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SPECIAL ISSUE

Psychophysiology: Thinking Outside the Cap

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The use of physiological measurements to gain insight into an individual's psychological state or to intervene with a given diagnosis requires the use of multiple modality measurements. Although any given modality (electroencephalography, heart rate variability, electrodermal activity, etc.) may provide the researcher and/or clinician the opportunity to see into the individual, the view through a single window is less than optimal. Examination of multiple data sources without bias will lead to a deeper appreciation and understanding of the mind-body system.

There were many ways that students benefited from involvement in the Brain Research and Neuropsychology Laboratory at the University of Tennessee. Our adviser and professor, Dr. Joel Lubar, demonstrated the utmost respect for each of us as individuals and emphasized the value of collaborative research. Lab meetings were a time for sharing new ideas, current joys, and sometimes our frustrations. Regardless, we had an environment in which we were able to learn from him and from one another. Everyone played an important role, and we all worked together to face each new challenge and to celebrate each others' successes.

As students, we all cut our teeth on quantitative electroencephalography (QEEG), but even then, we were exploring novel ways of examining and obtaining data. We not only investigated a variety of ways to collect physiological data but also engaged in continuous dialogues about current work in the QEEG field as well as related areas. Whether it was performing our own quasi–dense array recordings (i.e., placing 19 single leads over the frontal cortex) or attempting to investigate insight and conscious awareness by examining data records at the time a Magic Eye image came into focus, we were always asking questions and collecting data. This lesson of collaboration and integration was one that we couldn't completely understand at the time but has now become a philosophy as well as a model for research and clinical work.

The Example of Frontal Midline Theta

For example, one series of lab meetings focused on our attempt to better understand and possibly apply research on the role of theta and specifically frontal midline theta (Gevins, Smith, McEvoy, & Yu, 1997; Klimesch, 1996; Klimesch, Doppelmayr, Russegger, & Pachinger, 1996; Klimesch et al., 2001). We wanted to incorporate that body of research into our understanding of the lab's previous work with childhood attention deficit hyperactivity disorder (ADHD) and the theta-beta ratio (Lubar, 1991; Mann, Lubar, Zimmerman, Miller, & Muenchen, 1992). It was during one of those lab meetings that one of our lab mates offered a possible explanation for the apparent disconnect between findings of increased theta in working memory tasks and the observation of increased theta in children with ADHD who are assumed to not be engaged. It was suggested that perhaps individuals with ADHD experience a greater proportion of theta activity at rest because they are in fact actively engaged in working memory–type tasks, sometimes at the expense of not focusing on external events; in other words, they may be more occupied with what is going on inside their own minds (E. Angelakis, personal communication, 1997). That conversation continues to influence portions of our current work and is supported by anecdotal reports of many of our subjects and other individuals with ADHD with whom we have worked in other contexts.

Multiple Windows Into Human Psychophysiology

These discussions taught us to recognize that our preferred window was not the only window available for looking into the individual's psychology/physiology. Our primary work still involves the use of the EEG and QEEG because of our interest and understanding of this method; however, we accept the responsibility to recognize the system as a whole.

Not only did we learn to appreciate collaboration but also were encouraged to think beyond current paradigms and to explore new directions, all while embracing the past. This collaborative spirit and enthusiasm for both research and application still rings true, and this brief article is just one small example of that philosophy. As such, we will give a brief update on current and future directions in our own work that integrate this concept: one from the lab and another from the clinic.

From the Lab

Our current work is still focused on developing hypotheses and collecting data that we hope will lead to new horizons or assist us to better understand accepted knowledge. Just as in the lab at the University of Tennessee, the EEG and its many derived measures play a major role, but other sources of data are also examined. At present, the Georgia College and State University (GCSU) Psychophysiology Lab is engaged in the investigation of physiological and neurophysiological correlates of cognitive task performance in individuals, primarily adults, with and without ADHD.

As such, all QEEG recordings (Deymed Diagnostic 32-channel TruScan System) in the GCSU Psychophysiology Lab are currently accompanied by concurrent recordings of electrodermal activity (EDA). We record EDA not only during resting QEEG baselines but also during active tasks such the Paced Auditory Serial Addition Test, the Integrated Visual and Auditory Continuous Performance Test, event-related potential (ERP) paradigms (e.g., auditory odd-ball/P300), and during posttask resting baselines.

