in group comparisons
- Parents' subjective appraisal of treatment effect on ADHD was more positive for the videogame group
- The videogame treatment was rated significantly more enjoyable by both parents and children
- Trends on pre-post QEEG change maps indicate that the videogame training may have advantages in creating more quantitative EEG effect in the therapeutic direction

Conclusions

- We conclude that the videogame biofeedback technology, as implemented in the NASA prototype tested, produces equivalent results to standard neurofeedback in effects on ADHD problems
- Both the videogame and standard neurofeedback improve the functioning of children with ADHD substantially above the benefits of medication
- The videogame technology provides advantages over standard neurofeedback treatment in terms of enjoyability for the children and positive parent perception, and possibly has stronger quantitative post-treatment effects on EEG

Advantages of videogame biofeedback

- Inherently motivating, keeps trainees on task continually
- Blends sophisticated neurofeedback (or biofeedback) training into popular entertainment in such subtle ways that none of the entertainment value is lost and EEG biofeedback is no longer a chore but a treat
- Allows individuals to select the games that they like best, making sure that the games stay current and are suitable for each person's gender and developmental level
- Can be used largely without clinician involvement or effort – making group treatment or properly arranged home use easy
- Is inexpensive technology, as game software does not have to be written for EEG biofeedback