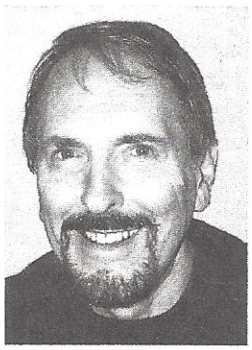
FEATURE ARTICLE



Reversing Age-Related Cognitive Decline: Use Of Neurofeedback And Audio-Visual Stimulation

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Abstract: *Reversing age-related cognitive decline in older adults is an important health care prerogative, especially as the population ages. Two methods of intervening neurologically which are to be described here are: neurofeedback and audio-visual stimulation. These two approaches induce shifts in EEG power toward frequencies known to be associated with higher levels of cognitive function. This single case illustrates the results the authors have come to expect with the application of these techniques to those elderly with age-related cognitive decline (ARCD). The study measures pre-post cognitive functioning through the use of the Microcog, a computerized program of neuropsychological testing. Results in this case study indicated improvement in cognitive function in 7 of 9 tests. Pre-post decreases were also seen in the power in low frequency EEG bands (1-3 Hz), (3-5 Hz) and (5-7 Hz) and increases in his alpha band (7-9 Hz) power. This case study represents only one of a number of successes with the use of neurologically based approaches with the elderly.*

Introduction

Age-related cognitive decline (ARCD) is a very common problem among age groups over fifty. Hayflick (1994) noted that by the year 2000 there will be approximately 60 million people in the U.S. who will be 55 years and older. Of these, 35 million will be 65 years and older.

Cognitive-behavioral treatment and natural dietary supplements such as ginkgo biloba are current practices. Audio-visual stimulation (AVS) and neurofeedback may offer alternative approaches of intervening neurologically to bring about a reduction of cognitive and memory deficits (Budzynski, 1996). Remediation through AVS and neurofeedback is achieved by inducing shifts in brainwave (EEG) parameters via simultaneous photic and auditory stimulation. Information about those shifts is then fed back to the user via neurofeedback. In effect, the system is intended to elicit and train brainwave states associated with higher levels of cognitive function. The rationale for using AVS with cognitive deficits in the elderly involves the known associations among cognitive decline, EEG frequency patterns and cerebral blood flow, and the effects of stimulation on these three bodily activities.

AVS has been utilized successfully to treat attention deficit disorder in children (Carter and Russell, 1997). Japanese researchers also examined the effects of an EEG-driven AVS system in two articles (Kumano et al. 1996; Kumano et al. 1997). Rozelle and Budzynski (1996) applied EEG-driven AVS in combination with neurofeedback for stroke symptom reduction in a difficult case. Mentis et al. (1997) used PET scans with elderly subjects to show how photic stimulation can activate even frontal areas of the brain. Photic stimulation was also used to improve academic performance in a controlled study by Budzynski et al (1999). Numerous anecdotal clinical reports of neurofeedback protocols for ARCD tout the success of this application but no controlled studies have been published to this point.

Cognitive Processes and Memory in Aging

For the most part, studies consistently confirm that the ability to perform memory retrieval is gradually reduced with normal aging (Peterson et al. 1992; Craik, 1991). As well, these deficits are reflected in lower information processing speed, decreased accuracy of processing and decreased quantity of information acquired. West (1996), applying a prefrontal cortex function theory to cognitive aging, found that dysfunction of the frontal lobes could account for some cognitive deficits in aging, but was incomplete as an explanation. In support of this finding, decades of tracing mental operations to specialized areas of the brain have eventuated in recent studies using nuclear imaging (Posner & Raichle, 1994). While studying enriched environments of rats, Greenough (1999) described memory as basic information networks laid in early life, with new learning generating new nerve cells connections, providing incredible structural interplay and plasticity. Cognitive deficits and regeneration in aging are recognized to function as global processes, responsive to general stimulation (such as enriched environments for rats and brain stimulation in humans).

