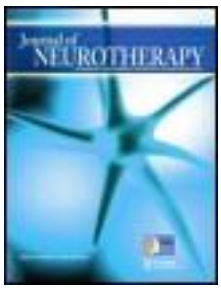

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Performance Enhancement Training Effects on Attention

S. Louise Norris Ph.D. [a] , Ching-Tse Lee Ph.D. [a] , Juan Cea [a] & Dmitry Burshteyn [a]

[a] clinical director of Mid-Hudson Medical Psychotherapy Center , Warwick, NY, USA

[b] City University of New York

[c] Laboratory of Neurofeedback and Behavioral Medicine, Brooklyn College and neurofeedback practitioner at Mid-Hudson Medical Psychotherapy Center in Warwick, New York

[d] Brooklyn College (CUNY); he is currently enrolled in Experimental Psychology Program at The Graduate Center (CUNY)

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Performance Enhancement Training Effects on Attention: A Case Study.

S.Louise Norris, Ph.D., Ching-tse Lee, Ph.D., Juan Cea, and Dmitry Burshteyn.[1]

The purpose of this case study was to evaluate the effects of alpha-increase biofeedback training on human attention. A healthy twenty-three year old male college student had undergone twenty-three sessions of alpha- increase biofeedback (8-13 Hz) at PZ electrode site for a period of eleven weeks. Pre-and Post- visual TOVA CPT test was administered to assess the changes in reaction times and their variability. QEEG evaluation was conducted prior as well as upon the completion of the study. The results of the TOVA test clearly indicate an improvement in individual's reaction time and the reaction time variability. Statistical analysis showed that before and after QEEG evaluations were within normal limits.

Attempts to train subjects to increase the level of alpha activity with operant conditioning began in the 1960s with Kamiya's (1969) work. Kamiya initially asked subjects to tell him at the sound of a tone whether their brain waves were in an alpha state or a non alpha state and found that subjects could successfully make this discrimination. In their 1970 article Nowles and Kamiya indicated that subjects could establish operant control of the alpha brain waves, namely increasing and decreasing alpha activity. This finding clearly demonstrated the possibility of voluntary control of alpha rhythms. Subjects also reported general relaxation and overall pleasant sensations as a result of the generation of alpha rhythm.

Ray and Cole (1985) emphasized the role of alpha waves as being an internal focus of attention. They reported that rejection tasks that require internal mental manipulation produce greater alpha activity than tasks that require input from the environment.

Other studies demonstrate improved performance in athletes following alpha training. In 1984 Hartfield noted that left hemisphere shifts in alpha were noted in peak performance of golfers, archers, gunners, and basketball players at the free throw line. He discovered a burst of alpha waves in the left hemisphere of an expert shooter just before he pulled a trigger. Crews (1989) found changes in left hemispheric alpha to be related to improved performance in golfers. Landers (1991) monitored the brain wave patterns of students as they learned archery. Landers found that as archers' skills improved, the brain wave patterns they displayed during the shooting changed too. At the end of the training they started to show the same bursts of left hemispheric alpha before releasing the arrow as expert archers.

O'Hanlon and Kelly (1993) compared performance and physiological changes between drivers who perform well and poorly during prolonged vehicular operation. They found a consistent relationship between the increase in theta waves, which in high proportions are associated with sleepiness, and an increase in driving errors. Crawford (1995) found that subjects who produce more high alpha perform better on sustained attention tasks. This findings points toward the importance of increase in alpha percentage and

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consequent decrease in proportion of other waves, such as theta, in order to sustain attention. According to Sterman (1994), the pilots who were able to maintain their alpha level during flight simulation were more accurate in their tasks than pilots whose alpha level decreased during flight simulation.

To be successful in the tasks investigated in the studies described above, an individual must be skilled in components related to attention such as concentration, impulse control, reaction time and accuracy. The Test of Variables of Attention (TOVA) is widely used in the clinical setting to assess the changes in the aforementioned components. It is also widely used to assess attention in normal populations. The TOVA was developed to measure processes in several areas such as attention, impulse control, reaction time, and reaction time variability. Greenberg and Waldman (1996) demonstrated that the TOVA is an objective and standardized continuous performance test used to assess attention. It is a non-verbal test which requires no left-right discrimination or sequencing and has no appreciable practice effects (Greenberg & Kindschi, 1996).

