

The Effects of using Biofeedback Technologies on Students' Perceptions of Stress, Health, and Problem-Solving Behaviors



Healthcare

KEYWORDS : Bio-communication technology, stress-resilience, positive emotions

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ABSTRACT

The objective of this study was to assess the effects of two software programs (alone and combined) on health, perceived stress and problem solving among college students. One hundred twenty four University students were recruited (August 2012) from general education health and psychology courses to participate. All four groups participated with pre-posttest instruments. Control subjects' only involvement with the study was with the pre-posttest instruments. In addition to pre-posttest instruments, intervention groups were instructed to practice ad libitum with heart-based, i.e., cardiac awareness (em group-Institute of HeartMath), voice-based (E group-Zyto Corporation) or a combination of cardiac awareness and voice (emE group) biofeedback-biocommunication software programs. Pre-posttest instruments used were the Health-Promoting Lifestyle Profile II (HPLP II, $\alpha=0.94$), the Response to Stressful Experiences Scale (RSES, $\alpha=0.91-0.93$), and Problem-Solving survey (PS, $\alpha=0.77$). Significant differences were identified.

Introduction

Detrimental health effects of stress reported in the last decade indicate that individuals living in the 21st century may, for the first time, experience a decline in life expectancy in the United States (Olshansky et al., 2005; Our Health at Risk, 2011). Associated with stress is the role of inflammation as a root etiological component to chronic disease and impaired mental and physical performance (Bordenave, 2011). Inflammatory responses can be initiated from feeling states, such as anxiety, stress and depression (Casey, 2012; Chung et al., 2012). While the interpretation of a stressor varies from person to person, college life is considered to be one point in time of feeling significant levels of stress, ranging from severe in 10-12% of students to moderate in intensity among 75-80% of students (Peirceall & Kim, 2007; Dussellier et al., 2005). According to data published in 2006, stress in students is the top ranking of 10 impediments to academic performance (ACHA-NCHA, 2007; Moss, 2012). Research suggests that the mental/emotional and spiritual dimensions of health have as much, if not more, far-reaching impact on health and well-being (Fredrickson, 2013; Cole et al., 2007) compared to the physical, social and environmental dimensions. New technologies are currently available that target and assess what might formerly have been considered these intangible facets of health (McCraty, 2006; McCraty, 2009). Some of the most influential contributors to health and optimal performance have to do with attitude, stress levels, motivations, and problem solving abilities (Cortis, 1997). The consequences of negative emotions and stress are generally apparent, and current research into the beneficial consequences of positive emotions (the antithesis to stress) is beginning to be established (Mein, 2005; Insel & Roth, 2012; Cohn et al., 2009). Accessing, nourishing, and self-generating positive emotional attributes for optimizing human function and self-efficacy among college students is a foundational theory and overarching theme for this investigation.

Factors that contribute to self-efficacious attributes of college-aged students include self-confidence, self-awareness, positive motivations and emotions, problem-solving acumen, stress-resilience, and general health and wellness practices (Kok & Fredrickson, 2010; Bradley et al., 2010). Collectively, these tenets support on-going research into the impact of positive emotions on physiology, psychology, and behavior (Thayer et al., 2009; Baqutayan & Mai, 2012). In addition, the concept of 'Emotional Intelligence' as a measurable parameter for positive behavior evaluation has developed since the 1980's (Colston, 2009). Emotional intelligence can be described as the ability to perceive, identify, assess, manipulate, and control emotions; an ability to validly reason with emotions and to use emotions to enhance thoughts/thinking

(Mayer & Ciarrochi, 2006). Similarly, within the last 20 years recognition of the anatomic heart (cardiac response as a barometer of general well-being) as a significant and powerful entity for influencing positive emotions/emotional intelligence, cognitive processing, stress reduction, improved health and wellness practices is currently underway in the corporate, military, and educational settings (Hasson et al., 2004; Schmitz et al., 2009; Sibinga et al., 2011; Seligman, 2011; McCraty & Atkinson, 2012).

