

QEEG: A NEW TOOL IN THE MITIGATION TOOLBOX

Landmark Ruling Admits QEEG Brain Maps As Part Of Mitigation Case

Successful death penalty defense requires high quality mitigation. A new tool known as Quantitative Electroencephalography, or QEEG, which was used for the first time in a death penalty proceeding in Florida, has been added to the arsenal in the battle to save clients from the ultimate penalty. Despite this success, attorneys and mitigation specialists may still face *Frye* and *Daubert* challenges to use of a QEEG.

THE MANDATE FOR MITIGATION

A brief overview of the importance mitigation is helpful to understanding the potential uses of QEEG. The importance of mitigation investigations flows from the Eighth Amendment's requirement that there be an individualized determination as to whether death is the appropriate penalty in any given case.¹ Mitigating evidence is "anything shown by believable evidence that, in fairness or in the totality of the defendant's life or character, extenuates or reduces the degree of moral culpability for the crime committed or that reasonably serves as a basis for imposing a sentence less than death."²

Florida's statutory scheme for capital punishment reflects these Constitutional concerns for individualized sentencing. Florida is one of the few states that will sentence a person to death by a simple majority vote of the jury. A simple majority, a single person, is all it takes for a recommendation of death. Once convicted, a lone holdout on the jury is not enough to avoid a death sentence, and a judge may still override a jury's decision for a life sentence.

After a defendant is found guilty of a capital offense, a second penalty phase trial determines whether a death sentence will be recommended to the judge. The same jury that decides guilt in the first phase sits on the penalty phase to decide the punishment recommendation to the judge.

During penalty phase, the jury hears evidence concerning aggravators, circumstances that weigh toward death, and mitigators, those circumstances weighing in favor of mercy. The defense and prosecution can present new evidence supporting these circumstances. The jury then makes a sentencing recommendation based on these aggravators and mitigators. This statutory scheme allows presentation of a wide range of mitigating circumstances, while limiting the uncontrolled use of aggravators.³

In addition to individualized sentencing requirements, presentation of mitigation evidence is key to Florida's constitutional requirement of proportionality review by the Florida Supreme Court in all death penalty cases.⁴ A proportionality review requires that court to thoughtfully and deliberately consider the totality of circumstances in a particular case, and to compare it with the circumstances in other capital cases.

THE DIFFICULTIES OF OBTAINING MITIGATION

ABA Guidelines require that the death penalty defense team include a mitigation specialist. The role of a mitigation specialist on a death penalty case is broad. Typically, the mitigation specialist assembles a comprehensive chronology of the client's life. This requires identification, location and retrieval of all records regarding the client ever generated, as well as all records regarding all immediate and extended family members.

In addition to obtaining records, the mitigation specialist must conduct comprehensive interviews with the client and as many individuals as possible who have known the client. These

include all family members, both immediate and extended friends, neighbors, landlords in all locations the client has ever lived, teachers, counselors and coaches – in short, anyone who had contact or influence in the client’s life.

For several reasons, locating and interviewing lay witnesses, especially family members, is a sensitive endeavor. A primary reason is that, as with the client, family members may similarly suffer from multiple impairments, including mental retardation, mental illness and substance abuse. In addition, there are usually problems obtaining the trust of the witnesses. In many cases lay witnesses are initially suspicious of talking to anyone about the client because it is assumed that the purpose is to incarcerate or in other ways hurt their loved one. Others are reluctant to reveal possibly painful and embarrassing facts regarding family history to a stranger, particularly any type of child or sexual abuse.

The limitations of witnesses, combined with the length of time between childhood and the time of the offense or post-conviction investigation, necessitates that lay witnesses be interviewed on more than one occasion in order to obtain valid and reliable data.

Even with multiple interviews, a client’s life history may lack hard documentation. A QEEG can be used to corroborate a self-reported life history, undocumented witness recollections, and even psychological assessments that point to brain dysfunction.

STATE OF FLORIDA v. GRADY L. NELSON

Grady Nelson was a 53 year old social worker’s aid who faced the death penalty on charges of killing his wife and molesting his stepchildren. Grady Nelson confessed to the murder in a videotaped statement to police.

The case of Grady Nelson presented a series of challenges to the defense team. The records were sparse, family and friends long dead, and multiple traumas were self-reported. When counsel were appointed in 2005, they knew that a thorough, leave-no-stone-unturned, mitigation investigation would be required to enable the jury to understand how and why Grady Nelson got to this point in his life.

As the defense team immersed themselves in Grady Nelson's life history and built a rapport with him, they were able to understand some of the difficult life challenges he faced, and look at him as a person.

The trial was heard in front of Circuit Court Judge Jacqueline Hogan-Scola. The jury deliberated for nearly eleven hours before returning a guilty verdict in Grady Nelson's wife's death. He was found guilty of the sexual battery of his step-daughter, but not of his step-son. The jury returned guilty in two counts of attempted premeditated murder for the stabbing of the step-children.

The penalty phase battle was on. The goal of the defense team now was to enable the jury to view Grady Nelson sympathetically as a flawed human being who had committed horrible crimes.

THE DEFENSE CASE FOR LIFE

However, the defense case for life starts long before the penalty phase – it starts in voir dire and the guilt phase of the case. Counsel cannot wait for the penalty phase to present facts that will help the jury vote for life.

The theme of the case was that Mr. Nelson had a “broken brain”, as demonstrated by the QEEG brain map, neuropsychological testing, and social history. It is imperative that counsel present a consistent theme to the jury. The most challenging case is when counsel argues factual

innocence in the guilt phase and then argues mental mitigation in the penalty phase. If the guilt phase defense is inconsistent with the penalty phase defense, the jury will not have a single theme upon which to base a life recommendation.

