Case Study:
Improvements in IQ Score and Maintenance of Gains Following EEG Biofeedback with Mildly Developmentally Delayed Twins
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ABSTRACT.
This study reports on the improvements in IQ scores and maintenance of the gains following EEG biofeedback with identical twin girls with mild developmental delay and symptoms suggestive of Attention Deficit Hyperactivity Disorder (ADHD). Full Scale IQ scores increased 22 and 23 points after treatment and were maintained at three follow-up retests over a 52-month period. ADHD symptom checklists completed by their mother showed a similar pattern of improvement and maintenance of gains. The extent of improvement is supported by anecdotal reports of behavioral changes. The results are discussed in the context of other studies of EEG biofeedback also showing improved intelligence following EEG biofeedback.

Advances in neuroscience bring hope that some day children with developmental delays can be systematically helped. EEG biofeedback is one intervention that holds promise in this regard. First discovered 30 years ago as a treatment for epilepsy (Sterman & Friar, 1972) EEG biofeedback, also called “neurotherapy” or “neurofeedback” has been applied to a range of disorders including Attention Deficit Hyperactivity Disorder (ADHD) and learning problems (Monastra, Monastra, & George, 2002; Nash, 2000; Othmer, Othmer, & Kaiser, 1999). Several studies have cited improvements in IQ scores as evidence that this treatment improves cognitive performance. Tansey (1991) reported improvements averaging 19.75 points on the WISC-R (Wechsler, 1974) Full Scale IQ score for 24 children with “neurological or perceptual impairments or attention deficit disorder.” Using a random assignment wait list control design, Linden, Habib and Radojevic (1996) reported that the 18 participants who received EEG biofeedback showed statistically significant gain of 9 points on the K-Bit IQ Composite. Lubar, Swartwood Swartwood and O’Donnell (1995) reported gains averaging 9.7 points for 23 children; Othmer et al. (1999) reported an average gain of 23.5 points with a sample of 15 children and Thompson and Thompson(1998) reported 98 children gaining an average of 12 points. Fuchs, Birbaumer, Lutzenberger, Gruzelier and Kaiser (2003) reported an improvement of only 4 points in a study of 22 children. It is unclear what accounts for the variability in improvement. However, selection criteria and the training protocols were not homogeneous.
Only a few studies have addressed the issue of whether improvements are sustained. Tansey (1990) discussed the academic and behavioral changes achieved by his participants and included an anecdotal report suggesting continued progress. Tansey (1993) did report a 10-year follow-up with one participant though there were no specific data regarding intelligence test scores. Lubar (1995) published follow-up data on 51 participants for up to ten years after treatment. An independent professional evaluator, blind to the treatment, collected behavioral rating scale data via telephone interviews and found significant improvements in all areas. However, like the Tansey reports, there were no data regarding IQ scores.

Reports of increases in IQ scores for children with various attention, neurological and learning disorders is especially remarkable in that IQ scores are generally very stable and not particularly malleable (Brody, 1992). Cheng, Liu and Gong (1993) reported that across a 1.5 to 2 year interval, both learning disabled and normal children displayed stable Verbal, Performance, and Full Scale IQ scores on a Chinese version of the WISC-R. Streissguth, Randels and Smith (1991) reported that IQ scores of patients with fetal alcohol syndrome or possible fetal alcohol effects remained stable over the average test/retest interval of eight years. Both Haddad, Juliano and Vaughan (1994) and Kaye and Baron (1987) reported that with learning disabled children WISC Verbal IQ scores tended to decrease while Performance IQ scores increased over a three year period.

Finally, Spitz (1986) reviewed the history of attempts to raise IQ in developmentally delayed and/or culturally disadvantaged children. Efforts included early intervention and compensatory education programs such as Head Start, behavior modification, medical and dietary interventions, and various sensory and motor therapies. He concluded that none have shown any significant effect in raising intelligence scores.

DISCUSSION
While based on treatment of only two participants, the results suggest that relatively dramatic improvements in IQ scores following EEG biofeedback could be achieved in relatively young children exhibiting mild mental impairment, and that these gains could be maintained over the long term. Of course, the results are only meaningful if one assumes that the pre-treatment IQ scores were valid. There are several reasons to accept this premise. First, the initial scores corresponded well to the girls’ overall impaired functioning with language, social skills and physical coordination. Second, while anxious, the girls also liked to please, and having been made comfortable with the examiner, both girls willingly cooperated with the testing. Finally, on one of the scales, Digit Span, they both performed in the Above Average range. Poor cooperation or lack of understanding would have resulted in low scores on every subtest or outright failure to complete the test.
Was their improvement in IQ scores simply a function of improved attention? Interestingly, improvements on the four ACID subtests (Arithmetic, Coding, Information and Digit Span) cited as most reflective of attention problems (Wechsler, 1991) were smaller than those on the eight non-ACID subtests. Nor were the gains mainly on either the Verbal versus performance Subscales or on the timed versus untimed subtests. Improvement was across the board though some subtests changed more than others.

Nor do the gains in IQ scores seem to be simply a matter of being better at some narrow ability in test taking. Rather they appear to represent a qualitative jump in cognitive functioning including rapid gains in physical coordination, language and what might be described as a layperson's sense of intelligence. The following is from a letter their mother wrote at termination.

Now that the biofeedback sessions are completed I can honestly say that it has made such a big difference in both girls. I don't know where to start! I went back through a journal that I had kept regularly throughout the biofeedback session. The first differences that we noticed, (after only 3 sessions) was a coordination improvement. Both girls—for lack of a better description—were clumsy. They couldn't ride bikes, [suspend themselves from] cross bars, climb, or slide down poles. And all of a sudden they are out crossing bars and after a few more sessions they were both riding bikes. It wasn't like before where everything they did was so “learned” or “taught.” They just got on one day and in a few tries were off and running.

Other things we noticed were the ability to carry on a two-way conversation. We had all of our family commenting on this – especially around 20 sessions. We had one friend who came to visit at Thanksgiving and said, “The girls have grown up, and they are talking to me instead of at me.”

The thing we are most pleased with is the progress they have made in school . . . they just seem smarter; they reason and think when they talk. They've gone from being extremely dependent to being average kids, the type that say, I'm going to go ride my bike, I'll check-in in awhile.

One intriguing question is why the second round of treatment was unable to produce further improvements in IQ scores. Is there a finite limit to improvement? Would the introduction of different neurotherapy protocols have achieved further benefit? Certainly this study suggests the need to replicate the study and the value of further research on neurotherapy with the mildly developmentally delayed. Even a modest favorable impact on level of intellectual functioning through neurofeedback portends significant societal benefits for the management of mild mental retardation and for the quality of life of the individuals concerned. Before this hope can be realized, however, there needs to be a more fundamental understanding of how neurofeedback can impinge on IQ through its reordering of cerebral control mechanisms in the bioelectrical domain.
REFERENCES