This research explores the use of cardiac awareness/intention software (emWave produced by the Institute of HeartMath™), alone and in combination with voice/ galvanic skin response parameters (EVOX program from the ZYTO Corporation), for evaluation of improved self-care decision making or general health, perceived stress reduction, and improved perception of problem-solving ability (IHM, 2013; Zyto, 2013). Discovering a systemic, i.e., global, all-encompassing, approach to stress may effectively address the psychological, physiological, and behavioral underpinnings, altering the well-established deleterious health effects of perceived stress (Huff, 2012). The emWave software program used in this exploratory investigation records individual heart-rate variability (HRV—a parameter of vagal tone) as a physiologic parameter in real-time using an ear-sensor device attached to the subjects ear. HRV graph patterns have been scientifically validated for reliability and validity when examining subjects during positive (e.g., appreciation) and negative (e.g., perceived stress) emotional states (IPPA, 2013; Abdullah et al., 2010). A positive feeling state, such as appreciation, appears as an ordered and coherent wave form. The EVOX software program records the subjects' voice frequencies (not the words spoken) and displays a graphic image that may enhance the subconscious influence on higher cognitive centers of the brain toward self-generated creativity and problem-solving efficiency. This may mirror results found by different genres of music triggering changes in vagal tone (Hinton, 2011). The correlation between EVOX graph results and the proverbial "eureka" idea (indicating new insight) is from a balanced Perception Index (PI). The analytical use of the term balance here leads to the subjective interpretation of equality between all twelve tonal zones on the recorded Perception Index. According to Zyto there are three ways to determine balance in a PI using the EVOX program. The first is the percentage of frequencies reflected with consecutive voice maps progressively increases approaching a theoretical ideal of 100%. Alternatively, the shaded areas from consecutive voice maps make a dramatic transition in position on the map; or the practitioner hears a change in the subjects voice tone. Both bio-feedback/communication programs yield immediate results from recording sessions (measure and display HRV wave pattern for the em-

Wave and Perception Index or voice map for the EVOX). These technologies can help to extrapolate the inner physical and emotional milieu into concrete, observable data for individual reference.

The purpose of this study was not to validate the computer generated data reports but to examine the potential influence of this technology (cardiac awareness, self-generated positive emotions, speaking, listening to instrumental music, and viewing the graph results of voice tones) to impact increased awareness of positive emotions via cardiac awareness (HRV) or vocal characteristics by providing visual/graphic feedback and to determine if this awareness had an effect on posttest scores addressing general self-care/health, response to stressful events, and perceived ability to solve problems. The results of this study will be used to determine which areas if any provide greater insight into the use of cardiac awareness, while reliving a positive emotional moment in one's life, and or voice or the two combined, facilitates improved overall health decisions.

Methods

An exploratory pilot research study was conducted using a pre-posttest design among college students to determine if software programs using focused attention on the cardiac region of the body while re-experiencing a positive emotion, or viewing graphic images of spoken voice tones, or the combination of both will reveal significant differences between survey responses given 8-10 weeks apart. Ninety-six of a possible 124 students enrolled in general education health or psychology courses elected to participate in this study. Subjects were randomly assigned to one of the four study groups. The Healthy Personal Lifestyle Profile II (HPLP II), Response to Stressful Events Scale (RSES), and Problem-Solving Surveys (PS) were administered the first week of the semester and again 8-10 weeks later to four study groups: control (C), cardiac awareness (em), voice (E), and combination of cardiac awareness/voice (emE) samples. Survey responses were analyzed using SPSS v.19 for frequency and descriptive statistics as well as Kruskal Wallis mean rank evaluation for differences between study groups during the survey collection times, initial and after 8-10 weeks. The study was approved by the Institutional Review Board, Human Subjects Committee of the University.

