Neurofeedback to Improve Physical Balance, Incontinence, and Swallowing

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D. Corydon Hammond, PhD

ABSTRACT. An innovative neurofeedback protocol for the treatment of problems with physical balance, incontinence, and swallowing is described. Successful case reports from four consecutively treated cases are presented. This protocol holds potential promise for work with the elderly, stroke and head injury patients, primary nocturnal enuresis, and in peak performance training where balance is important. Further controlled research is warranted. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress.com> Website: <http://www.HaworthPress.com>*

KEYWORDS. Neurofeedback, EEG biofeedback, balance, incontinence, stroke, head injury

INTRODUCTION

Margaret Ayers (personal communication, July, 15, 2000), who has been doing neurofeedback full time since 1975, taught me a protocol that she discovered. Ayers learned that it would result in improvements in physical balance, centrally mediated incontinence, and problems in

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swallowing. This protocol consists of placing two electrodes directly below the electrode sites O1 and O2, barely above (at the top edge of) the inion, which is a location for which QEEG normative data is not available. This location would appear to be approximately over Brodmann areas 18 or 17. The protocol utilizes a bipolar (sequential) montage, inhibiting 4-7 Hz, while mildly reinforcing 15-18 Hz. The amplitudes of the EEG are very low at this location, and thus the threshold settings must be adjusted accordingly.

This paper presents the results of four consecutive clinical cases where this protocol was used. In each case, treatment was done with Ayers' all-digital, real-time Neuropathways EEG neurofeedback unit. This equipment samples at 250,000 samples/second and digitally filters the EEG signal, with a common mode rejection ratio >110 db wideband and >120 dB at 60 Hz.

CASE 1

The first opportunity to use this protocol was with a patient who called me from another part of the country. He was a prominent attorney, 50 years old, who indicated that his memory was becoming so impaired that it was difficult for him to go into court and do the expert witness work that was a central part of his practice. He had been evaluated by several neurologists who had done CAT scans, MRIs, and a clinical EEG which were all judged to be normal. The best estimate was that his problems stemmed from several mild head injuries incurred when he had fallen while hiking and skiing. In our initial interview he indicated that he also had some problems with balance and unsteadiness. When we discussed balance, he explained that all of his neurologists had him do the same evaluation. He was asked to stand with his feet together, hold his arms out to the sides, close his eyes, and then walk heel-to-toe. He indicated that this evaluation always resulted in the same outcome (i.e., by the third step he would lose his balance and fall over). The patient then abruptly got out of his chair and demonstrated this to me. On the second step he was extremely wobbly, and on the third step he was falling over and catching something to keep from falling down.

On this first trip to Utah his schedule only permitted four neurofeedback sessions. I minimized his expectations about what we could accomplish in such a brief time frame. On the first day I completed two 30-minute sessions utilizing the protocol for balance. The next day he indicated, to my surprise, that he felt steadier and as if he had been "bumping into walls less" in the hotel halls. I found myself wanting to believe

that this was a genuine effect, but it was so rapid that I also considered that it could well be a placebo effect. We did another 20-minute segment during the third session using this protocol. In his fourth neurofeedback session we worked in another area. As he was about to leave for the airport, he commented again that he was feeling steadier on his feet. Therefore, I asked him if he would once again stand up, put his feet together, close his eyes, and walk heel-to-toe. He stood up and this time he walked with far better balance and went 12 steps until he bumped into my wall. We were both convinced that he could have gone further. Needless to say, both he and I were impressed and he indicated that he wanted to make another appointment to return. Four and a half further sessions with this protocol during his future visits brought greater improvements in balance, and 28 other neurofeedback sessions produced improvements in memory and intellectual function as well.