The purpose of our study was to determine whether there were changes in variables measured by TOVA visual test upon the completion of Performance Enhancement Training sessions.

Method

Participant

The participant was a twenty-three year old white male who is currently a full-time undergraduate student at Brooklyn College. He participated in this study as a volunteer and had no previous history of EEG biofeedback training.

Materials

All sessions were conducted in the sound-isolated room. The alpha-increase training was conducted using Lexicor POD-2 Mental Conditioning System. The pre- and post visual TOVA continuous performance test was used to assess variables of attention. QEEG evaluation was conducted using Lexicor Neurosearch-24 brain wave acquisition unit.

Procedure

Our participant was administered the TOVA test twice at about the same time of the day. The first test was given one day prior to the beginning of the first session of alpha-increase training and the second test a day after the conclusion of the twenty-third alpha-increase session. Prior to the initiation of the treatment, the participant was advised that biofeedback will be used to increase his alpha amplitude. QEEG evaluations were conducted before and after the training to rule out any neurological abnormalities or Attention Deficit Disorder in our participant.

The participant was given twenty-three thirty minute sessions for a period of eleven weeks (2 sessions per week and 1 final session).The experiment was conducted in a sound-isolated room. Before the beginning of each session a five-minute baseline reading was recorded. The individual threshold for each session was established according to the outcome of five minute baseline. The threshold was set at 85 per cent of alpha baseline value. Feedback was contingent upon the presence of Alpha (8-13 Hz) activity. The Standard International (10-20) Electrode Placement System was used to determine electrode placement. Based on this system four electrodes were placed at the following locations: (1) one at Mid-Parietal (PZ), (2) one at Frontal (ground (G)), and (3) one at each earlobe for reference.

The participant received both auditory and visual feedback. When the threshold level was surpassed by the participant, he was given a bell-sound as an auditory reward and blue bar graph exceeding the threshold line appeared on the computer screen as a visual reward. At the end of each session the participant's statements on his subjective experience of the session were recorded.

Upon completion of his twenty-third session the participant was asked to demonstrate his ability to increase the level of

alpha wave at experimenter's request without feedback.

After twenty-three sessions of alpha-increase training at PZ, the participant exhibited an increase in alpha amplitude from 10 uV in the initial session to 17.6 uV in the last session average.