Mr. Nelson insisted that he was innocent of the crime and demanded a defense of factual innocence. Counsel argued factual innocence, but was able to elicit testimony from an officer at the scene that Nelson was impaired, incoherent, and appeared to be in a daze. Counsel also elicited evidence that Nelson burned videotapes because he thought he was being spied upon by police, and that there were empty cocaine baggies found in the house. The elicitation of these facts supported the “broken brain” theme. Counsel’s closing argument, which discussed reasons why the killing was provoked by cocaine-induced rage and paranoid, impaired thinking, dovetailed with the “broken brain” theme.

The statutory mitigators seemed few in comparison. At best, the defense team hoped to convince the jury that Grady Nelson acted under the influence of extreme mental or emotional disturbance⁵ and that he was so substantially impaired due to crack cocaine that he could not appreciate the criminality of his conduct or conform to the requirements of law.⁶

But counsel is not limited to statutory mitigating factors; Grady Nelson’s entire life history was used as a mitigating factor.

Investigating Grady Nelson’s background for mitigating factors was difficult due to his age and the lack of records. Grady Nelson grew up in a small rural Georgia town in the 1950’s and 1960’s. The town was segregated, and few records or accounts of the African-American community were kept. Older eyewitnesses had died, and much of the oral history of Grady Nelson’s family life died with them. Grady Nelson never knew his father. Grady Nelson’s mother was an alcoholic prostitute who drank constantly, even while pregnant. There were no

social service agencies available to the African-American community, so when Grady's mother was arrested, the sheriff would bring Grady to his mother's jail cell, where he was fed and housed. Grady remembered that he liked to sleep in the jail cell because it was warm and he was fed good food.

At age four, Grady remembered seeing his sister being raped by a gang of white carnival workers, while he hid behind a wall, too terrified to speak. The sister died as a result of the rape, and Grady was left with a lifetime of guilt and recrimination. A death certificate was found for Grady's sister, but no details of her death were chronicled in medical reports, obituaries, or news papers. Grady revealed that he had been abused as a young boy by a pastor, but there no witnesses to the molestation, which was never reported. Eventually, Grady's mother realized that she was an unfit mother and gave him to her sister to raise. Grady's mother abandoned the maternal relationship and Grady never saw her again. Grady rarely went to school and began to experiment with drugs to medicate his personal pain. Grady was a very angry child and began to get into legal trouble in high school. Eventually, to avoid jail, he enlisted in the military and continued to abuse drugs and alcohol. He received a general discharge as a result of his unresolved anger issues.

Grady reported being knocked unconscious several times and had a scar on his head. However, no military records or hospital records could be found to confirm these injuries.

As an adult, Grady became more dependent on cocaine and his life became less manageable. He had several drug-related arrests. He served a prison term. He was able to secure a job with the City of Miami as an outreach counselor helping to feed and shelter homeless people, but his drug use interfered with his job performance.

Numerous experts were hired- a community psychologist opined that Grady had maternal abandonment syndrome, a recognized DSM-IV syndrome, and explained the effect of childhood racism on his adult behavior, a forensic psychologist presented significant events in his life as a “social historian”, an oncologist was hired to describe his prostrate cancer and limited life expectancy, a psychologist who specialized in prison adjustment issues would testify that based upon his review of prior prison records, Grady Nelson would be a manageable prisoner who was not a danger to prison staff, and a psychologist who had expertise in fetal alcohol syndrome and with the effect of cocaine on the brain’s decision-making functions.

Despite the compelling circumstances of Grady Nelson’s life history, the defense team felt that the jury needed to see neurological evidence of a brain disorder that could explain Grady Nelson’s actions before they would be willing to look beyond the facts of the crime, listen to a mitigation case, and consider a life sentence.

A neuropsychological evaluation in capital cases should be comprehensive because of the high incidence of psychiatric and neurological disorders among murderers and violent offenders. Research has demonstrated that brain dysfunction, especially in the frontal lobes, is a risk factor for violence. Should neuropsychological or neurological disorders be identified, the brain dysfunction and its association with violent acts may be a significant mitigating factor in a jury’s deliberation.

A detailed social history and neuropsychological evaluation may delineate crucial mitigating variables such as possible birth defects, developmental disabilities, physical or sexual abuse, history of suicide attempts, and history of psychological problems and psychiatric hospitalizations, and adaptive behavior dysfunction. Neuro-psychological measures quantify important psychological and neuropsychological mitigating factors using scientifically validated

assessment instruments. Syndromes that are particularly relevant in capital cases include traumatic brain injury, organic brain syndromes, mental retardation, learning disabilities, attention deficit hyperactivity disorder (ADHD), fetal alcohol syndrome, chronic use of drugs/alcohol, as well as psychiatric and personality disorders.

The psychologists and neuropsychologists who examined Grady Nelson found a clinical history of early childhood abuse and possible closed head injuries. Objective testing was needed to corroborate these findings because the history was self-reported, and no supporting records existed.

A psychologist on the defense team had experience with controversial brain mapping evidence known as quantitative electroencephalography (QEEG), and suggested that a QEEG examination be performed on Grady Nelson.

WHAT IS QEEG BRAIN MAPPING?

Understanding QEEG brain mapping requires basic knowledge of its underlying technology, electroencephalography.