CASE 2

An elderly woman contacted me about the possibility of my seeing her 45-year-old daughter. Seven years earlier the daughter had suffered a brain aneurysm in her right carotid artery while living in the Pacific Northwest. During neurosurgery she had a stroke. She appeared for the appointment in a wheelchair. She had almost no movement in her left leg, but a physical therapist had taught her to wear an ankle brace, use a cane with a large base, and to throw her hip. Her balance was very compromised and she relied heavily on the cane to move awkwardly on her feet. In this way she was able to move around minimally in her kitchen and she was able to leave her wheelchair outside my office door. However, she spent an estimated 98% of her time in a wheelchair.

Her left arm was constricted tightly against her chest, with her left hand was clenched in a fist. She could not open her fingers or hand, and could not move her left arm. This was extremely uncomfortable for her, but she had resisted a physician's recommendation that they cut nerves leading to her hand and arm to allow them to relax. There had been a deterioration in general intellectual function following the stroke. She could no longer concentrate well enough to read very much, and she spent most of her days watching television in her wheelchair. She also had problems with urinary incontinence, having "accidents" four to five times a day, despite taking three pills a day for bladder control.

Our initial sessions focused on her left hand and arm. With electrodes about an inch in front and behind C4, we inhibited 4-7 Hz and mildly reinforced 15-18 Hz. After six to seven sessions, her arm had relaxed, fallen

away from her chest, and her hand was open. She indicated that if we did nothing else for her, she would still be profoundly grateful. We continued to have sessions similar to this over the area of the homunculus related to her hand, but it appeared that the damage was too great and we were never able to obtain hand movement.

Next we began to work with electrodes about an inch in front of and behind Cz, over the area of the homunculus associated with her legs. She traveled from a rural area in Utah, with her mother driving her about three hours to our appointments. Therefore, we usually did one neurofeedback training session at 10:00 a.m. and had a second session at 2:00 p.m. Commonly, one of these sessions would be over the area for her legs, and the other session utilized the balance protocol. Although she had commented on her problem with incontinence in the intake interview, I simply told her that this electrode placement was to improve her balance, along with the work we were doing to improve her ability to use her left leg, thus making this into a single blind case study.

At the conclusion of a total of 50 sessions, the patient was spending 95% of her time out of her wheelchair. She was taking one-half to full mile walks daily with her mother. When she was outdoors (for instance, going to get her mail from the mailbox at the edge of the road) she would use her cane because she was afraid she might fall. However, around the house and walking from the waiting area to my office, she was obviously walking better without a cane than she had been with a cane previously. In our next to last session, the patient told me about some unanticipated improvements with which she was delighted. She was now reading, and her mother confirmed that she had resumed reading regularly. She then said that there had been another unexpected improvement. Instead of having four to five "accidents" a day, incontinence was now a rare occurrence and she had reduced her medication for bladder control from three pills daily to one pill a day.

CASE 3

The third case was a 46-year-old woman who came for cognitive rehabilitation after a series of small acute or subacute strokes. An MRI found the most numerous foci in the posterior fossa, several of these involving the inferior cerebellar hemispheres both right and left of the midline, but most numerous on the left. There was also found to be involvement of the posterolateral left medulla and a large lesion in the posterior right temporal lobe. Small lesions were found in the right occipital lobe, left parietooccipital lobe, left prefrontal gurus and a single lesion in the right

posterior thalamus. One of the two MRI reports indicated that "the most concentrated collection of lesions is in the posteroinferior left cerebellar hemisphere."

Her complaints were: (a) problems with physical balance, requiring her to use a cane and making her unable to drive; (b) right-sided numbness and tingling; (c) fatigue; (d) daily headaches; (e) lack of endurance in her right leg; and (f) depression. We decided to concentrate first on her problems with balance utilizing the protocol that has already been described. I had a physical therapist administer a functional balance scale, the Berg Scale, to the patient. However, I learned that this scale is designed to measure very severe balance problems, and thus she obtained a score of 55 out of 56. Therefore, to obtain measures of our progress, prior to and during neurofeedback training, I had the patient use a 10 cm visual analogue scale with one end labeled the best balance she had ever had, and the other end anchored as the worst balance she had ever experienced. Once daily she held her arms out to the side, put her feet together, and walked heel-to-toe, afterwards rating her degree of balance. A seven-day baseline was gathered prior to her first neurofeedback session. Her mean balance rating for this seven-day period was only 26 mm.