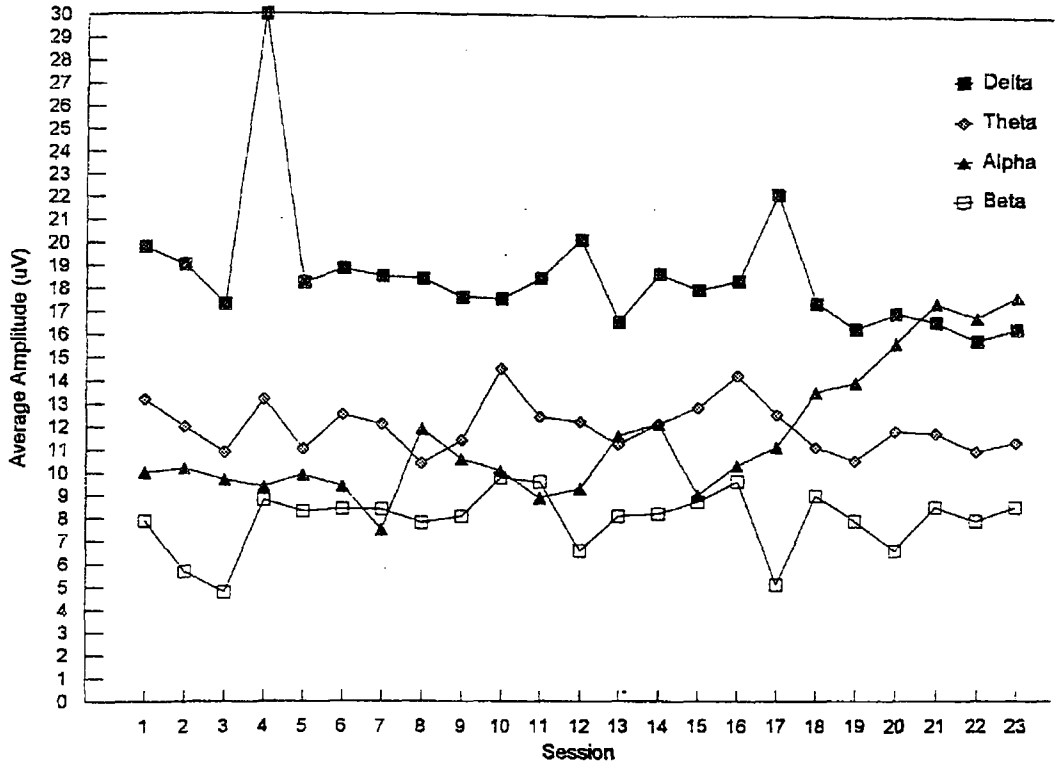
Table 1

Twenty-three session end average amplitudes (μV) collected for Delta, Theta, Alpha, and Beta brain waves collected from one participant over the 11-week period

Session number	Brain Wave			
	Delta	Theta	Alpha	Beta
1	19.8	13.2	10.0	7.9
2	19.0	12.0	10.2	5.7
3	17.3	10.9	9.7	4.8
4	30.0	13.2	9.4	8.8
5	18.2	11.0	9.9	8.3
6	18.8	12.5	9.4	8.4
7	18.5	12.1	7.5	8.4
8	18.4	10.4	11.9	7.8
9	17.6	11.4	10.6	8.1
10	17.5	14.5	10.1	9.8
11	18.4	12.4	8.9	9.6
12	20.1	12.2	9.3	6.6
13	16.5	11.2	11.6	8.1
14	18.6	12.1	12.1	8.2
15	17.9	12.8	9.0	8.7
16	18.3	14.2	10.3	9.6
17	22.1	12.5	11.1	5.1
18	17.3	11.1	13.5	9.0
19	16.2	10.5	13.9	7.9
20	16.9	11.8	15.6	6.6
21	16.5	11.7	17.3	8.5
22	15.7	10.9	16.7	7.9
23	16.2	11.3	17.6	8.5

The results of the pre- and post- visual TOVA test clearly indicated that participant appreciably improved his scores in response time (RT) and response time variability (V) measures of attention. The total standard score for RT changed from 102 in the pre- test to 125 in the post-test-- a difference of 23 standard score points or an improvement of more than 1.5 standard deviations. Response time variability changed from 93 standard score points on the pre-test to 112 standard score points on the post test-- a difference of 19 standard score points or an improvement of 1.26 standard deviations. Omission and Commission errors committed by the participant remained virtually unchanged. The participant demonstrated his ability to increase alpha wave amplitude at will in the feedback-absent condition. The results of before and after QEEG evaluations were within normal limits as defined by Thatcher's data base.

Figure 1
23 Session End Average Amplitudes for Delta, Theta, Alpha and Beta Brain Waves Collected from One Participant over the 11-week Period



