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JOHNSTONE

SUPERIOR COURT OF THE STATE OF CALIFORNIA

FOR THE COUNTY OF LOS ANGELES

MERALIE ADAMS DODGE, an individual, Plaintiff, vs. DALE ROY CARPENTER, et al., Defendants.	Case No. BC 163 482 RULING OF THE COURT CONCERNING MOTION *IN LIMINE* TO EXCLUDE EVIDENCE OF PET SCANS AND QEEG STUDIES

The court having read the motion *in limine* and supporting documentation in support of said motion, and the opposition to said motion, now makes the following order:

The motion is denied. The court finds that the evidence concerning Pet scans and QEEG studies should be allowed to come before the jury as it goes to the weight rather than the admissibility.

The court relies in part in making this decision on several California cases that have allowed such evidence to come before the jury, including *People v. Musselwhite*, 17 Cal.4th 1216 (1998) and *People v. Crittender*, 9 Cal.4th 83 (1995).

In ruling on motions *in limine*, the court takes the position that the jury should be able to decide as to which expert testimony is more credible but that such matters should be left to the sound discretion of the trial jury and are not to be decided as a matter of law.

The clerk shall send copies this date to all counsel via U.S. mail.

DATED: July 28, 1998

Irving S. Feffer

IRVING S. FEFFER
Judge of the Superior Court

ISF:sa
28Jul98

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SUPERIOR COURT OF THE STATE OF CALIFORNIA

FOR THE COUNTY OF LOS ANGELES

MERALIE ADAMS DODGE, an individual, Plaintiff, vs. DALE ROY CARPENTER, an individual, JKG ENTERPRISES, INC., a California corporation; JKG, INC., an unknown corporation and DOES 1 to 20, inclusive, Defendants.	CASE NO.: BC 163482 (Assigned to Dept. 51) PLAINTIFF'S OPPOSITION TO EXCLUDE EVIDENCE OF QEEG STUDIES OR FOR HEARING PURSUANT TO EVIDENCE CODE §402 CONCERNING ADMISSIBILITY; MEMORANDUM OF POINTS AND AUTHORITIES; DECLARATION OF ROGER V. BERTOLDI, M.D. TRIAL DATE: August 4, 1998 TIME: 10:00 a.m. DEPT: 51

INTRODUCTION

Plaintiff MERALIE ADAMS DODGE sustained traumatic brain injury after her parked vehicle was impacted by defendant's tractor-trailer. Plaintiff's physicians diagnosed a post-concussion syndrome which was later documented by two separate EEG and QEEG tests, a PET scan and two separate neuropsychological consultations. Defendant seeks to exclude valuable corroborative and assistive evidence of brain damage as shown by QEEG based upon its erroneous assumption that QEEG was used for diagnostic purposes and that QEEG is not recognized by the relevant scientific community as an appropriate tool for diagnosis of brain injury from head trauma. Defendant's position is untenable for several reasons:

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1. QEEG testing has been admitted in evidence in numerous trials and has been validate by the Supreme Court of the State of California.
2. QEEG testing is not a new scientific test, but is based on "gold standard" methodolog
3. The QEEG is not offered or used by plaintiff for diagnosis, but for corroboration.
4. There is an abundance of scientific opinion contained in reliable medical literature t support the validity, reliability and usefulness of the QEEG.
5. QEEG is recognized, accepted and used on a daily basis by major hospitals and medica centers across the United States.

For the reasons presented in this brief, defendant's motion to exclude this relevant evidenc should be denied and there is no need for an *Evidence Code* §402 hearing.

I.

THE SUPREME COURT OF CALIFORNIA RECOGNIZES THE ADMISSIBILITY OF QEEG TESTING, INCLUDING BRAIN MAPPING AS ADMISSIBLE EVIDENCE

On May 7, 1998, the California Supreme Court validated the use of QEEG testing, including brain mapping. In *People v. Musselwhite*,[1] defense experts introduced brain mapping evidence using a BEAM machine to prove that the defendant had organic brain damage, making him incapable of premeditation at the time of the offense. A QEEG expert, Dr. Bittle, presented evidence on behalf of defendant on the brain mapping issue. A psychiatrist also testified for the defense basing his opinion on the QEEG testing. The prosecutor produced its own witness to contradict the reliability of the QEEG brain mapping. The Supreme Court validated the trial court's admission of QEEG evidence and permitted the debate amongst experts to go to the weight of the evidence for the jury's consideration:

> "This division of professional opinion among medical experts over the forensic value of brain mapping was ventilated before the jury at trial."