Electroencephalography (EEG) is the recording of the brain waves, which are the fluctuation of electric impulses produced by the firing of large groups of neurons in the brain.⁷ Neurons, or brain cells, generate the electrical activity. When acting in large groups, these assemblies of neurons are responsible for the brain waves that can be measured from the surface of the human head.⁸

An EEG is performed by attaching electrodes to the surface of the scalp. Wires from each of these electrodes transmit measurements of the electrical activity from that specific location of the brain to a computer. The computer then produces a graph of the raw unfiltered measurements known as an electroencephalogram. This resulting electrical activity is displayed in an analog waveform in an electroencephalograph. See Figure 1.

Neurologists, medical doctors specializing in the nervous system, assess the shape of the waveforms, using the naked eye.⁹ Typically, a neurologist is looking for gross or large scale problems in the brain such as focus centers for seizures, epilepsy or tumors. The neurologist is primarily interested in the analog wave shape. This clinical use of the electroencephalograph is primarily for testing in most hospital settings. EEG is used widely in the field of medicine, especially neurology, to diagnose epilepsy and brain injury.¹⁰

With the advent of computer technology, the EEG analog waveforms are transformed into digital signals. Digitization means more EEG parameters can be mapped and assessed than was possible before. The raw EEG data is transformed mathematically to have a computer analyze the frequency and amplitude characteristics of the brain waves.¹¹

Quantitative electroencephalography, commonly known as QEEG, is a child of the digital age resulting from the marriage of computer technology and traditional electroencephalography. A QEEG program amplifies the EEG data, mathematically transforms the EEG data, and compares the data against statistically- valid, normative databases of EEG data. A normative database is a collection of brainwave patterns of individuals that meet certain criteria for “normalcy”.

In a QEEG examination, the data are drawn from 19 electrodes in a latex cap that is placed on the subject’s head. The QEEG operator extracts samples from the raw EEG data. The operator is trained to avoid “contamination” of the sample. These “contaminants” are called artifacts. Artifacts can be caused by certain environmental conditions, wearing of dentures, improper administration of the test, or muscle movements. The QEEG operator must isolate samples from the EEG data that is free of these contaminants. These samples are then compared against a collection of normal EEG readings. A neuropsychologist then considers the clinical history of the patient with the results of the QEEG to make a diagnosis.

Conceptually, a QEEG is the same as the familiar blood test used by physicians. A technician draws a blood sample, carefully following procedures to avoid contamination of the sample. After a blood sample is drawn, the different types of blood cells are counted. These counts are then compared to the counts that are considered to be within normal ranges in the general population. Abnormalities are noted in the results, and physicians use these results to help diagnose the patient. It is important to note that the blood test results are not a diagnosis, but an invaluable diagnostic tool used by physicians.

The QEEG examination produces a three-dimensional, color-coded, topographical representation of the EEG waveforms generated by the brain.¹² See Figure 2. Utilizing a laptop computer, this brain map can be shown to the jury while the expert describes the findings and relates them to the behavior of the defendant.

QEEG is particularly well-suited for incarcerated or indigent clients. QEEG is inexpensive compared to other brain mapping technologies such as magnetic resonance imaging (MRI) or single photon emission computed tomography (SPECT/CT) scans. MRI equipment averages over \$1 million dollars,¹³ and SPECT/CT equipment averages around \$1.8 million¹⁴ and requires a costly radioisotope for each scan. Because of the costs, the subject must go to a hospital or mobile clinic. QEEG equipment averages less than \$10,000 and is portable. QEEG can be performed in any quiet room, which is easily arranged even in a jail or prison. Additionally, QEEG brain mapping does not require any prior patient preparation, which is important when the subject is incarcerated.

QEEG seemed to be a good fit for use in Grady Nelson's case. A well-respected local QEEG certified operator was recommended. The operator administered the QEEG using the

FDA-approved Neuroguide™ system, developed by the prominent QEEG pioneer Dr. Robert Thatcher.

The results came in. The QEEG brain map revealed frontal lobe brain damage consistent with Grady Nelson's predisposition to impulsiveness and violence. The results of the QEEG were highly consistent with brain wave activity found by other researchers to be associated with pre-natal alcohol exposure, loss of cognitive function consistent with traumatic brain injury, and early childhood abuse. These results were consistent with the Defendant's history.

The defense team had found objective evidence of frontal lobe brain damage which proved the "broken brain" theme. Now the only thing standing between the QEEG brain map results and the jury was the State's *Frye* challenge.

FRYE CHALLENGES

QEEG is a relatively new clinical tool when compared to conventional EEG. In 1994 Dr. Frank H. Duffy of Harvard Medical School published the first paper on the use of QEEG in clinical practice.¹⁵ The paper suggested that QEEG was a valuable aide in diagnosing neuropsychological conditions, including learning disabilities, attention deficit disorder, traumatic brain injury, mild head injuries, and post concussion syndrome.¹⁶ QEEG was identified as a major diagnostic aid to traditional neuropsychological diagnoses where the diagnosis was in doubt.¹⁷ Other studies soon found QEEG "particularly well suited to identifying subtle changes" in brain functions and as an aid to difficult differential diagnoses in differentiating mood disorders, evaluating alcohol or substance abuse, post-concussion syndrome, and assessing other cognitive, attentional, or developmental disorders.¹⁸

One reason for the controversy is that new technologies are often not welcomed by the established practitioners that are threatened by the newcomers. Neurologists such as Dr. Mark

Nuwer immediately challenged the use of QEEG for conditions that were hard to visually diagnose. Severe brain trauma and epilepsy could easily be seen on an EEG, but mild brain injury and conditions such as depression, fetal alcohol syndrome, and attention deficit disorders, are not detected.

Second, insurance companies loathe to give credence to a technology that supports potentially costly claims for injuries that are not apparent on conventional EEGs. As a result, admission of QEEG results in civil cases has been heavily litigated, and Dr. Nuwer has been the main expert witness opposing its admissibility.