An important neuroscience research basis for the study of cognitive decline in aging and regeneration (as potential for restoration of cognitive functioning) is the re-growth of nerve cells. The most promising findings are in the validation of neurogenesis of hippocampal and hypothalamic neurons as key brain

processes for overcoming cognitive effects of stress and aging. A decade ago Diamond (1988) found differences in synaptic growth between elderly rats who were placed in an enriched environment and rats whose environment was not enriched. Dendrites were structurally modified to be greater in number and branching in the enriched condition. Similar changes to those in rats are evident in humans. Now it appears that stem cells can generate new nerve cells in the hippocampus as well (Kempermann & Gage, 1999).

EEG Patterns and Aging

As compared to 30 year olds, adults age 65 years and older typically exhibit EEG frequency shifts to lower frequencies. There is a decrease in the dominant Alpha frequency, an increase in magnitude in theta rhythm (4-7 Hz) and a decrease in magnitude of Beta-1 and Beta-2 (>13 Hz). Some researchers report that among the elderly who have cognitive decline, the most pathognomonic characteristic in the quantitative EEG (QEEG) patterns is a generalized increase in *diffuse slowed activity* (Prichep, et al. 1994). In dementia patients, the brain wave activity is characterized by a generalized significantly increased magnitude in theta and delta activity with decreased blood flow and cerebral metabolic rate. This may indicate that metabolic/circulatory activities are significant factors in cognitive decline. Increases in magnitude of theta and delta appear to be early prognostic indicators of cognitive decline and life expectancy. Williamson et al (1990) found significant positive correlations of Beta-1 with performance on cognitive testing at frontal and central locations bilaterally. Also, the reduction of Alpha frequency was significantly related to decreased cognitive functioning.

Some Facts Concerning ARCD

1. Among individuals aged 50-59, 40%, meet the criteria for ARCD. Those aged 60-69 show ARCD at a 50% rate. Greater ages show even higher percentages.
2. Since ARCD is not considered a disease, prescriptive drug therapy is not usually applied.
3. ARCD shows up as decreased ability to perform memory retrieval, slowed information processing speed, decreased accuracy of processing, and decreased quantity of information acquired.
4. Deficits are usually found in the frontal and temporal areas.
5. Chronic stress, chronic depression, PTSD and early trauma can all lead to memory deficits in adulthood.
6. Head trauma, even mild head injury, can result in cognitive problems.
7. Certain chronic illnesses such as chronic fatigue syndrome, can increase cognitive symptoms.
8. Chronic lack of sleep will result in cognitive difficulties.
9. Vascular blockages, whatever the cause, e.g. cholesterol, are the most probable cause of ARCD.
10. Certain prescription medications may result in cognitive deficits as well.

A Case Study Demonstrating the Effects of Neurofeedback/AVS

S1-76 was a 76 year old male in fragile health with a history of two heart bypass surgeries, a balloon angioplasty of the left carotid, implantation of a pacemaker, hearing problems, and self-reported cognitive deficits. He was administered the Microcog (Psychological Corporation, 1993), a computer presentation of a battery of cognitive tests, before and after training. He received 30 sessions of neurofeedback (primarily suppression of the power in the 2-12 Hz EEG band in the frontal area) along with 14 Hz AVS (audio/visual stimulation) augmentation at the start of the neurofeedback sessions and for home use. About the date of his 20th session he received his regular hearing exam and adjustment of his hearing aids. To the physician's surprise, his hearing had improved significantly whereas it had always been found to have worsened in prior exams. This fortuitous event cannot be attributed conclusively to the training, however, Figure 1 shows the pre-post power change in 2 Hz bands at Cz. The lower frequency bands (1-3, 3-5, and 5-7 Hz) show a reduction in power, while the there is an increase in Alpha power in the 7-9 Hz band, which is a positive finding since Alpha power tends to diminish with age. Due to several trips and a long vacation, the training was extended over a five month period, nevertheless, as seen in Figure 2 the pre-post Microcog percentiles show improvements for all but two scales.

