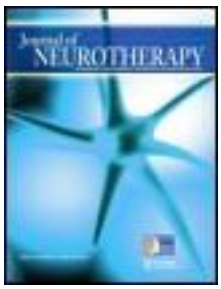

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Applied Research Using Alpha/Theta Training for Enhancing Creativity and Well-Being

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SCIENTIFIC ARTICLES

Applied Research Using Alpha/Theta Training for Enhancing Creativity and Well-Being

Tracy Boynton, PhD

ABSTRACT. *Introduction*. Previous research has supported anecdotal reports of a possible correlation between the state of hypnagogia and the enhancement of creative ability (Green, 1972; Green, Green, & Walters, 1970, 1974; Parks, 1996; Stembridge, 1972; Whisenant & Murphy, 1977). Some psychologists (e.g., Maslow, 1963; Rogers, 1978) have suggested that there is also a correlation between creative ability and enhanced well-being.

Methods. This study utilized an 8-week repeated-measures experimental design to investigate the effects of electroencephalogram (EEG) biofeedback on the willful use of hypnagogia for increasing creativity and well-being. The sample size of 62 (30 experimental subjects and 32 controls) was comprised of both sexes with a mean age of 45. The EEG parameters of hypnagogia were broadly defined as the presence and pre-

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dominance of alpha and theta brain wave activity. Creativity was defined by the three most readily agreed upon divergent thinking abilities: (a) fluency (the ability to generate numerous ideas), (b) flexibility (the ability to see a given problem from multiple perspectives), and (c) originality (the ability to come up with new and unique ideas).

Results. Hypnagogia was analyzed through multiple univariate analyses of variance. The EEG data showed that both experimental and control participants were able to achieve light to deep hypnagogic states in every training session. T-tests results on fluency and originality scores from the Torrance Test of Creative Thinking and the Christensen-Guilford Associational Fluency Test showed no significant changes in pre- and post-tests for either group. However, flexibility in thinking, as measured by the Alternate Uses Test was significantly increased ($p < .001$) for all participants. Well-being, as measured by the Friedman Well-Being Scale, also significantly increased for all participants ($p = .002$).

Discussion. The data suggest that willful use of hypnagogia may indeed increase creativity and well-being. Participants reported increased personal creativity, stress reduction, heightened self-awareness, emotional equanimity, and improved work performance.

KEYWORDS. Neurofeedback, EEG feedback, alpha/theta state, hypnagogia, creativity, well-being, altered states of consciousness

INTRODUCTION

Many notable creative people have described their innovative ideas as coming from a state of deep reverie, an almost dream-like condition in which thoughts often materialize in symbolic form. This altered state of consciousness has been referred to by many names, including hypnagogia (Maury, 1848), the reverie state (Green, Green, & Walters, 1970), and the twilight state (Budzynski, 1977). Subjective reports from highly creative individuals are the most direct source of information depicting how this state of consciousness facilitates the inspiration for new and unique ideas (e.g., Poincare, 1978; Kekule, as quoted in Japp, 1898). Wolfgang Amadeus Mozart wrote that the inspiration for his music often came to him in a dream-like state.

> When I am, as it were, completely myself, entirely alone, and of good cheer-say, traveling in a carriage, or walking after a good meal, or during the night when I cannot sleep; it is on such occasions that my ideas flow best and most abundantly. Whence and how they come, I do not know; nor can I force them. . . . All this fires my soul, and, provided that I am not disturbed, my subject enlarges itself, becomes methodized and defined, and the whole, though it be long, stands almost complete and finished in my mind, so that I can survey it, like a fine picture or a beautiful statue, at a glance. Nor do I hear in my imagination the parts *successively*, but I hear them, as it were, all at once. What a delight this is I cannot tell! All this inventing, this producing, takes place in a pleasing lively dream. (Mozart, 1978, p. 55)

The purpose of this research is to study whether the commonly held belief that hypnagogia enhances creativity and well-being is supported by empirical evidence. Previous research has reported anecdotal data that supported a possible correlation between the state of hypnagogia and the enhancement of creative ability (Green, 1972; Green, et al., 1970, Green, Green, & Walters 1974; Parks, 1996; Stembridge, 1972; Whisenant & Murphy, 1977). Some psychologists (e.g., Maslow, 1963; Rogers, 1978) have suggested that there is also a correlation between creative ability and enhanced personal well-being. Although the potential utility for enhancing creative thinking and personal well-being through the willful use of an altered state of consciousness (i.e., the alpha/theta state) appears worthy of additional scientific exploration, very little research has been conducted on these topics in the past two decades.