Likewise, in *People v. Crittenden*[2], the Supreme Court of California held that QEEG evidence,

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[1] (1998) 17 Cal.4th 1216

[2] (1995) 9 Cal.4th 83

including brain mapping, introduced at trial indicative of mild brain damage could be contradicted by testimony of witnesses demonstrating a lack of brain damage. The Supreme Court did not overrule the admission of QEEG evidence offered to prove mild brain damage, but instead allowed the jury to assess all of the evidence, including the QEEG and lay testimony, on the issue of brain damage.

If a trial court's decision to admit new scientific evidence is affirmed by a published appellate opinion, that precedent controls subsequent trials[3]. Here, there is no need to reinvent the wheel considering the endorsement by the Supreme Court of admissibility of QEEG evidence in two recent cases.

II.

QEEG TESTING PERFORMED ON PLAINTIFF IS ADMISSIBLE FOR THE PURPOSE FOR WHICH IT IS BEING PROFFERED

Defendant's motion misconstrues the purpose for which the QEEG testing is being utilized and offered by plaintiff. Defendant contends it is not relevant as a method of diagnosing brain damage from head trauma. Plaintiff is not offering the QEEG to diagnose brain damage. Plaintiff's physician ordered EEG and QEEG testing after taking an extensive medical history and performing a physical examination. The use of QEEG in this manner has been widely accepted by the scientific community. Numerous hospitals and universities in Los Angeles County perform QEEG testing on a daily basis. Such facilities include UCLA Medical Center, County USC Medical Center, Harbor General Hospital, and the Veterans Administration Hospital. In 1989 Dr. E. Roy John wrote: "By industry estimates about 400 topographical mapping quantitative EEG machines are now in routine use this country. Conservatively about 50,000 patients are being examined by these devices. . . Most (physicians) reported regularly repeated referrals as a major source of patients for mapping, indicating that the results were useful to the physician making these referrals. Ninety percent considered quantitative EEG as a valuable adjunct to routine clinical practice."[4]

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[3] *People v. Kelly* (1996) 17 C.3d 24; *People v. Smith* (1989) 215 CA3d 19

[4] *John, The Role of Quantitative EEG Topographic Mapping or Neurometrics in the Diagnosis Psychiatric and Neurological Disorders* (1989) (Appendix No. 1)

The fact that QEEG testing is not in itself diagnostic is not surprising. Most medical testing is not in and of itself diagnostic except for certain blood tests and x-rays of fractured bones. A thermometer can read temperature but it is not diagnostic. Frank H. Duffy, M.D., a notable authority on the QEEG stated: "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."[5]

Defendant's reliance on the position paper from the American Academy of Neurology (1989) to support their opinion that QEEG is not diagnostic misses the point of the QEEG in the everyday practice of medicine. The same report indicates:

> "EEG brain mapping can help highlight or identify regional features of the EEG. Occasionally this will identify subtle features that escape identification by traditional visual inspection of the polygraph alone. EEG brain mapping also helps in the communication of EEG features and their localization, especially for communication to persons who are not expert in EEG. Quantifying the EEG features can help in the assessment of whether some features are present to an abnormal degree. Computer-based EEG processing can also calculate abstract features that cannot be visualized."

These are the very reasons that plaintiff's EEG was subjected to computer analysis and for which plaintiff seeks to introduce the results thereof.

In 1994, the American Medical EEG Association (AMEEGA) stated in regard to the clinical value of QEEG as follows:

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[5] *Topographic Mapping of Brain Electrical Activity: Clinical Applications and Issues, F.H. Duffy, Topographical Brain Mapping of EEG and Evoked Potentials (1989)* (Appendix No. 2)

> "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."[6]

AMEEGA commented on the value of QEEG in organicity detection: "A major goal of QEEC therefore, is to provide objective measures that aid in the search for global or focal abnormality which if present, may signal an underlying organic process."[7]

QEEG testing of the plaintiff was intended not to diagnose brain damage but to aid, assist, correlate and corroborate the clinical diagnosis. It provides valuable clinically relevant information which is used by physicians as an aid in making the clinical diagnosis. No rule of law requires that a scientific method or technique such as a QEEG test be diagnostic.

III.