emWave and EVOX Training

The Institute of HeartMath has a curriculum established for qualified individuals to use emWave technology and teach HeartMath techniques. The mission of the Institute of HeartMath is to help establish heart-based living and global coherence by inspiring people to connect with the intelligence and guidance of their own hearts and this is accomplished with well-defined protocols and procedures developed by the founder of HeartMath, Doc Childre and his research team. The principle investigator of this study has had this training and presented the information as prescribed by the company. Subjects were randomly assigned to one of four groups. The control group-C subjects were instructed to access a web-site (URL) which provided access to the survey instruments used in this study the HPLPII, RSES, and PS within the first two weeks of the fall semester and again 8-10 weeks later. The cardiac awareness (em), voice (E) and combined cardiac awareness and voice (emE) subjects were given two, two, or three, one-hour training sessions, respectively. During the training sessions (em) subjects were shown how to use the software and given information about the history and current findings of the HeartMath organization for how the software program reflects health via heart rate variability (HRV) statistics, as well as specific techniques involving how to focus the attention of the mind on the anatomic location of the heart while focusing on positive emotions and controlling breathing and to apply these combined steps periodically during the day which would purportedly facilitate stress resilience, improve creativity and problem solving ability, and increase productivity,

performance, and interpersonal relationships, especially with repeated accurate practice of these tools.

Subjects in the cardiac awareness/voice combined group (emE) had an additional training session about the use of the EVOX software program. Subjects were invited to practice the HeartMath quick coherence steps shown during the training ad libitum between the initial and final survey collection times. There was no instrument in place to document when or if subjects voluntarily practiced with the em or emE programs beyond the training sessions provided as encouraged by the investigator. At a minimum subjects in the em or emE groups were asked to take time each day to focus their attention on their hearts (anatomic location), pace their breathing such that inhalation and exhalation were of equal time frame, and re-experience a positive emotion of their choosing. They were also given the web-sites for the Institute of HeartMath and ZYTO Corporation for unlimited access to resources from these entities to assist them with stress reduction.

Subjects in the voice (E) or (emE) groups were given two or three, one-hour information sessions, respectively. The software procedures were explained and subjects were offered individual practice sessions for report generation after the training sessions. During the private EVOX practice session subjects were asked to talk about any topic of their choice or to read the EVOX brochure. Sessions included recording three-four voice collections, each lasting 15-20 seconds followed by a 30-second timed output (during the timed output subjects' listened to instrumental music) between each subsequent voice recording collection to allow the subconscious to process the information previously spoken. Thus a session would begin with the investigator explaining the repeated nature of the session prior to voice collection. Subjects would decide if they were going to speak on a topic of their choice or read the EVOX informational brochure published by the ZYTO Corp. Once this was decided the background noise was determined and the calibrations set to capture the voice of the subject who would read for approximately 20 seconds and then listen to music for 30 seconds. Subjects were welcome to participate in more than one private session. An example of progress with the EVOX software and voice recording is revealed by the Perception Index. The PI graph was explained to subjects during their private recording session.

Subjects differed from the general population in which this convenience sample was selected in that 66% (N=63) are female compared to 56% at the University, whereas 34% (N=33) were males (44% for the University population). One hundred percent of the subjects in this study were between the ages of 18-21 compared to 83.15% of students at the University in this age group.

Measures

Permission to use all instruments was obtained prior to electronic dissemination. All instruments have previously been tested for validity and reliability. The Health-Promoting Lifestyle Profile II (HPLPII $\alpha=0.94$) is used to evaluate general health concepts and practices among college students. The Response to Stressful Experiences Scale is used to evaluate students' responses to stressful events and determine if these reactions would be altered after the independent variables of software programs were administered. The Response to Stressful Experiences Scale (RSES) is a measure of individual differences in cognitive, emotional, and behavioral responses to stressful life events. The Problem Solving instrument used was based on research among similar study participants (University Students).