METHOD

Participants

This study contributed to the existing body of knowledge in a number of different ways beginning with the uniqueness of the participant sample. Whereas the preponderance of recent research on alpha/theta training has been done with subjects with psychopathology (Fahrion, Walters, Coyne, & Allen, 1992; Peniston & Kulkosky, 1989; Peniston & Kulkosky, 1990), the sample in this study was comprised of 62 normal, healthy individuals. The sample had 29% males and 71% females with a mean

age of 46.21 years and a mean of 16.4 years education. All participants completed a screening questionnaire before they were accepted into the study. The screening questionnaire covered questions that were directly related to the exclusion criteria for this study, which included epilepsy, acute attention deficit disorder (ADD), severe depression, bi-polar disorder, post-traumatic stress disorder (PTSD), dissociative disorders, and high levels of anxiety. Each of the aforementioned medical conditions has particular neurological or psychological risk factors, for which this type of brain wave training may be contraindicated. Participants were also informed that they would be excluded from the study if they were unable to produce any alpha brain waves when in a relaxed, reclined position with their eyes closed. A baseline recording for each participant was done in first session and no one was excluded.

Once an individual was accepted into the study, he/she signed up for a convenient time. Subjects were randomly assigned to either the experimental or control condition. The control and the experimental group received a similar eight-week training regimen, with the only difference between groups being the presence or absence of audio neurofeedback, which served as the independent variable in this study. During the experiential portion of the training, only the experimental participants received the audio neurofeedback. Experimental participants heard two different audio tones, one for alpha and another for theta. The pitch of the alpha and theta feedback tones fluctuated in conjunction with changes in the microvolt production in either frequency range. The alpha tone had a hollow flute quality (Proteus Factory Preset # 17 Verb Flute), and the theta tone had a keyboard sound (Proteus Factory Preset # 122 Mr. Minister). During the de-briefing portion of each session, both the experimental and control groups received delayed visual feedback of their EEGs as recorded and displayed on the host computer. Participants reported that the delayed feedback was a useful tool for assimilating their internal experience with the physiological data.

EEG Biofeedback System

This study provided a novel application of alpha/theta training with groups of up to four people, instead of the individual training reported in earlier research (Fahrion et al., 1992; Green, 1972; Green et al., 1970, 1974; Parks, 1996; Peniston & Kulkosky, 1989, 1990). The EEG data was recorded using The WaveRider Pro, manufactured by Mindpeak in Sebastopol, California. The features of this apparatus included four independent differential input channels, with a sampling rate of 128

Hertz per channel, which allowed the collection of EEG data from two to four participants simultaneously. The ground wire on the hardware apparatus of the WaveRider was modified to accommodate multiple users. The Fast Fourier Transform (FFT) frequency resolution was 1 Hertz and the common mode rejection ratio was 100 dB minimum. The high pass filter was at .5 Hertz, and the low pass filter was at 40 Hertz and reaches 72 dB of attenuation at 60 Hertz. Gold-plated ear clips were used for the ground and reference electrodes. The active electrodes were also gold-plated, and site PZ, as per the 10-20 Electrode System of the International Federation, was used for electrode placement.

The data stream from the WaveRider hardware was connected via a serial cable to a 300 MHz laptop computer with a Pentium II processor. FFTs analyzed the electrical signal into its component frequencies for visual display to the computer monitor. The WaveRider system allowed for visual monitoring of the raw waveform and a real-time display of the spectral output, from .05-40 Hertz, for each participant. The data stream from the hardware was filtered for alpha (8-12 Hertz) and theta (4-8 Hertz) brain waves in the WaveRider software program. The alpha and theta amplitude data were then transferred into the Musical Instrument Digital Interface (MIDI), which provided the output signals for the audio feedback. The MIDI data stream was output through the controlling computer's MPU 401 game port, via a MIDI cable, to a Proteus Emu 1 synthesizer. The synthesizer provided four independent, monophonic sound channel outputs and was capable of producing a wider range of biofeedback tones of better quality than a standard internal computer sound card. The biofeedback tones from the synthesizer were sent into a Q-Mix HM-6 headphone matrix amplifier. The amplifier had six stereo headphone outputs. This allowed for each one of the four participants to have their own headphone output and for the experimenter to have two other channels available for monitoring purposes. The amplifier combined the biofeedback signals with the background music and with microphone input from the experimenter. This allowed the experimenter to have voice contact with any selected participant(s) during the experiential portion of the training. The Q-Mix HM-6 allowed for individual volume adjustments. Also, the volume of the neurofeedback tones, relative to the background music, could be separately adjusted, to suit the individual preferences of the experimental participants.