THE PRINCIPLE OF QEEG TESTING IS BASED ON SCIENTIFIC PRINCIPLES THAT ARE BEYOND DISPUTE

QEEG is based on conventional EEG which records brain waves using paper and pen. "The raison d'etre of QEEG is to extract, in an objective and quantified manner, those perimeters of clinical EEG that are traditionally obtained by experienced electroencephalographs using unaided visual inspection. A typical example would be the estimation of EEG background spectral content by Fourier analysis. More specialized QEEG analysis address aspects of EEG not easily appreciated visually."[8] The EEG of man consists of complex waveforms which are difficult for the human eye to evaluate completely. With the advent of modern computers, the EEG is able to resolve complex waves into their constituent component waves, quantify the frequency and energy distributions in the waves, reveal

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[6] Frank H. Duffy, et al., *Status of Quantitative EEG (QEEG) in Clinical Practice* (1994), Clinical Electroencephalography (Appendix No. 3)

[7] Id.

[8] Id.

features, patterns and relationships that elude the human eye. Thus, computer assisted EEG provides a source of new knowledge. "The EEG contains an enormous amount of data relating to the electrical or functional performance of the brain, such as frequency, amplitude, power, and specific wave shapes (such as spikes), which have direct diagnostic significance. In a polygraph EEG this information is displayed on tracings created with ink needles. The shear amount of data generated by the EEG, however, makes it difficult for even a qualified physician to interpret the waveforms by a simple visual inspection."[9]

"The QEEG takes the same raw electrical data collected by the EEG and converts it into digital data that is stored in the computer's memory. The digitized data then can be quantified and displayed in a number of different formats, including graphs and topographical maps of the brain. The most common use of a QEEG is to use the computer to reduce the raw EEG waveform into its component waveforms, using Fourier mathematics. This ability to split the raw EEG waveform into its component waveforms is an important feature of the QEEG. It permits medical experts to see potentially significant abnormalities that are not apparent in viewing the single EEG wave."[10]

Fundamental techniques of analysis of waveforms is owed to the French genius in mathematical physics, Gene-Baptist Josef Fourier, who almost 200 years ago demonstrated that the transformation of waves from the domain of time to that of frequency can be done without loss of information. The mathematical techniques are known as spectral analysis in which the energy in waves are displayed across the frequency band being analyzed. Fourier's proofs were found essentially unassailable. Spectral analysis is the cornerstone of the quantitative approach to EEG. Its utility in the sciences proceeded the discovery of the EEG for nearly 200 years. The images and MRI scans are often Fourier's transformations of the energy shifts in magnetic processes.

QEEG has the ability to display the raw EEG data in the form of colored topographical maps of the brain. Topographical brain mapping does not require computerized quantitative analysis but are built from simply measurements of the raw EEG data. Although the maps are produced for clinical use are

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[9] Bennett, *et al., Topographical Brain Mapping: An Overview* (Appendix No. 4)

[10] Id.

usually from information that has been produced through computer processing of the digitized EEG data, the most common maps are frequency analysis maps which use Fourier mathematics to reduce the raw EEG waveform to its component waveforms. The topographical brain mapping is by no means the only application of the QEEG. The brain mapping is merely the summation of the quantitative or digitized EEG data in the form of a brain map.

The computerized quantification of the raw EEG data does not rest on any new or unproven scientific principle or technique. The QEEG is merely a computer-assisted method for quantifying the raw EEG data and reducing it to a format that maximizes the informational content; and while, like most laboratory tests, including the EEG, cannot by itself be used to diagnose any particular brain condition, it can show patterns with diagnostic significance. Its use for this purpose is well accepted by the scientific community.

In the present case, quantifying features of the QEEG were used to split the plaintiff's raw EEG data into its component waveforms using Fourier mathematics. This frequency analysis permitted plaintiff's doctors to view certain asymmetries and peculiarities that are completely consistent and indicative of brain trauma not easily seen or visualized from the raw EEG data. This quantified data has also been summarized in the form of a colored topographical brain map that will be of great assistance in communicating the EEG features to a lay jury. The use of the QEEG for these purposes has been sanctified by the American Academy of Neurology:[11]

> "EEG brain mapping can also help in communication of EEG features and their localization, especially for communication to persons who are not expert in EEG."