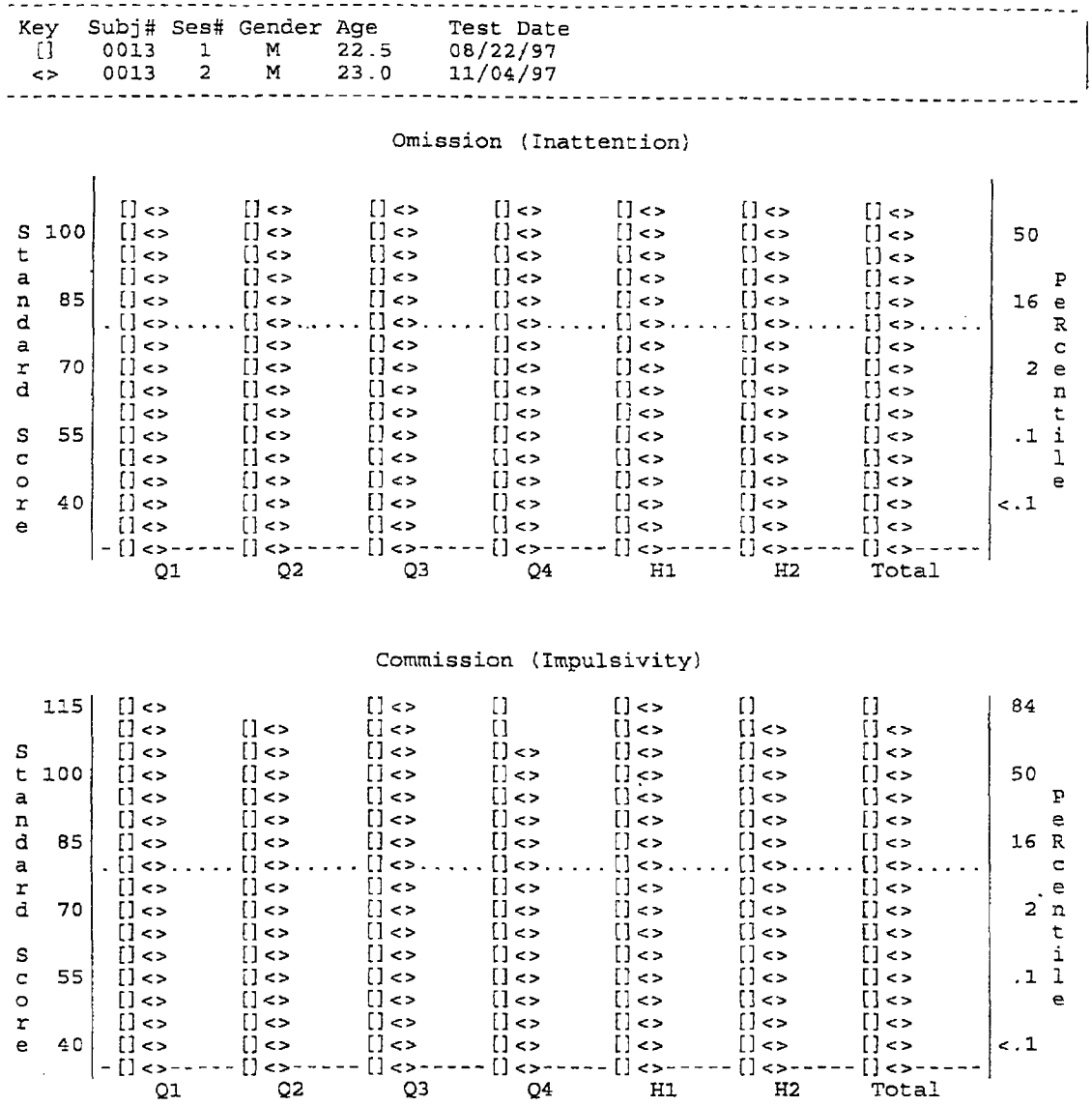
Discussion

Based on our results, we can clearly conclude that Performance Enhancement Training which in this case consisted of twenty-three alpha-increase sessions, produces positive effect on the two important measures of variables of attention such as reaction time and reaction time variability.

An encouraging piece of information is a report given by our participant who stated that he experienced changes in the way he approached his daily activities. According to him, his decision making has improved. He became more focused on his daily activities and, in more broader sense of this word, on his future goals and plans. He became more active, and started getting more involved in materializing his previous dreams and aspirations. To mention a few, over this period of time he made a definite career decision, something that according to him, he was postponing for a long period of time. When given an opportunity to participate in one of the research projects, he was eager to assume responsibility and accomplish it in a short period of time. As a consequence of these improvements in his life he reported feeling stronger, more balanced, and somewhat happier.