A court must prevent a jury from being confused by proponents of junk science. Accordingly, when the State raised a challenge to QEEG brain mapping in Grady Nelson's case, Judge Hogan-Scola ordered a *Frye* hearing.

Under *Frye* in Florida, an expert's opinion testimony that is based on scientific principles or theories is admissible only when the underlying bases are generally accepted in the field in which it belongs.¹⁹ The methodology applying the process must similarly be accepted in the relevant scientific community.²⁰

However, the *Frye* standard does not require the judge to assess the scientific reliability or validity of a principle or procedure.²¹ Rather, the only assessment required is to review the literature "merely to determine whether there is a quantitative and qualitative acceptance of the science."²² The judge is not required to become an expert, but only to determine "the level of agreement or dissension within [the relevant scientific community.]"²³ In making this determination, a court may also consider scientific and legal literature²⁴ as well as other judicial decisions.²⁵

A proponent of QEEG brain mapping will almost certainly face some of the challenges that were raised in Grady Nelson's *Frye* hearing. In addition to challenges to the credentials of witnesses, the following should be expected.

➤ CHALLENGE: QEEG IS NEW AND NOVEL.

In Florida, expert testimony does not always need to be *Frye* tested to be admissible. Only the underlying scientific principles, not the opinions drawn from those principles, is subject to *Frye*.²⁶ *Frye* testing applies only to new or novel scientific techniques.²⁷

In QEEG, the underlying scientific principles are not new or unique. The QEEG performs essentially the same comparisons as those used in analyzing blood or in automated electrocardiograph analysis.²⁸ The transformation from the analog signal to digital data is accomplished using mathematical calculations (developed by Joseph Fourier in 1810), which should not be subject to challenge. Such use of computer technology and mathematics is not new or novel in the medical field.

➤ CHALLENGE: THE RELEVANT SCIENTIFIC COMMUNITY IS NEUROLOGISTS.

The relevant scientific community for QEEG use consists of psychologists, psychiatrists, non-neurological medical doctors, neuropsychologists, clinical Ph.D. neuroscientists, and other trained individuals. In the field of neurology, QEEG is not as widely accepted and is used by a small but growing number of neurologists. As one follower of Dr. Marc Nuwer, Dr. Charles Epstein, testified at Grady Nelson's *Frye* hearing:

There is only one relevant community for the diagnosis of disease. There's only one group of people specifically and extensively trained in the diagnosis of disease and that is MDs. And in that community, it would not be proper.²⁹

Dr. Marc Nuwer has admitted under oath that only a small number of neurologists use QEEG, perhaps totaling less than 1% of the total QEEG users. Therefore neurologists cannot be considered the relevant scientific community because they are not the ones “espousing the theory” or “using QEEG.”

In Florida, the method of determining the size of the relevant scientific community is not clearly defined.³⁰ One Florida court has suggested that the relevant scientific community “should include a broader group of clinical and experimental psychologist and psychiatrists, and not merely the group of licensed professional who are making a living by relying on these tests.”

³¹ Another *Frye* jurisdiction suggests that the relevant community is those who espouse and use the technology.³²

However, it is clear that within that community, scientific unanimity is not a requirement.³³ “Therefore, while a ‘nose count’ is not alone sufficient to establish general acceptance in the scientific community, such acceptance likewise need not be predicated upon a unanimous view.”³⁴

Quantitatively, QEEG has the nose count in its favor. QEEG is performed by over 12,000 (25,000 by some estimates) psychologists, psychiatrists, non-neurological medical doctors, neuropsychologists, clinical neuroscientists and other trained individuals but only rarely by neurologists.³⁵ The vast majority of the over three thousand peer reviewed QEEG studies of traumatic brain injuries are authored by psychiatrists, clinical psychologists, psychologists, internal medicine medical doctors, family practitioners, and clinical neuroscientists and not neurologists.³⁶

A survey of the peer-reviewed literature attests not only to the quality but the vitality of the QEEG scientific community. There have been approximately 96,241 peer reviewed journal articles of EEG listed by the National Library of Medicine between 1998 and 2010 and approximately 99% used QEEG analysis.³⁷ This includes articles published by Harvard, Stanford,

UCLA, and other major universities throughout the world.³⁸ The fact is there is “extensive peer reviewed literature quantifying the superior reliability³⁹ (i.e., reproducibility or the ability to repeat a measurement), validity and specificity of QEEG.⁴⁰ Multiple authors from the fields of psychology, psychiatry, and neuropsychology have written and reviewed these articles.⁴¹

QEEG is endorsed by numerous professional societies, including the EEG and Clinical Neuroscience Society and the American Board of Electroencephalography and Clinical Neurophysiology. The United States Department of Veterans Affairs and the Department of Defense utilize QEEG to evaluate returning soldiers for mild traumatic brain injury.⁴²

➤ CHALLENGE: VISUAL EXAMINATION IS MORE RELIABLE.

Diagnoses from EEGs done without computer assistance are far more error-prone than QEEG. Visual examination is highly dependent on the expertise of the human reading the data, and as such, is prone to a high degree of variability. For example, in mild traumatic brain injury, visual examination of EEG traces has approximately zero detection accuracy and 100% false negatives.⁴³

In contrast, the use of QEEG has been empirically verified through numerous studies.⁴⁴ For example, in the case of traumatic brain injury, other QEEG studies found a reliability of 97% for the detection of a pattern consistent with traumatic brain injury as a causal agent.⁴⁵

➤ CHALLENGE: THE EXPERT WITNESS IS UNRELIABLE BECAUSE OF A MONETARY INTEREST.