Post-concussion syndrome following minor head injury is a common presentation. Patients often complain of irritability, memory loss, concentration difficulty, depression, blurred vision, headache and dizziness[12]. "Abrupt acceleration and/or deceleration of the brain can cause cerebral contusions and

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[11] *American Academy of Neurology Assessment: EEG Brain Mapping* (1989) (Ex. "B" to Motion)

[12] *Applications of Quantitative EEG/EP in Psychiatry*, Johnstone and Giannini, *Contemporary Psychiatry, Psychiatric Annals* (1990) (Appendix No. 5)

diffuse axonal injuries. It is precisely these neurological injuries that are believed to be the cause of both short and long term disability following mild head injury. Unfortunately, conventional CT and MRI scans are unable to detect structural damage at the microscopic level in mild head injury patients."[13] "Diffuse slowing of the EEG is a nonspecific finding that may be seen after concussion. Localized slowing, especially polymorphic delta, suggests a contusion, even in the absence of clinical or CT abnormalities."[14]

R. W. Thatcher, et al., conducted extensive QEEG testing and analysis on 608 mild head-injury patients and 108 age matched normal subjects resulting in accuracy of 96.2% for the brain trauma patients and 90.5% for the normals. Repeated testing yielded discriminate accuracy of 92.8% for mild head-injured patients[15]. This scientific data confirms the validity of QEEG in mild traumatic brain injury.

Several studies have shown that a predominate pattern of injury in cerebral trauma is of a diffuse and nonspecific nature, with the most common substraight for the diffuse effects being diffuse axonal injury (DAI). "DAI is the consequence of shear-strain forces on brain tissue that result from rapid acceleration and deceleration which accompany high velocity impact. The shear-strain forces result in torn axonal fibers, damage to supportive structures, and degeneration of neuronal fibers that are often distal to the point of impact. . . However, CT and MRI do not reliably image mild DAI, and hence, cannot provide quantitative measures of the neurophysiologic consequences of DAI. In contrast, EEG coherence and phase (QEEG) have been shown to reflect the topographic pattern of human corticocortical fiber bundles. Based upon these studies, the most concise explanation of the consistently strong prognostic measures of EEG phase and coherence (QEEG) on the one hand and the latency of

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[13] Johnstone and Thatcher, *Quantitative EEG Analysis and Rehabilitation Issues in Mild Traumatic Brain Injury EEG Analysis and Rehabilitation in TBI* (1991) (Appendix No. 6)

[14] Frank H. Duffy, et al., *Clinical Electroencephalography and Topographic Brain Mapping Technology and Practice* (1989) (Appendix No. 7)

[15] Thatcher, et al., *EEG Discriminate Analysis of Mild Head Trauma, Electroencephalography and Clinical Neurophysiology* (1989) (Appendix No. 8)

brain stem auditory evoked potentials on the other hand, is that these measures reflect, to some extent, the magnitude of diffuse axonal injury in the cerebral cortex and brain stem."[16] "Topographical mapping appears to provide better detection of low amplitude slow activity not easily discernable by routine EEG. It also provides faithful correspondence with localization of many lesions on neuroimaging procedures and at times distinguishes abnormalities not immediately definable by CT/MRI. Topographical EEG mapping is a valuable adjunct to routine EEG."[17]

As has been demonstrated, QEEG is widely accepted as providing information that is not readily available using conventional EEG, MRI or CT. This is particularly true where a person suffers from diffuse axonal injury, as in this case. MRI and CT are able to detect structural damage to the brain but cannot detect whether the brain is alive or dead. The QEEG, on the other hand, is able to detect microscopic damage to the brain based upon the principles of EEG methodology converted to digital information through the computer process. The methodology used is generally accepted in the relevant scientific community. Evidentiary foundation for the QEEG is patent from its administration by Roger V. Bertoldi, M.D., a Board Certified Neurologist and Neurophysiologist who has administered QEEG testing more than 2,000 times. Defendant's objections to the use of the QEEG go to the weight of the evidence rather than its admissibility.[18] The quantitative EEG is simply the representation of the conclusions "deduced from a well-recognized scientific principle or discovery"—the record of brain activity recorded in the universally accepted EEG. The techniques and scientific principles underlying

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[16] Thatcher, et al., *Comprehensive Predictions of Outcome Enclosed Head-Injured Patients, The Development of Prognostic Equations,* Annals NewYork Academy of Sciences, 1991 (Appendix No. 9)

[17] Jerret and Corsak, *Clinical Utility of Topographic Brain Mapping from Clinical Encephalography* (1988) (Appendix No. 10)

[18] *People v. Yorba* (1989) 209 Cal.App.3d 1026; *People v. Axell* (1991) 235 Cal.App.3d 836; *People v. Musselwhite, supra*; *People v. Crittenden, supra.*

the EEG have long been accepted.[19] The quantitative EEG is simply an improved method of compiling and viewing a large quantity of EEG data.

IV.