Creativity and Well-Being Instruments

Whereas previous research suggested a possible correlation between alpha/theta training and enhanced creativity (Green et al., 1970, 1974)

this study extended the empirical data by operationally defining creativity. The literature review was used to find the three, most widely agreed upon divergent thinking abilities and to locate the most readily used instruments by which to measure these abilities. In an effort to define the mental characteristics of creative ability, researchers began to look at the personality characteristics and biographical details of creative people in the fields of science and technology (Craig, 1966; Lowenfeld, 1958; Roe, 1963). Creative thinking was investigated as it pertained to problem solving.

The general consensus indicates that fluency, flexibility, and originality are among the primary mental attributes pertaining to creative ability (e.g., Guilford, 1968; Thorndike, 1963; Torrance, 1998). Fluency is defined as the ability to produce an abundance of ideas pertaining to the problem at hand. The rationale for this measure of divergent thinking is based upon the idea that the more ideas a person is capable of generating within a given time period, the higher the probability that some of these ideas will be useful and significant to the problem at hand. Flexibility is the ability to view a problem from many different perspectives. The rationale for this variable is based upon the idea that the more perspectives a participant is able to consider in generating ideas for a problem, the greater the likelihood that a new and innovative solution will be produced. Originality is the ability to come up with new and unique ideas.

The Torrance Test of Creative Thinking, Figural Forms A and B (Torrance, 1990, 1998), the Christensen-Guilford Associational Fluency Test, Forms A and B (Guilford & Guilford, 1980), and the Alternate Uses Test, Forms B and C (Guilford, Christensen, Merrifield, & Wilson, 1978) were used to measure these creative abilities. To control for the effect of taking the same test twice, only creativity tests that had two forms were selected. Although these tests have been used extensively in previous research (e.g., Haynes, Hebert, Reber, & Orme-Johnson, 1975; MacCallum, 1975; Orme-Johnson, Clements, Haynes, & Badaoui, 1975; Orme-Johnson & Granieri, 1975, Parks, 1996), there is limited data regarding the reliability or validity of these instruments.

Data regarding the reliability of the TTCT were provided in the Norms-Technical manual that accompanied the test (Torrance, 1998). The normative sample presented was based upon the results of TTCT scores from 55,600 students from 37 states and Canada. Kuder-Richardson split-half reliability coefficients ranged from .89 to .93 for Form A and from .88 to .93 for Form B with samples sizes greater than 1000.

Using the Spearman-Brown formula, estimates of test-retest reliabil-

ity for the Alternate Uses Test were derived from large samples at three age levels–sixth grade (.85), ninth grade (.75), and adults (.75). Exact sample sizes were not provided.

Reliability data on Christen-Guilford Associational Fluency Test ranged from .57 to .63 in a study of 457 ninth graders. A study of 200 college honor students at the University of Southern California produced reliabilities of .74 for Form A and .72 for Form B. Olive (1972) conducted a large study of 434 high school students and reported estimates of reliability on the Associational Fluency Test to be .73. However, the time intervals between testing periods were not reported. Other test-retest reliabilities were reported by Stimson (1968), whose sample of 35 male college students showed test-retest reliabilities of .64 with a 6-month time interval between testing periods.

The Friedman Well-Being Scale (Friedman, 1994) was chosen from among a variety of psychological instruments, many of which suggested a pathological orientation that potentially could have been offensive to the participant sample used in this research. This instrument was non-offensive, easily administered, and readily understandable. It took very little time to complete and was easily scored.

Spearman-Brown reliabilities for this instrument ranged from .91 to .93 for three different studies conducted on psychotherapy clients (n = 48, 22, and 23) (Friedman, 1994). The test-retest reliabilities for the clients in psychotherapy ranged from .81 (n = 19, 10-week testing interval) to .85 (n = 26, 3-week testing interval). The test-retest reliability coefficient for a sample of college students (n = 95) was .73, with a 4-week interval between tests (Friedman, 1994).

Convergent validity of the Friedman Well-Being Scale has been demonstrated by correlational analyses with a number of other psychological instruments (Friedman, 1994). A positive correlation of .72 was found when comparing the Friedman Well-Being Scale to the Watson-Affect Balance Scale. A negative correlation of −.68 was demonstrated between the Friedman Well-Being Scale and the Beck Depression Inventory.

RESULTS

EEG Data

Univariate analyses of variance were performed on seven variables: the mean alpha amplitude, the mean theta amplitude, the mean percentage of alpha, the mean percentage of theta, the mean percentage of time

spent in crossover (amount of time that theta was larger than alpha in amplitude), the mean percentage of the depth of crossover (when theta was larger than alpha, the ratio of theta/alpha as a percentage) and, the mean ratio of theta − alpha/theta + alpha.