While there are numerous clinics that provide QEEG services, an examination of the literature shows that the tool is used as an adjunct to other services and a research tool in hospitals and universities. Because a portion of the QEEG community derives income from the use of QEEG does not invalidate the technology any more than it invalidates the use of X-Ray or MRI technology. The wide acceptance of QEEG has led to over 45 companies manufacturing QEEG

devices. While these companies owe their livelihood to acceptance of QEEG, so do the manufacturers of MRI's and CT scan equipment – which does not invalidate their validity.

➤ CHALLENGE: THE PARTICULAR QEEG DEVICE IS UNRELIABLE.

Choice of the QEEG system is important. The QEEG system is a medical device for brain mapping and statistical analysis of the brain. There are over 45 manufacturers of QEEG devices. Certification for use by the Food and Drug Administration (FDA) can overcome any concerns regarding the particular system used. The FDA has approved several QEEG devices, which include the Neuroguide™ System, Lexicor Neurosearch NRS24™ and the NXLink™ database.

The NeuroGuide™ Analysis system has been tested and found reliable by the FDA since 2004 for the statistical evaluation of the electroencephalogram.⁴⁶ Dr. Thatcher's application submitted to the FDA stated that his software "was based upon the results of an extensive, 25-year effort to construct a viable normative and clinical database at the Applied Neuroscience Laboratory at the University of Maryland."⁴⁷

➤ CHALLENGE: THE NORMATIVE DATABASE IS TOO SMALL FOR RELIABILITY.

The size of the databases has been shown to be statistically reliable, again using statistical analyses (logarithmic transforms, Gaussian distributions, t-tests, Analysis of Variance, leave-one-out cross-validation), mathematics which should not be subject to challenge. QEEG implements strict standards for developing databases similar to the criteria used by many blood databanks and many other databases in medicine.⁴⁸ The databases consist of "a large enough sample to be representative of a normal population, no history of neurological disorders, no history of

epilepsy, no history of traumatic brain injury, no history of psychiatric disorders, performing adequately or well in the society.”⁴⁹

➤ CHALLENGE: QEEG IS NOT ACCEPTED FOR USE IN TRAUMATIC BRAIN INJURY.

Of particular interest to plaintiff attorneys is using QEEG as a diagnostic aide for mild or moderate traumatic brain injury (TBI). In this area alone, there are over 100 peer-reviewed articles.⁵⁰

In a 2000 Volume of *Journal of Head Trauma Rehabilitation*, Dr. A. M. Salazar,⁵¹ published the results of his study, which was underwritten by the Defense and Veterans Head Injury Program. The study concluded that QEEG is useful as a part of the standard battery of clinical testing:

Advanced studies of QEEG and qMRI (with Dr. R. Thatcher at Bay Pines Veterans Hospital). Dr. Thatcher has defined a strong biophysical link between MRI, QEEG measures and cognitive function in TBI patients, as well as increased brain homogeneity in TBI patients. Based on these findings, he has developed a powerful QEEG-based TBI discriminate function that can distinguish MTBI patients from normals and from controls with dementia (Alzheimer’s disease) and provides an inexpensive, objective physical measure of injury severity to predict outcome in the DVHIP population.⁵²

In a 2008 Volume of *Brain Injury*, Dr. J. Leon-Carrion published a study using QEEG to objectively determine the extent of disability in TBI patients and those with cerebral vascular accidents.⁵³ Dr. Leon-Carrion writes as follows:

Moreover, the development of mathematical tools and data visualization has made it possible to quantitatively analyse the human EEG, a technique known as quantitative EEG (QEEG). Human QEEG measures have been correlated with certain diagnostic categories, both in healthy and clinical populations. By meeting certain statistical requirements, these studies have obtained a set of QEEG variables, known as discriminant functions, which can predict the severity of a clinical condition. Studies on QEEG present a consistent and common neurophysiological pattern associated with severity of brain injury, which involves increased slow

band amplitudes, decreased fast band amplitudes and changes in EEG coherence.”⁵⁴

Dr. Leon-Carrion, using Dr. Thatcher’s software,⁵⁵ was able to predict the level of functioning in neurologically disabled based upon his/her QEEG pattern.⁵⁶ Dr. Leon-Carrion demonstrated classification accuracy of 100% in the training set sample and 75% in an external cross-validation sample; 100% sensitivity and specificity were reached.⁵⁷

In 2004 Dr. Duff, a psychologist, published an article in *Clinical EEG and Neuroscience*.

Dr Duff writes:

QEEG is particularly suitable for the evaluation of post-concussion syndrome, as it is empirical, objective, noninvasive and has been shown to be highly accurate in identifying and discriminating various neurophysiological patterns of brain dysfunction.⁵⁸

➤ CHALLENGE: A QEEG BRAIN MAP IS A STAND-ALONE DIAGNOSIS.

The purpose of QEEG is to aide in the diagnosis of psychological or neurological conditions. Like most medical tests, including CT scans and MRIs, these tests are used as an adjunct to give more information in treating a patient. As early as 1994, the American Medical EEG Association stated as follows:

When used on proper equipment by physicians with appropriate training and certification, the committee believes that QEEG provides clinically relevant information that is additive of that obtained from standard EEG interpretation.⁵⁹

Dr. Frank H. Duffy, the noted neurologist at Harvard’s Children Hospital and an authority on QEEG, explained:

A cornerstone of our approach is the belief that neurophysiologic data are not “diagnostic” but may provide important information to aid in the formation of a diagnosis. It is the clinician who makes the diagnosis, not the machine. This is a generalization of the well-known statement that the EEG does not diagnose epilepsy, but may confirm or extend the clinicians’ presumptive diagnosis.⁶⁰

➤ EXPECT CASE-SPECIFIC CHALLENGES

In addition to these challenges, an attorney should expect that the credentials and training of the operator will be scrutinized, and most importantly, that the samples chosen for the QEEG by the operator will be opposed based on contamination by artifacts.