Treatment for balance consisted of nine sessions across the time frame of a little over one month. During the days following session 1 (and preceding sessions 2 and 3, which later were held on the same day), the mean patient balance rating improved from the 26 mm during baseline to 55 mm. The mean balance ratings following sessions 2 and 3 (but prior to session 4), averaged 79.1 mm. Once again, sessions 4 and 5 were conducted a few hours apart on the same day. The balance ratings following sessions 4 and 5 averaged 92.7 mm. After sessions 6 and 7, her balance ratings averaged 95.3 mm, and following session 8 the mean balance rating was 97.8 mm. The mean balance ratings during a two-week follow-up after the ninth session were 96.4 mm. She had stopped using a cane. The patient discontinued her daily balance ratings at that time.

The patient had problems with depression, which had been a pre-existing condition before her stroke. Therefore, after our work on balance, we had 14 neurofeedback sessions over a six-week period focused on depression. These sessions utilized a neurofeedback protocol for treating depression (Hammond, 2000), inhibiting alpha and theta activity, while simultaneously reinforcing 15-18 Hz beta for 20 minutes, followed by reinforcing 12-15 Hz (while inhibiting alpha and theta) for the final 10 minutes of training. A month following the ninth session for balance, a 12-minute segment of one session consisted of reinforcement with the balance protocol because the patient provided an overall estimated bal-

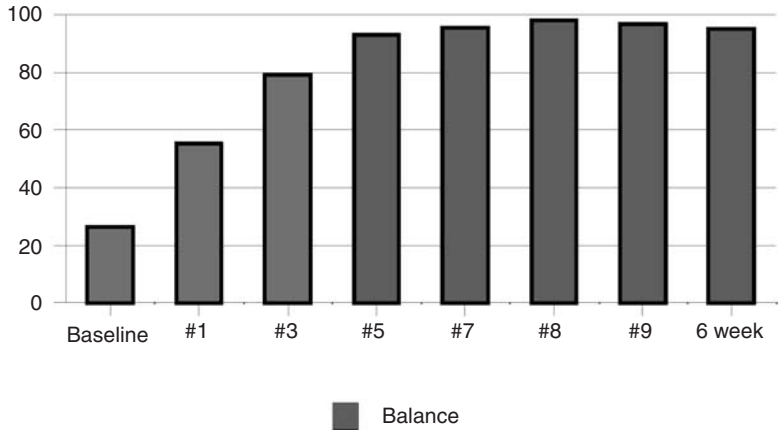
ance rating for the previous two weeks of 89 mm. Two weeks later, she terminated treatment because the winter weather season was beginning and she lived in a rural area requiring her to travel through the mountains for a two-hour commute to come to my office for appointments. When I learned that she planned to terminate treatment at least temporarily, I had her do four more daily ratings prior to her final session. The mean of these balance ratings was 95 mm. Due to financial considerations, the patient never returned for further treatment. However, in a telephone follow-up nine months after treatment ended, she indicated that she had maintained the improvements in balance.

Figure 1 summarizes the progress of this patient with her balance. It can be seen that improvements began following the very first session, and most of the gains in balance had occurred after five sessions. There is a very slight decline near the end of treatment that suggests the possibility that another full session or two of reinforcement may have been of some further benefit.

CASE 4

The fourth case was a 32-year-old woman who presented with multiple problems, including fibromyalgia, depression, insomnia, problems with physical balance and problems with swallowing. A quantitative EEG using the Nx Link (NYU) and NeuroGuide databases found a diffuse excess of relative power theta activity, which was most excessive in

