New Support for the Use of QEEG Scanning in Diagnosing ADHD

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Quantitative Electroencephalographic (QEEG) scanning is a technique used to measure electrophysiological activity in particular regions of the brain. In a prior issue of Attention Research Update, I discussed a study describing the use of QEEG scanning as an objective procedure for diagnosing ADHD.

Results from this study indicated that individuals with ADHD could be reliably distinguished from non-ADHD individuals by QEEG scan results of the prefrontal cortical areas. Approximately 90% of individuals who had been carefully diagnosed with ADHD using standard diagnosed procedures showed a pattern of under activity in these areas (referred to as “cortical slowing”). In contrast, 94% of a control population did not. These data provided good initial evidence that QEEG scanning might be a useful “objective” procedure to assist in the diagnosis of ADHD. Recent work from the same research team provides additional support for the use of QEEG scanning in the ADHD diagnostic process. The first paper reviewed below encompasses 3 separate studies and was published in the January 2001 issue of Neuropsychology. (Monastra et al. (2001). The Development of a Quantitative Electroencephalographic Scanning Process for ADHD: Reliability and Validity Studies. Neuropsychology, 15, pp. 136-144.)

Study 1
The initial study described in this report was designed to replicate findings from the prior work. Participants were 96 individuals between the ages of 6 and 20 who were diagnosed with ADHD, and 33 age-matched comparison subjects. ADHD diagnosis was based on a combination of structured clinical interviews and behavioral rating scales. Comparison subjects received a similar evaluation to rule out ADHD, as well as other neurological conditions that could affect attentional functioning. The ratio of males to females was approximately 3 to 1, which is consistent with the rates of referral for ADHD evaluations to clinical settings.

The QEEG scanning procedure utilized measured the ratio of theta waves to beta waves in the prefrontal cortical area during 4 different activities: a baseline procedure in which participants were instructed to focus on a single stimulus; a 90-second silent reading task; a 90-second listening task; and a 90-second drawing task in which the subject was asked to reproduce geometric shapes. Theta waves are low-frequency waves associated with a mental state that has
been described as “day-dreamy” and inattentive. Beta waves are higher-frequency waves associated with focus and attention. All individuals produce both theta and beta waves. However, in individuals with ADHD, the ratio of theta waves to beta is typically greater during tasks that demand focus.

During the QEEG scan, electrophysiological activity is measured in prefrontal cortical areas of the brain using electrodes attached to the scalp. These data are used to compute the ratio of theta waves to beta waves -- referred to as the “Attention Index”. Attention Index scores above a certain level are indicative of “cortical slowing” and are associated with greater difficulties sustaining attention (i.e. higher Attention Index scores indicate more likelihood of difficulty). Such scores are rarely found in individuals without ADHD. As you would expect, because the ability to sustain attention typically increases with age, adults generally obtain lower Attention Index scores on a QEEG scan than children. (Remember, lower scores are “better” in the sense that they are presumed to more a more highly developed ability to focus attention.)

Results from this study provided a strong replication of those previously reported. Specifically, ADHD individuals were substantially more likely than comparison subjects to show Attention Index scores above the age-appropriate cut-off score. The exact figures were virtually identical to those that had been found earlier - 90% of individuals with ADHD had scores above the cut-off and 94% of those without ADHD did not. (It should be noted that none of the participants were on stimulant medication at the time the QEEG scan was taken.)

In considering these results, it is important to remember that ADHD is currently diagnosed by determining whether individuals display a particular constellation of behavioral symptoms. That is how the participants in this study were diagnosed as well. A pattern of abnormal results on a QEEG scan -- or any other type of physiological measurement -- is not one of the diagnostic criteria. Thus, the results reported above indicate that most participants diagnosed with ADHD according to the behavioral criteria outlined in DSM-IV also had atypical QEEG scan results. Conversely, individuals not showing the behavioral symptoms of ADHD almost never showed the abnormal QEEG scan.

Study 2
The second part of this study included an entirely different sample of 285 6- to 20-year-old participants -- all of whom were diagnosed with ADHD using structured interviews and behavior rating scales. The purpose of this study was to determine how well participants' Attention Index scores (from the QEEG scan) compared with scores they obtained on established procedures used in the diagnosis of ADHD. The other procedures used were parent ratings on the Attention Deficit Disorder Evaluation Scale (ADDES), and two computerized tests of sustained attention -- the Conners' Continuous Performance Test (CPT) and the Test of Variables of Attention (TOVA).