A proponent should be prepared to have a neuropsychologist correlate the QEEG brain mapping results with a specific disorder. Just as with traumatic brain injury or fetal alcohol use, this support can usually be found in the numerous journals and research articles on a particular area.

CONCLUSION

After hearing all the evidence at the *Frye* hearing, Judge Hogan-Scola admitted Grady Nelson's QEEG evidence. Judge Hogan-Scola, for the first time in a death penalty case, found QEEG meets the legal prerequisites for reliability under *Frye* standards: "[E]verything I have heard, the methodologies are sound, the techniques are sound, the science is sound."⁶¹

As part of the mitigation case for life, the jury heard the testimony of Dr. Robert W. Thatcher, the nationally known pioneer in QEEG analysis. Dr. Thatcher explained how the QEEG works in layman's terms and showed the jury the irrefutable, objective evidence of frontal lobe damage on a color-coded, three dimensional, topographical brain map.

After listening to a comprehensive mitigation life history, the jury was able to understand that Grady Nelson's maladaptive behaviors were the result of frontal lobe brain damage and a horrific upbringing, not simply because he was a bad person.

After only one hour's deliberation, the jurors returned a recommendation of life for Grady Nelson. At least two of the jurors reported that the QEEG brain map evidence helped them make their decision for a life sentence.⁶²

As QEEG analysis becomes more common in capital litigation, counsel will be expected to exercise their professional judgment regarding its utility in a particular case. In at least one reported case, a post-conviction motion based primarily upon the results of a QEEG examination has resulted in a death sentence being vacated.⁶³

Counsel should also be cautious not to over-value the impact of a QEEG and fail to conduct a comprehensive mitigation investigation of the client. The QEEG test is not the proverbial “silver bullet”. In Grady Nelson’s case, the QEEG test was a small part of a comprehensive and well-documented mitigation presentation of his entire life.

Attorneys who want to use QEEG in cases where brain function is an issue will still face *Frye* and *Daubert* challenges as prosecutors and civil defense attorneys seek to exclude this evidence. The strategies used by the defense team in Grady Nelson’s case provide a roadmap for maximizing this powerful new technology as part of an overall mitigation presentation to a jury. As a result of Judge Hogan-Scola’s watershed evidentiary ruling, the QEEG test is another tool that can be added to counsel’s mitigation toolbox.

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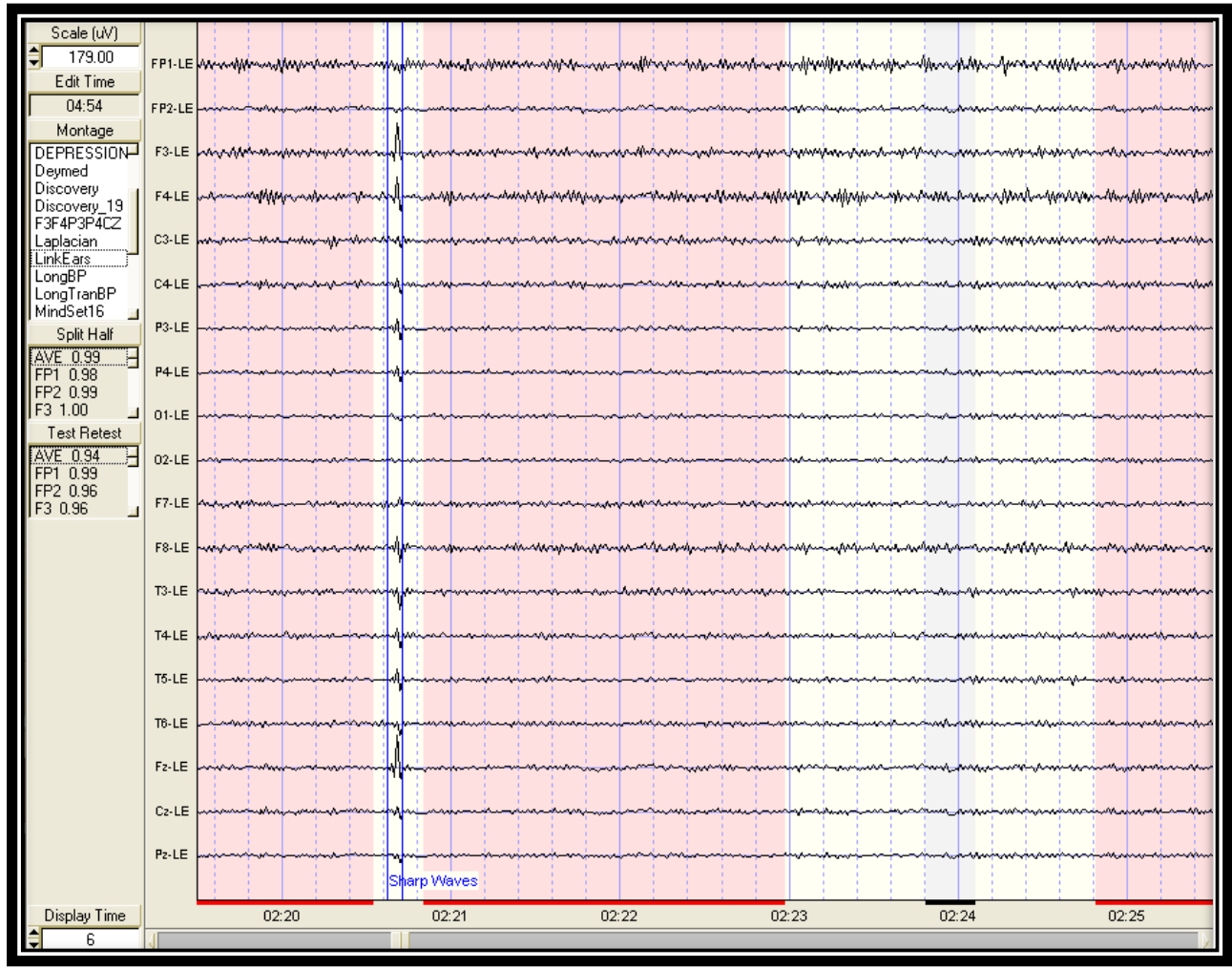