The mean amplitudes of alpha and theta reflected microvolts of activity in these two frequency bands. The mean percentages of the amplitudes of alpha and theta, relative to the total amplitudes of all the EEG frequency bands, measured the extent to which the alpha and theta components dominated the entire spectrum of EEG amplitudes. The percentage measure was also a way of adjusting for substantial individual differences in total EEG amplitude due to such non-neurophysiological sources as skull thickness and conductivity. The percentage of time spent in crossover showed how much of the time in a given session theta amplitude was greater than alpha amplitude. This variable provided one way in which to gauge the depth of the hypnagogic state. The depth of the crossover variable provided another way by which to gauge the depth of the hypnagogic state. When theta amplitude was greater than alpha, the ratio of theta/alpha, measured how much greater it was.

The final EEG variable that was analyzed (i.e., ratio of theta − alpha/theta + alpha) provided another index of the depth of hypnagogia. In contrast with the crossover indexes, this ratio was computed and averaged for the entire session. The reason for the choice of this ratio instead of the more commonly used simple ratio (e.g., theta/alpha) is that the latter is not symmetrical around the point of equality, where the ratio is 1. For example, if theta microvolts are equal to 4.0 and alpha is 2.0, the ratio is 2, but if alpha is 4.0 and theta is 2.0, the ratio is 0.5. This non-symmetry results in a misleading measure when the ratios are averaged. Logarithmic transforms of ratios are often used to correct this problem. However the logarithmic transforms also present problems. Log (a/b) goes to infinity when b goes to zero, but (a − b)/(a + b) goes to the + or − unity in those limits. Therefore, the latter is a much better measure when there is any possibility of a, or b being very small compared to the other. Conceptually the measure is readily transformed linearly into a more understandable measure, the proportion of the difference between the two variables relative to their average, by simply dividing the denominator by two or by multiplying the numerator by two. However, in this study the transformation was not done.

Although the EEG data indicated that all participants were able to attain from light to deep hypnagogic states in all training sessions, there were no significant changes in any of the variables mentioned above. Interestingly, the analyses on the depth of crossover and the time spent

in crossover variables indicated that the control participants attained deeper states of hypnagogia than the experimental participants, although not to a statistically significant degree. One possible explanation for this finding may be that the tones created a distraction for the experimental participants, which could have prevented deepening of the alpha/theta state.

Creativity Data

The overall raw scores from each of the three creativity instruments were used for analyses. Multiple t-tests were used for within-participant comparisons and for between-group analyses. Bonferroni corrections were applied to compensate for the use of multiple t-tests and the resulting significance level was established as $p < .01$. The paired t-test on the flexibility test scores showed a significant increase for all participants $t\ (61) = -4.37$, $p < .001$. Paired t-tests on the variables of fluency and originality showed no significant changes. The between-group independent t-tests showed no significant differences on the pre-test, post-test, or the change in pre- to post-test scores on any of the three creativity variables.

Well-Being Data

The overall score and five subscale scores (sociability, self-esteem/self-confidence, joviality, emotional stability, and happiness) of the Friedman Well-Being Scale were analyzed using paired and independent t-tests. Bonferroni corrections were utilized and the resulting significance level was established as $p < .01$.

Results of the t-tests showed no significant differences between the two groups on the pre-test, post-test, or test scores changes. The within-participant data showed significant increases in the overall scores and on three of the five subscales. Paired t-tests on the overall scores showed a significant increase $t\ (61) = -3.16$, $p =. 002$. Paired t-tests on the sociability subscale also showed significant increases on the pre- to post-test scores, $t\ (61) = -2.88$, $p = .005$. Paired t-tests on the self-esteem/self-confidence subscale showed that there was no statistically significant increase in the pre- to post-test scores, $t\ (61) = -.24$, $p = .02$. Paired t-tests on the joviality subscale showed there to be no significant differences in the pre- to post-test scores, $t\ (61) = -1.96$, $p = .06$. Paired t-tests on the emotional stability subscale showed that there was a statistically significant increase in the pre- to post-test scores, $t\ (61) = -3.58$, $p = .001$. Paired t-tests on the happiness subscale showed no significant differences in the pre- to post-test scores, $t\ (61) = -.38$, $p = .70$.