For each of these procedures, scores within a certain range are believed to be indicative of ADHD. In this study, all participants had previously been diagnosed with ADHD, so one would expect that most would have abnormal scores on each of the different “tests”. Of course, no test is perfect, so not every individual would show abnormal results on each test. Because the QEEG procedure is relatively new, and the other procedures are all well-established and widely
used, the researchers were interested in the rate of agreement between classification results based on the QEEG scan with classification results based on results from each of the other instruments.

In other words, if a participant's QEEG scan fell in the “abnormal” range, how likely was it that his or her score on the other procedures would also be in the abnormal range? Demonstrating that classification results from a new procedure are consistent with results obtained from established procedures is one strategy that researchers use to validate a new test. Results indicated that classification agreement percentages between the QEEG and the other procedures were as follows: 83% for the ADDES; 70% for the TOVA; and 48% for the Conners' CPT. For the ADDES and the TOVA, these rates of agreement are significantly higher than would be expected by chance. For the Conners’ CPT, they were not. Recent studies using the Conners' CPT, however, indicate that it has questionable validity in the diagnosis of ADHD, so this low-level of agreement is not surprising.

Because all participants in this study were carefully diagnosed with ADHD using standard procedures, each participant would have received abnormal scores on each measure if the QEEG scan, ADDES, TOVA, and Conners' CPT were perfectly accurate diagnostic instruments. This, of course, was not the case. It is interesting to note, however, that more participants obtained abnormal results on the QEEG scan than on any of the other procedures. The rates of abnormal results were 80%, 78%, 72%, and 49% for the QEEG, ADDES, TOVA, and Conners' CPT, respectively. Thus, results of this study indicate that QEEG scan results show significant consistency with other well-established procedures used in diagnosing ADHD, and that it is at least as accurate as these other procedures.

(It is important to note that classification agreement between the different procedures was not perfect, and that some individuals who met DSM-IV diagnostic criteria for ADHD did not score in the deviant range on each of the instruments. This makes clear that errors can be made if too much emphasis is placed on results obtained from any single diagnostic procedure. Instead, it is important to obtain data from a variety of sources in the evaluation process, and then make a careful diagnostic judgment that reflects a thoughtful integration of these different data sources.)

Study 3
In the final study in this paper, the researchers examined the consistency of QEEG scan results that individuals received on different occasions. The consistency of results obtained on a test is one measure of a test's reliability, and high test-retest reliability is especially important for tests intended to help with diagnosis. Fifty-five individuals between 6 and 20 participated in this reliability study. Each was given the QEEG scan on 2 occasions, one month apart. The correlation between individuals’ scores for the 2 administrations was .96, which is really very high (i.e. the highest possible correlation that can be obtained is 1.00). This result means that individual's Attention Index scores from the QEEG scan were remarkably stable over the 30-day period. Thus, the score one obtains on a particular day is likely to be very similar to the score one would obtain at another time. An abnormally high score that is suggestive of ADHD is thus unlikely to occur because of chance. Instead, it is likely to reflect a stable characteristic of an individual's underlying EEG activity.
SUMMARY AND IMPLICATIONS
Collectively, the 3 studies described in this paper replicate prior results showing that: QEEG scanning provides an accurate tool for differentiating between individuals with and without ADHD; QEEG scan results demonstrate adequate agreement with more established evaluation procedures; and, results obtained on QEEG scans are remarkably stable over at least short time intervals. Such results provide strong support for the utility of QEEG scanning as an objective procedure to assist in the diagnosis of ADHD. Although these results are encouraging, they are limited by the fact that the utility of QEEG scan results in distinguishing between individuals with ADHD and individuals with other psychiatric disorders was not tested. Instead, when QEEG results between individuals with and without ADHD were compared, the comparison group was comprised of normal individuals without any other disorder. Thus, we don't know whether individuals without ADHD, but with other psychiatric disorders, would also score in the abnormal range on the QEEG scan. Thus, the utility of this procedure for differentiating between ADHD and other conditions -- which clinicians are often required to do -- remains undetermined. This critical test of the utility of QEEG scanning as a diagnostic procedure for ADHD was examined in a more recent study from this research group.