Figure 1. EEG Samples

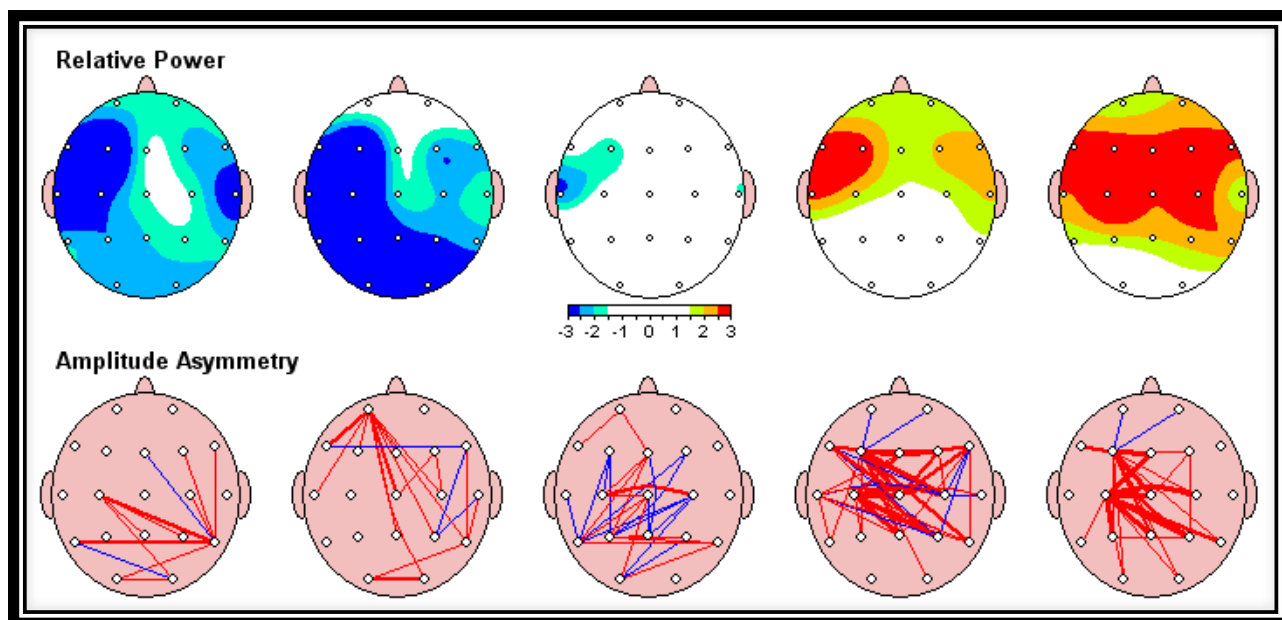


Figure 2. Example of QEEG Report

¹ See U.S.C. Amend. 8; *Kansas v. Marsh*, 548 U.S. 163, 174 (2006) ("The use of mitigation evidence is a product of the requirement of individualized sentencing."); *Tennard v. Dretke*, 542 U.S. 274, 275 (2004) ("The Eighth Amendment requires that the jury be able to consider and give effect to a capital defendant's mitigating evidence.").

² *Crook v. State*, 813 So. 2d 68, 74 (Fla. 2002).

³ See Fla. Stat. § 921.14].

⁴ See *Barnes v. State*, 29 So. 3d 1010, 1025 (Fla. 2010).

⁵ Fla. Stat. § 921.141(6)(b) ("The capital felony was committed while the defendant was under influence of extreme mental or emotional disturbance.").

⁶ Fla. Stat. § 921.141(6)(f) ("The capacity of the defendant to appreciate the criminality of his conduct or to conform his conduct to the requirements of law were substantially impaired.").

⁷ Behavioural Neurotherapy Clinic, QEEG Brainmapping, <http://www.adhd.com.au/QEEG.htm>.

⁸ Behavioural Neurotherapy Clinic, QEEG Brainmapping, <http://www.adhd.com.au/QEEG.htm>.

⁹ Behavioural Neurotherapy Clinic, QEEG Brainmapping, <http://www.adhd.com.au/QEEG.htm>.

¹⁰ Kiel H.R. Wiedemann, *The Pioneers of Pediatric Medicine – Hans Berger (1873-1941)*, 153 *Eur. J. Pediatr* 705 (Springer-Verlag 1994).

¹¹ QEEG Assessment, Brain Mapping & Neurometric Analysis, http://www.drmueller-healthpsychology.com/Treatments_QEEGAssessment.html.

¹² QEEG Assessment, Brain Mapping & Neurometric Analysis, http://www.drmueller-healthpsychology.com/Treatments_QEEGAssessment.html.

¹³ Compare MRI Cost, <http://www.comparemricost.com>.