Qualitative Data

This study would be incomplete without including data on the subjective experiences of the participants involved. Every participant completed a questionnaire at the end of each session. Participants in both groups reported high levels of physical and mental relaxation along with correspondingly low levels of awareness of the external environment, and little or no control of their mental content. Comments on stress reduction were made by numerous research participants (12 control/12 experimental). Approximately 44% of the male participants (n = 8) and 36% of the female participants (n = 16) commented on stress reduction as a benefit of the training. Increased self-awareness was reported by both experimental (n = 13) and control participants (n = 11) over the eight-week training period (17 females/7 males). Emotional equanimity was also reported by many of the participants (10 control/10 experimental). Sixteen females (36%) and four males (22%) noted a sense of emotional equanimity. Approximately 34% of the research sample (7 control/14 experimental) reported that the training had a positive effect on their work performance and in their ability to solve problems in new ways. Sixteen females (36%) and five males (28%) reported ways in which they attributed enhanced work performance to their participation in this study. One participant said, "My sense of self is much more positive and more developed. My self-awareness is greater. I think this will lead to better problem solving and thinking ability." About 24% of the research participants (9 control/6 experimental) reported very meaningful spiritual experiences during their hypnagogic training (14 female/1 male). A second participant said, "[I] Saw an angel-type figure and could feel a God-like presence." Approximately 10% of the sample reported that the hypnagogic training appeared to have affected nocturnal dream states. A third participant said, "I have never been able to remember my dreams before I started doing this training. The other morning I awoke and remembered part of a dream that I'd been having."

DISCUSSION

Limitations

The strongest limitation to this study was the fact there were several different components that comprised the training program (e.g., educa-

tional lectures, individual creativity questions, a variety of background music, and post-session group discussions), leaving the evaluation of the contributions of the different components impossible. An analysis of the effects of each single component was not done in this study, with the exception of an analysis of the effect of the real-time audio EEG biofeedback for the experimental group.

The strength and certainty of the findings of this study would have been substantially improved by using a control group that had no intervention. Since this was not done, one cannot assume with confidence that the training protocol helped participants to enter and sustain the hypnagogic state. Without a waiting list or treatment control group, the increases in creativity and well being that were evidenced could be attributed to factors outside the scope of this experimental design.

There are questions about how well these creativity tests measure creativity in real-life situations, and those questions arose during the course of this study. In addition, high intercorrelations between the instruments confounded the certainty of the results by raising the question as to whether or not each of these instruments was measuring a different divergent thinking ability. Therefore, the creativity instruments were another limiting factor in this study.

There were many interpersonal factors, which were not controlled for in this research. This study did not control for the impact of the interaction between the experimenter and the participants, nor did it control or assess the impact of group interactions.

Suggestions for Future Research

Length of Training

For research purposes, a training schedule of two-three times a week for four weeks might be better. Training regimens with this design would concentrate the experiential learning within a much shorter time period and could increase the total number of training sessions. The eight-week training protocol that was used in this study may have been too long. The rate of absenteeism was three times higher in the second half of the training period than in the first. Future studies might like to test for the effects of the number of training sessions.

Sample Size

A larger sample size would be recommended for future research on this topic. The significance of the correlational relationships between

the dependent variables in this study might have been improved with a larger sample. It might be feasible to work with groups of four to eight people at a time if sufficient funding were available for additional equipment and personnel.

Training Protocol Modifications

The experiential portions of the training could be increased to 30-40 minutes, instead of the shorter interval of approximately 20 minutes that was used in this study. Another suggestion would be to use the same audio music each week, provided that the participants had favorable reactions to the selection that was chosen. The changes in audio that were used in this research could have precluded the research participants from developing their ability to pay attention to the subtle, internal phenomena that are associated with hypnagogia.

The use of hypnagogia as a stress reduction technique might also be explored. Other physiological data, such as heart rate, skin temperature, and muscle tension could be collected in conjunction with EEG data, to provide a broader perspective of what happens to a person while in this state of consciousness. A study of this kind might demonstrate that other physiological changes (i.e., reduced muscle tension, lower heart rate) contribute to increases in well-being.

Contributions

This research explored a topic of interest in psychology (i.e., altered states of consciousness) utilizing an experimental research design. The dependent variables of hypnagogia, creativity, and well-being were operationally defined to provide more definitive information on these variables. The use of pre- and post-tests to measure changes in creativity and well-being provided new information about the efficacy of using hypnagogia to enhance these two measures.

This study provided physiological measurements of a psychological state, which helps to elucidate the mind-body connection. The collection of EEG data combined with self-reports from the participants provided a descriptive portrayal of the hypnagogic state of consciousness and its usefulness for enhancing creativity and well-being. This represents a step beyond anecdotal data presented in previous research.

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