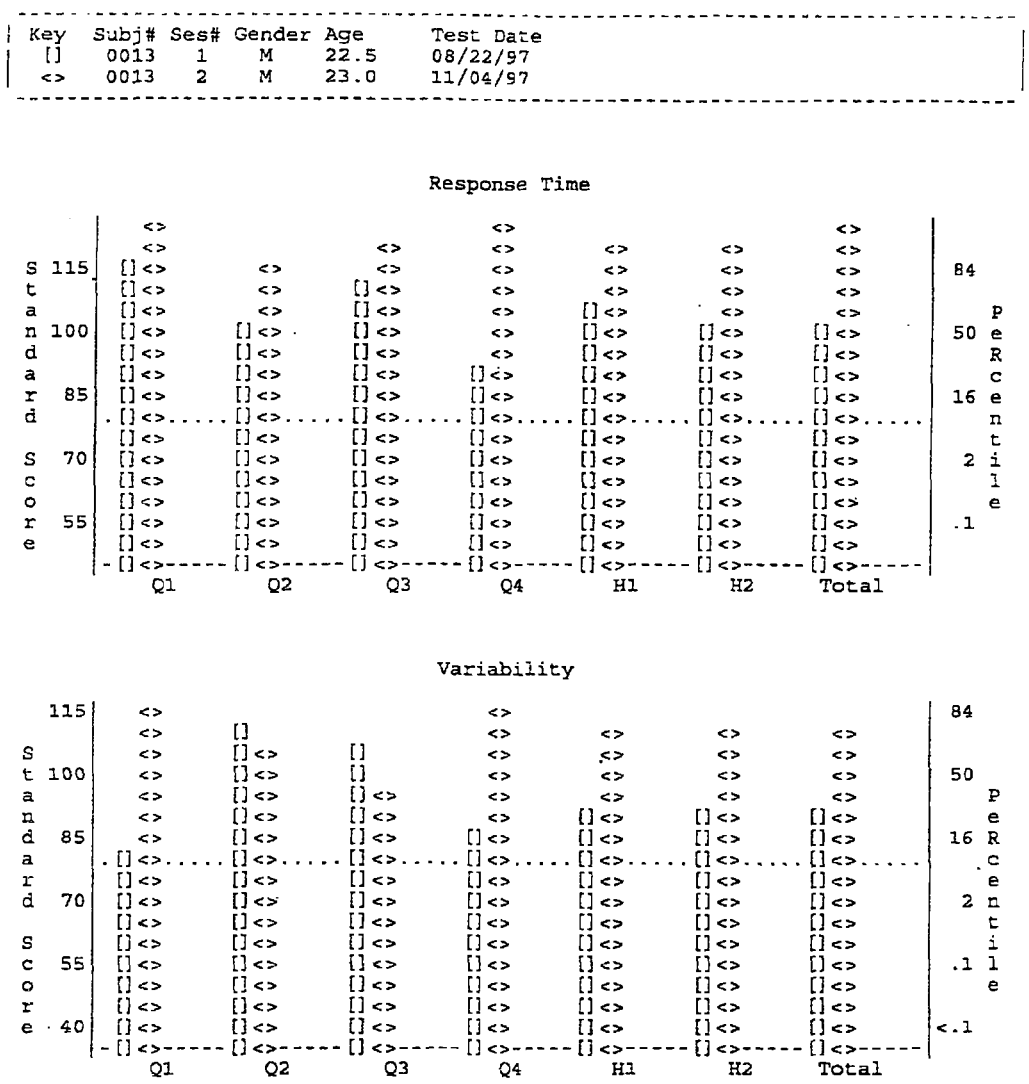
It can be argued that our results are largely incidental due to our inability to generalize them, after all this is only a case study. Still, the results uncovered by this case study make us very optimistic. Our participant belonged to a much larger sample of college students who are currently undergoing the same type of training and are part of the experimental group. We are looking forward to report their progress in our future publications and to follow up on all participants who completed the training.

Figure 2
Pre and Post Transformed Standard Scores for Ommission and Commission Errors Committed by One Participant and Measures by TOVA Test on 08/22/97 and 11/04/97.



Higer scores indicate better performance

Figure 3
Pre and Post Transformed Standard Scores for Response Time and Response Time Variability Collected from One Participant and Measured by TOVA Test on 08/22/97 and 11/04/97.



Higher scores indicate better performance

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S.Louise Norris, PhD., is a licensed psychologist and clinical director of Mid-Hudson Medical Psychotherapy Center in Warwick, NY. Her practice focuses primarily in the area of neuropsychology and she utilizes neurofeedback to address a wide range of disorders including Attention Deficit Disorder, Traumatic Brain Injury, Anxiety, and Depression. She is on staff at St.Anthony's Hospital in Warwick, and a member of Traumatic Brain Injury Advisory Board for Horton Hospital in Middletown. She is an instructor for EEG biofeedback with the Biofeedback Institute of NY. She completed her Ph.D. at Rutgers University, NJ; her M.A. at Montclair State College, NJ; and her B.A. at Evangel College in MO.

Dr. Ching-tse Lee is a professor of psychology at Brooklyn College, City University of New York. He is a member of Executive Committee of the Experimental Psychology Subprogram at the CUNY Graduate Center. His research areas include Applied Psychophysiology, Biofeedback, and Behavioral Medicine.

Juan Cea is currently a research associate at the Laboratory of Neurofeedback and Behavioral Medicine, Brooklyn College and neurofeedback practitioner at Mid-Hudson Medical Psychotherapy Center in Warwick, New York.

Dmitry Burshteyn is an adjunct faculty member at Brooklyn College (CUNY); he is currently enrolled in Experimental Psychology Program at The Graduate Center (CUNY) and is working on his Doctoral Dissertation project.