¹⁴ Changing Market for PET Brings Challenges and Opportunities, http://www.biotechsystems.com/breakingmarketnews/changing_market_for_pet.asp.

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- ¹⁵ Behavioural Neurotherapy Clinic, QEEG Brainmapping, 2 available at <http://www.adhd.com.au/QEEG.htm>.
- ¹⁶ Behavioural Neurotherapy Clinic, QEEG Brainmapping, 4, available at <http://www.adhd.com.au/QEEG.htm>.
- ¹⁷ Behavioural Neurotherapy Clinic, QEEG Brainmapping, 4, available at <http://www.adhd.com.au/QEEG.htm>.
- ¹⁸ John R. Hughes, M.D., Ph.D. & E. Roy John, Ph.D, Conventional and Quantitative Electroencephalography in Psychiatry, 11 J. Neuropsychiatry Clin NeuroSci 2, 199 (Spring 1999).
- ¹⁹ See *Marsh v. Valyou*, 977 So. 2d 543 (Fla. 2007).
- ²⁰ See *Hayes v. State*, 660 So. 2d 257, 264-65 (Fla. 1995).
- ²¹ See *U.S. Sugar Corp. v. Henson*, 787 So. 2d 3, 15 (Fla. 2002).
- ²² *Id.*
- ²³ *Id.*
- ²⁴ See *Ramirez v. State*, 810 So. 2d 836 (Fla 2001).
- ²⁵ See *Flanagan v. State*, 625 So. 2d 827, 828 (Fla. 1993).
- ²⁶ See *Ramirez v. State*, 810 So. 2d 836, 849-51 (Fla. 2001).
- ²⁷ See, e.g., *Spann v. State*, 857 So. 2d 845, 852 (Fla. 2003) (noting handwriting comparison is not new or novel).
- ²⁸ See, e.g., S. Zhou, et. al., New Approaches in Philips ECG Database Management System Design, Diagnostic ECG Group, Philips Medical Systems, <http://www.cinc.org/archives/2003/pdf/267.pdf>.
- ²⁹ Transcript of Record at 665, *Nelson v. State*, No. F05-00846 (Fla. 11th Cir. Ct. Dec. 3, 2010) (hearing on Oct. 19, 2010).
- ³⁰ See *In re Commitment of Burton*, 884 So. 2d 112 (Fla. 2d DCA 2004).
- ³¹ *Id.*
- ³² See *Zito v. Zabarsky*, 28 A.D.3d 42(2006).
- ³³ *Brim v. State*, 695 So.2d 268, 272 (Fla. 1997).
- ³⁴ *Id.*
- ³⁵ *Id.* at 8.
- ³⁶ *Id.*
- ³⁷ *Id.* at 6.
- ³⁸ *Id.*
- ³⁹ Ironically, it is the paper authored by one of QEEG's most vociferous critics, Dr. Nuwer, that is not peer reviewed. See Affidavit of Thatcher at 10-11.
- ⁴⁰ *Id.* at 6.
- ⁴¹ *Id.*
- ⁴² *Id.* at 2-3.
- ⁴³ *Id.* at 8.
- ⁴⁴ *Id.* at 7-8.
- ⁴⁵ See Thatcher, Biver, & North, Quantitative EEG and the Frye and Daubert Standard of Admissibility, 34 Clinical Electroencephalography 2, 2-15, p. 26 (2003).
- ⁴⁶ See Thatcher, 510(k) Application and response letter from the FDA at ¶ (a)(5) (emphasis added).
- ⁴⁷ *Id.* at ¶ (b).
- ⁴⁸ See Affidavit of Dr. Thatcher at 4.
- ⁴⁹ *Id.*
- ⁵⁰ See Thatcher Affidavit, p 30-42.
- ⁵¹ Dr. A. M. Salazar is a Professor of Neurology, Uniformed Services University of the Health Sciences, President of the International brain Injury Association as well as the Principal Investigator at the Walter Reed AMC.
- ⁵² See Defense and Veterans Head Injury Program: Background and Overview, <http://drjhoffman.com/TBI/2000%20Salazar%20Zitnay%20Warden%20Schwab%20et%20a%20-%20TBI%20Res&Sys.pdf>.
- ⁵³ See Leon-Carrion et al., A QEEG Index of Level of Functional Dependence for People Sustaining Acquired Brain Injury: The Seville Independence Index (SINDI), Brain Injury, at 61-74 (January, 2008):.
- ⁵⁴ *Id.* at p. 62.

⁵⁵ Neuroguide™ is Dr. Thatcher's software.

⁵⁶ See Leon-Carrion, *supra* note 17 at p. 65

⁵⁷ *Id.* at p. 61.

⁵⁸ See J. Duff, The Usefulness of Quantitative EEG (QEEG) and Neurotherapy in the Assessment and Treatment of Post-Concussion Syndrome, 35 *Clinical EEG and Neuroscience* 4, 198 (2004).

⁵⁹ Frank H. Duffy, et al., Status of Quantitative EEG (QEEG) in Clinical Practice, at p. XVII, (1994), *Clinical Electroencephalography*.

⁶⁰ F. H. Duffy, *Topographic Mapping of Brain Electrical Activity: Clinical Applications and Issues, Topographical Brain Mapping of EEG and Evoked Potentials* (1989).

⁶¹ Transcript of Record at 4-5, *Nelson v. State*, No. F05-00846 (Fla. 11th Cir. Ct. Dec. 3, 2010) (hearing on Oct. 22, 2010).

⁶² David Ovalle, *A grotesque crime, a novel explanation*, *Miami Herald*, 12/12/2010, Sec A, at 20.

⁶³ See *Valdez v. State*, 46 P.3d 703 (Ok. 2002).