The incorporation of EDA into our research paradigm was based largely on work out of the Brain and Behaviour Research Institute at the University of Wollongong and specifically the work of Adam Clarke and Robert Barry. Their recent work suggests a reexamination of classical conceptualizations of ADHD, cortical hypoarousal, and EEG power measures such as the theta-beta ratio (Barry et al., 2004; Clarke, Barry, McCarthy, & Selikowitz, 2001; Clarke, Barry, McCarthy, Selikowitz, & Brown, 2002). Other researchers have also investigated simultaneous EEG and EDA assessment in adolescents with ADHD (Hermens et al., 2005; Lazzaro et al., 1999), but to our knowledge, few if any publications exist that investigate these measures as they relate to adults with ADHD.

Pilot studies are being planned that will use the Nexus-10 system (Mind Media) and will not only investigate traditional QEEG, ERP, and EDA measures but will also examine slow cortical potentials during various cognitive tasks. Other peripheral measures (e.g., blood volume pulse, respiratory effort) will also be incorporated into our investigations of adult ADHD.

In sum, the primary goals in all of our current endeavors is to identify a subset of physiological data that can (a) assist in the understanding and diagnosis of adult ADHD and (b) serve as a research basis for investigations into new biofeedback applications and treatment paradigms.

From the Clinic

Although the laboratory provides an ideal controlled environment for investigating and exploring ideas, the clinical practice for most is where the rubber meets the road. As was mentioned from the laboratory perspective, the same is true for the clinician. We are always asking new questions and seeking new ways of understanding, but we are also trying to determine how to best intervene. Our current clinical practice and clinical research work are focused on understanding the relationship of various physiological data to the client presentation of complaints. By understanding this sometimes very complicated matrix, we can determine how to best intervene.

As a practical example, let me explain a current industry-sponsored study that we just completed. One of our responsibilities as clinicians is to help determine the most effective intervention that will require the least amount of time and cost of the client. As a multimodality biofeedback practitioner (e.g., EEG, EDA, heart rate variability [HRV]) in the teaching medical center of the Southwest College of Naturopathic Medicine and Health Sciences, it is sometimes difficult to determine which modality may work best for any given client or situation. These decisions are often able to be determined through an evaluation in which data are collected and examined for each physiological component. The practitioner then determines the component that is most deviant from accepted normal limits. We have seen in the literature how biofeedback using the modalities of EEG, HRV, EDA, electromyography (EMG), and skin temperature can be helpful to the complaints of anxiety (Hammond, 2005; Labbe, Delaney, Olson, & Hickman, 1993; Marcus & Levin, 1977; Rice, Blanchard, & Purcell, 1993). The real question the clinician has to consider is which modality should be used to get maximal compliance and results. This decision currently might be determined simply based on the equipment or expertise that is possessed by the clinician; however, we suggest that a deeper understanding of the interaction between the modalities may lead to a better decision process when considering which modality to use.

When we determine that altering the EEG patterns is the best intervention, we still have to recognize that EEG biofeedback may not be the only effective intervention. It is well established that systems of the body are connected together, so it may be possible to combine modalities in the office and in the home of the client to maximize the intervention (Allen & McKeen, 1991). In the aforementioned recent study, we recorded multiple physiological modalities (EEG, EMG, finger temperature, EDA, blood volume pulse, respiration) in a population of subjects diagnosed with an anxiety disorder. These subjects were randomly assigned to either a treatment group or a control group. We recorded the resting baseline, a Stroop test, and 15 minutes of respiratory sinus arrhythmia (RSA) heart rate wave feedback using the

Stress Eraser device by Helicor, Inc. (the treatment group) or 15 minutes of a placebo Stress Eraser device (control group), a second resting baseline, and a final Stroop test. The preliminary data are quite striking because they indicate that participating in 15 minutes of RSA feedback had some impact on most physiological measures. Of course, we expected to find the increased HRV and increase in controlled slower breathing. We were happy to see that our initial hypothesis that EEG would show an increase in slower-faster frequency ratios was supported as well. A number of these findings are currently being written and submitted for publication. So by this example, it might be the best intervention to use EEG biofeedback in our office and, in addition, to recommend an RSA device for home training and simultaneously affect the system as a whole.

Summary

The purpose of this article is not to elaborate on the particular findings of our laboratory or clinical research but to dispel the belief that any single window contains the entire view. Despite our strong roots and training in QEEG, we were fortunate to initially be trained in an environment that was conducive to evaluating all the possibilities. We hope that these brief examples have provided you with the opportunity to evaluate your practices, and we want to encourage you to examine other data and consult with colleagues outside your own expertise or niche. It is evident that understanding any disorder in the framework of psychophysiology requires the use of multiple modality measurements. This complex system that is the human mind and body is far too elaborate to be summed into a given frequency band or measured with a single sensor.

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