Analysis

Using a pre-posttest design among four groups with ordinal data non-parametric analysis was conducted via IBM-SPSS vs. 19. This program was used to determine if the independent vari-

ables had significant impact on survey responses between study groups. The control group was used for determination of homogeneity among group members. There were no qualitative data collected with this exploratory investigation. Descriptive statistics were collected to note details of group membership.

Results

There were significant differences between groups in that the control group-C had completed more years of academic course work and earned higher academic standing compared to intervention groups. No adjustments were made with the control group to address baseline differences between groups or to investigate this finding. Significant findings pre-posttest with this group was a confounding issue and would require screening for equal ages, more equal representation between males and females, and adequate sample size to possibly prevent this in the future. A priori assumptions for normalcy with regards to central tendency and the central limit theorem were to obtain a minimum of 30 students per group. Non parametric analysis using Kruskal Wallis for mean rank comparison between groups was used to determine if significant differences occurred between control and interventions groups. Significant posttest findings

occurred with the HPLP II items "pace myself to prevent tiredness", $\chi^2=12.80$, $df=3$, $p=.005$ and approaching significance was "believe that my life has purpose", $\chi^2= 11.14$, $df=3$, $p= .011$.

The following tables describe the data collected and statistical analysis results. A zero value was assigned to all blank responses for all instruments. Scales for all instrument items are: HPLPII-never=1, sometimes=2, often=3, and routine=4; RSES-nothing like me=1, somewhat like me=2, neutral=3, very like me=4, and exactly like me=5; and PS-strongly disagree=1, disagree=2, neutral=3, agree=4, and strongly agree=5. Demographic scales are listed in Table 1. In Table 2 significant findings post-intervention according to Kruskal Wallis Mean Rank are depicted.

Table 1. Demographics of subjects from the effects of using biofeedback technologies on students' perceptions of stress, health, and problem-solving behaviors

Item	N	Male	Female	Age	GPA	Year in School
Group						
C	20	8	12	18-21	3.1-3.50	Junior
em	24	6	18	18-21	2.6-3.0	Freshman/Sophomore
E	19	6	13	18-21	2.6-3.0	Freshman
emE	33	13	20	18-21	2.6-3.0	Sophomore

Table 2. Kruskal-Wallis Mean Rank Pre-Post Test Results N=96 p=.0083

Item	Group	Mean Rank	Pre	Post	χ^2	df	Asymp. Sig
HPLP II							
Follow planned Exercise program	C	61.83	✓		12.21	3	.007
	emE	50.30					
	em	47.85					
	E	32.16					
HPLP II							
Item	Group	Mean Rank	Pre	Post	χ^2	df	Asymp. Sig
Exercise Vigorously 3x per week	C	59.95	✓		13.02	3	.005
	emE	53.59					
	em	45.52					
	E	31.37					
Exercise Vigorously 3x per week	C	57.45		✓	11.82	3	.008
	emE	56.48					
	em	39.42					
	E	36.68					
Read Labels to identify nutrients	em	59.67	✓		10.73	3	.013
	C	52.33					
	emE	46.50					
	E	33.84					
Read Labels to identify nutrients	em	58.90		✓	12.22	3	.007
	C	55.43					
	emE	46.00					
	E	32.42					
Attend Education Programs	C	60.83	✓		7.94	3	.047
	E	49.84					
	em	47					
	emE	40.71					
Reach my target heart rate when exercising	C	62.50	✓		12.96	3	.005
	em	50.25					
	emE	48.27					
	E	31.95					

Reach my target heart rate when exercising	C	59.60	✓	12.85	3	.005
	em	51.69				
	emE	49.76				
	E	30.61				
Pace myself to prevent tiredness	emE	58.24	✓	12.80	3	.005
	em	50.75				
	C	45.15				
	E	32.26				