Summary

A growing number of clients reporting cognitive deficits have now been trained by us and by Elsa and Rufus Baehr using combinations of "Brain Brightening" protocols. Most are tested with the Microcog before and after their training. During or following training the clients often report a resurgence of abilities in relevant areas of their lives, e.g. recovering writing skills, card games, short-term memory and sound, restful sleep. Since ARCD symptoms can began in the 40s or 50s there is a great potential for application in our rapidly aging society.

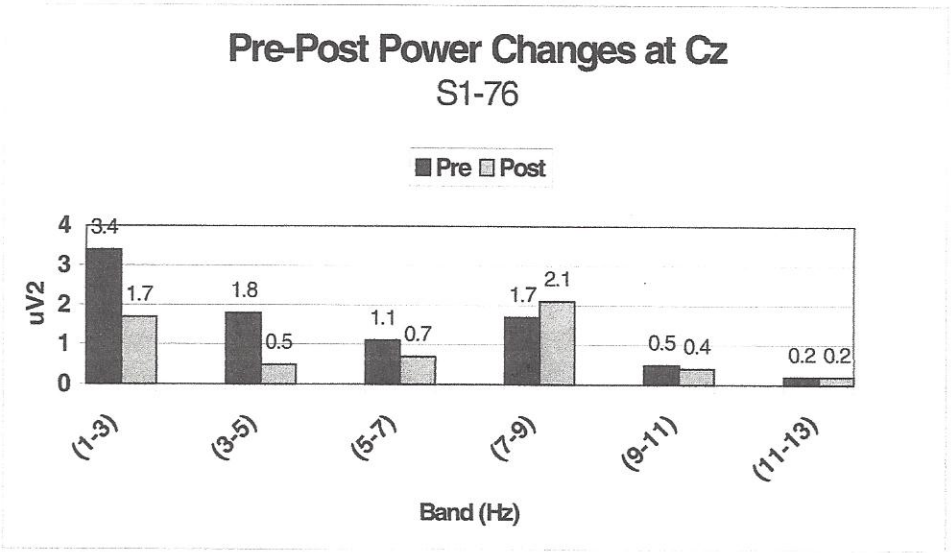

Figure One

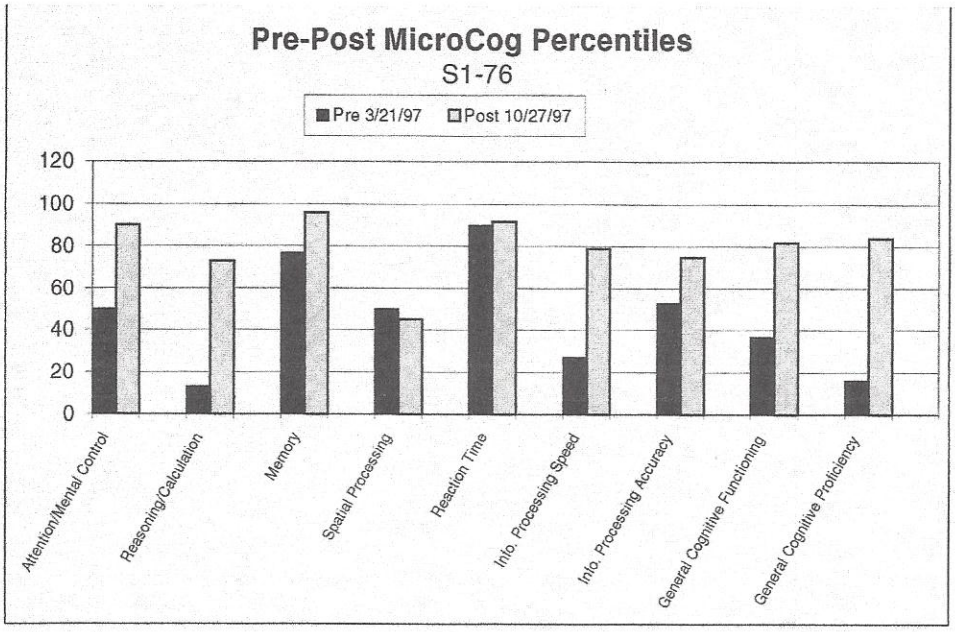

Figure 2

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