FIGURE 1. Balance Ratings

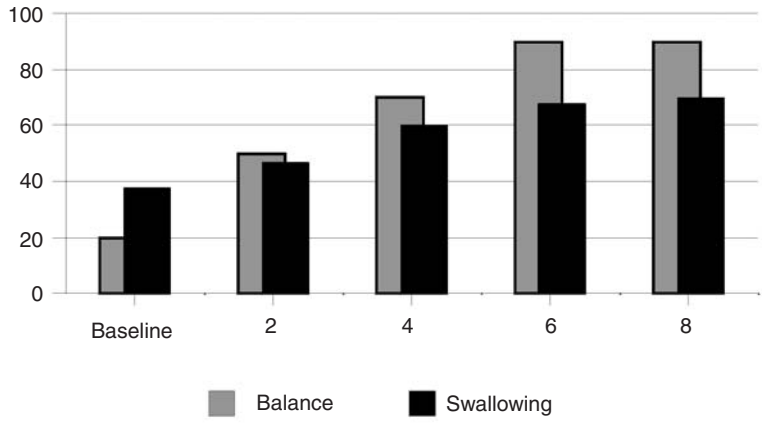


posterior and left frontotemporal areas, with a mild occipital and right posterior temporal-parietal delta excess. In general, this excess slow activity was in the range of 2-7 Hz. She was on no medication. The patient also had a history of six mild head injuries, including four whiplash injuries within a two-year period in adolescence. Although there had never been a loss of consciousness, in the worst injury her stopped small car was hit from behind at 40 miles per hour. A frontal alpha asymmetry was found to be present, with the patient averaging 44.6% on Rosenfeld's (Baehr, Rosenfeld, & Baehr, 2001; Gotlib, Ranganath, & Rosenfeld, 1999) protocol, where scores of 58% or less suggest a biological predisposition to depression, and there was a strong family history of depression. Treatment started with 22 sessions with a depression protocol (Hammond, 2000; Hammond, in press) that was described earlier. After six sessions she was reporting less depression and more energy. By the completion of 22 sessions, her depression level, which she initially rated as being 9, was now rated as 0. She reported that her problems with physical balance and swallowing had not been influenced by the training.

We then turned our attention to her problems with balance and swallowing, using the Ayers' protocol. The patient had completed an 11-day baseline rating period in which each morning before breakfast she closed her eyes and with her arms stretched out to the sides, she walked heel-to-toe, and then rated her level of balance on the 10 cm visual analogue scale, with 0 being the worst her balance had ever been, and 10 being the best her balance had ever been. At breakfast, as she was eating, she used another similarly anchored visual analogue scale to rate her swallowing. On both rating scales, rather than making a line, it was found that she simply wrote a number on the scale. She continued this pattern throughout her ratings. The mean of her baseline ratings for physical balance was 2 cm, and it was 3.8 cm for swallowing.

The patient's progress with balance and swallowing can be seen in Figure 2. The Ayers' protocol was used with her for 30 minutes in each session, and the first two sessions occurred two days in a row. During the time between these sessions she did not record any ratings. Following two neurofeedback sessions, her mean balance rating for the next seven days had improved to 5, and her ratings on swallowing had improved to a mean of 4.7. Following treatment sessions three and four (held on consecutive days), her balance ratings improved to an average of 7 and her ratings on swallowing increased to a mean of 6. In three days of ratings following session five, her balance averaged 7.7 and her swallowing 6.7.

FIGURE 2. Ratings for Balance and Swallowing



In the five days following treatment session six, her balance rating averaged 9 and her swallowing averaged 6.8. Her seventh and eighth treatment sessions occurred on two consecutive days. Over the next eight days, her mean ratings were 9 for balance, and 7 for swallowing. The patient felt satisfied with her progress at this point and we went on to focus on her problem of insomnia. At a three-month follow-up these changes have been maintained without any further reinforcement.