HPLP II

Item	Group	Mean Rank	Pre	Post	χ^2	df	Asymp. Sig.
Feel connected to some force greater than myself	C	61.95	✓		11.10	3	.011
	em	49.96					
	emE	47.79					
	E	33.74					
Feel connected to some force greater than myself	C	64.43		✓	9.76	3	.021
	emE	46.48					
	em	44.60					
	E	40.16					
Take part in light to moderate physical activity 3 or more x/week	C	60.45	✓		11.71	3	.008
	emE	51.70					
	em	46.88					
	E	32.42					
Believe that my life has purpose	emE	56.91		✓	11.14	3	.011
	em	49.19					
	C	49.09					
	E	32.47					
Eat 6-11 serv. of bread, cereal, rice and pasta each day	emE	56.91		✓	7.48	3	.013
	em	51.54					
	E	45.13					
	C	34.17					
Inspect my body at least monthly for physical changes/danger signs	C	56.80	✓		8.30	3	.04
	emE	53.55					
	E	41.42					
	em	39.02					
Work toward	C	56.80		✓	8.86	3	.034

long-term goals in my life	emE	54.00					
	em	41.69					
	E	38.82					
Expose myself to new experiences and challenges	em	57.92	✓		10.80	3	.013
	emE	51.71					
	C	46.85					
	E	32.76					
RSES							
Item	Group	Mean Rank	Pre	Post	χ^2	df	Asymp. Sig.
During and after life's most stressful events I tend to face my fears	E	57.97	✓		10.36	3	.016
	C	52.83					
	emE	50.67					
	em	34.42					
During and after life's most stressful events I tend to face my fears	C	57.38		✓	9.81	3	.020
	E	56.71					
	emE	46.83					
	em	36.90					
During and after life's most stressful events I tend to bounce back	emE	59.68	✓		13.64	3	.003
	em	49.46					
	E	45.13					
	C	32.10					
PS							
When making difficult decisions, I review all possibilities and options necessary	emE	53.68		✓	8.04	3	.045
	em	51.27					
	C	50.53					
	E	33.87					
I have the ability to solve difficult problems, even if I do not see an immediate solution	em	58.75	✓		7.98	3	.047
	C	48.40					
	emE	47.18					
	E	37.95					

Discussion

The aim of this pilot study was to determine if significant differences exist between control and intervention groups on survey tests score taken twice, (baseline and then again 8-10 weeks later).The only posttest item found to have significant difference was “pace myself to prevent tiredness” although there were several items found significant prior to the intervention and within the control group, e.g., on the RSES item “During and after Life’s most stressful events I tend to know I will bounce back” was not anticipated. This finding contributes to the limitations of this

study and the ability to make generalizations about the factors of perceived health, stress-resilience, and problem solving improvements after cardiac awareness, voice, or a combination of both interventions. The item concerning pacing to prevent tiredness may be from academic learning occurring simultaneously to this study or possibly an attribute of self-care was increased.

Limitations

Small sample size (especially the failure to secure 30 subjects per group), unequal numbers of males and females participating, dif-

ferent levels of academic prowess (GPA) and University years of study completed, may all preclude causal statements and generalizations about this study and support for hypotheses statements. The study design was not strict in recording/monitoring how diligent students were in practicing with the software and the amount of time spent in training students using the programs was very brief. No plans were in place to repeat the study with other courses to attempt to correct study limitations of sample size, inequity between males and females, age or year in school, demographic parameters.

Conclusions

Although only one item was found to meet the criteria for sta-

tistical significance and one item approached significance it is hoped that this pilot venture may yield promising findings for this population (University students) in the future. Other findings about the influence of biofeedback type reinforcement, the role of vagal tone along with HRV, suggest that this type interaction (biofeedback) and this parameter (HRV and cardiac awareness for positive emotion generation) improve physiological, emotional, and cognitive performance, result in an expanded outlook on life, is more vital than self-esteem, allows for goal attainment, and increases understanding (Seligman, 2011; Emmon, 2007; Neff, 2011; Ginty& Conklin, 2011; VanCappellen&Saraglou, 2012; Leary et al., 2007; Insel& Roth, 2012; Rizzolatti et al., 2006).

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