DISCUSSION AND SUMMARY

The preliminary results from these four cases suggest that the Margaret Ayers' protocol for balance, incontinence, and swallowing appears to be a very valuable clinical protocol. What has particularly startled me in all of these cases is how quickly patients begin to report significant improvement, usually within two to three sessions. Since presenting these findings in a scientific meeting, I have been contacted by several clinicians who have used neurofeedback equipment from other manufacturers, but who have reported impressive improvements from using this protocol with patient problems of both balance and incontinence. In one instance, a well adjusted, 19-year-old college student with a lifelong problem with bedwetting was successfully treated in three 20-minute neurofeedback sessions (Gruzelier, 2003). In regard to the latter,

readers may find it interesting that children in special education classes, which is a population we often see in neurotherapy, have more problems with nocturnal enuresis than other children (Spee van der Wekke, Hirasing, Meuhmeester, & Badder, 1998). I do not believe that neurofeedback practitioners have been aware that there are also some interesting QEEG studies on primary nocturnal enuresis (e.g., Kaada & Betvedt, 1981; Hallioglu et al., 2001). In one of these studies, Hallioglu et al. found a decrease in alpha activity in the dominant temporal lobe and bilaterally in the frontal lobes. They also reported an increase in delta activity in the right temporal area and differences from control subjects in the EEG after hyperventilation. Their results led them to conclude that "insufficient cerebral maturation is an important factor in the pathogenesis of primary nocturnal enuresis" (p. 714). The implication from the Hallioglu et al. study, from this current preliminary report, and from the anecdotal report mentioned earlier by Gruzelier (personal communication, November 12, 2003), is that neurofeedback may hold valuable potential in treating enuresis.

I believe that the Ayers' protocol described in this paper has potential for being useful with all three of these problems in the elderly, with stroke and brain injury patients, for peak performance training in areas such as gymnastics or ballet that require physical balance, as well as with chronic enuresis in children and adolescents. Why does neurofeedback at this location produce improvements? I have theorized that improving function in the vicinity of Brodmann areas 17-18 may improve the visual guidance for the cerebellum. These are visual processing areas that are involved in analysis of movement, position, orientation, and depth, and the cerebellum "utilizes visual cues and integrates this with motor output" (Joseph, 1996, p. 387). This idea would not explain the improvements in incontinence and swallowing. But, if the neurofeedback is indirectly influencing the cerebellum, it should be noted that there are connections between the dentate nucleus (in the cerebellum) and the motor cortex, which would be involved with control of movement, inhibitory control over the bladder, and swallowing (Joseph, 1996). This is all speculation, of course, and the mechanism of action by which our positive results are obtained remains unclear. Further controlled investigation of this protocol seems merited. The unusually rapid rate at which improvements occur should make it particularly attractive to academics for controlled outcome research.

REFERENCES

Baehr, E., Rosenfeld, J. P., & Baehr, R. (2001). Clinical use of an alpha asymmetry neurofeedback protocol in the treatment of mood disorders: Follow-up study one to five years post therapy. *Journal of Neurotherapy*, *4* (4), 11-18.

Gotlib, I. H., Ranganath, C., & Rosenfeld, J. P. (1999). Frontal EEG alpha asymmetry, depression, and cognitive functioning. *Cognition & Emotion*, *12*, 449-478.

Hammond, D. C. (2000). Neurofeedback treatment of depression with the Roshi. *Journal of Neurotherapy*, *4* (2), 45-56.

Hammond, D. C. (in press). Neurofeedback treatment of depression and anxiety. *Journal of Adult Development*.

Hallioglu, O., Ozge, A., Comelekoglu, U., Topaloglu, A. K., Kaik, A., Duzovali, O., et al. (2001). Evaluation of cerebral maturation by visual and quantitative analysis of resting electroencephalography in children with primary nocturnal enuresis. *Journal of Child Neurology*, *16* (10), 714-718.

Joseph, R. (1996). *Neuropsychiatry, neuropsychology, and clinical neuroscience* (2nd ed.). Baltimore: Williams & Wilkins.

Kaada, B., & Retvedt, A. (1981). Enuresis and hyperventilation response in the EEG. *Developmental & Medical Child Neurology*, *23*, 591-599.

Spee van der Wekke, J., Hirasing, R. A., Meuhmeester, J. F., & Badder, J. J. (1998). Childhood nocturnal enuresis in The Netherlands. *Urology*, *51*, 1022-1026.

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