QEEG TESTING MEETS THE APPROPRIATE EVIDENTIARY STANDARD AND EXPERT TESTIMONY DEDUCED THEREFROM IS ADMISSIBLE

Under the "Kelly" rule, evidence based upon a new scientific method, technique or device may be received in evidence if the following factors have been established:

1. The reliability of the method in general;
2. The evidence is furnished by a properly qualified expert; and
3. The use of proper scientific procedures in the particular case.

Plaintiff has presented ample evidence of the reliability of the QEEG, which is in use at major hospitals, universities and fee-for-service providers across the United States and worldwide. QEEG is based on conventional EEG, which is performed at the same time and by the same physician who uses the QEEG to extrapolate more data than is available with the unaided human eye merely looking at pen tracings on paper. "Thus, spectral analysis (QEEG) is a sensitive and reliable process that, if properly used, significantly augments classic EEG."[20] The AMEEGA report highlights the general acceptance and reliability of the QEEG in stating,

> "QEEG is clearly of clinical value when performed in concert with standard EEG and analyzed by clinicians with demonstrated competency in standard EEG followed by specialized training and demonstrated competency in QEEG. QEEG is not a simple substitute for conventional EEG and cannot been seen as a substitute for clinical

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[19] *In Re Kemp* (1969) 1 Cal.3d 190

[20] *Status of Quantitative EEG (QEEG) in Clinical Practice* (1994), supra. (Appendix No. 3)

competence. Although continuing to develop, QEEG technology has been matured sufficiently and is now well established."[21]

Dr. Roger V. Bertoldi is a proper qualified expert in the performance of EEG and QEEG. He used appropriate scientific procedures in conducting these tests. The results of the QEEG are based on a contemporaneous EEG. A stand-alone QEEG was not administered, but rather a conventional EEG provided the basic data in accordance with standards of appropriate medical societies and scientific literature.

QEEG testing has achieved general acceptance within the relevant scientific community for the use to which it was put by the physicians attending plaintiff and for the purposes for which it is offered as evidence. Every physician administrating EEG, as well as QEEG, is acutely aware of factors in the performance of testing that effect the results, including artifact identification. Comments on these common problems found in the administration of conventional EEG and QEEG by defendant's expert are sophomoric, elementary cautions suitable as amateur advice. Nowhere has defendant disclosed any relevant discussion of any failure on the part of Dr. Bertoldi to measure up to be a properly qualified expert in QEEG testing, nor that he used improper scientific procedures in conducting said testing. This is especially noteworthy because the defense doctor is board certified in clinical neurophysiology and apparently administers QEEG testing at his brain mapping center in Pasadena.

Satisfaction of the "Kelly" rule does not require absolute unanimity of views within the relevant community.[22] It is not for the Court to decide whether a new technique is reliable as a matter of scientific fact, but rather that the technique has obtained "general acceptance in the relevant scientific community."[23] If defendant alleged that the process of conducting the QEEG was careless or that the process was flawed, it goes to the weight of the evidence, not its admissibility.[24]

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[21] *Id.*

[22] *People v. Guera* (1984) 37 Cal.App.3d 385; *People v. Reilly* (1987) 196 Cal.App.3d 1127.

[23] *People v. Axell* (1991) 235 Cal.App.3d 836

[24] *People v. Cooper* (1991) 53 Cal.3d 771

QEEG is not in reality a new scientific technique or procedure, but rather a new application of an established technique. It is unnecessary to conduct a "Kelly" hearing on the reliability of a particular scientific procedure, if the methodology or technique at issue is merely a refinement or development of an established scientific procedure.[25] The test of reliability does not require that the QEEG be diagnostic or of clinical utility. The QEEG is part of the overall picture of information obtained by physicians to assist, aid, corroborate and correlate clinical techniques and diagnosis. In *People v. Joehnk*[26], the court held that an HGN (Horizontal Gaze Nystagmus) test is admissible although not conclusive evidence of intoxication by itself because HGN can be caused by factors other than alcohol intoxication. Instead, the court held that HGN can be used in conjunction with other tests (breath, blood) as the basis for findings or an opinion on whether the subject is intoxicated. It is enough that the test is relevant to the issue.

A partial list of cases known to plaintiff in which QEEG evidence has been admitted into evidence, aside from the Supreme Court cases of *People v. Musselwhite* and *People v. Crittenden* are attached as Exhibit "A" The use of QEEG should be admissible where the electroencephalographer is well trained and the methodology employed follows accepted standards, as in this case. The QEEG is utilized as but one piece of a complex puzzle. No authority cited by defendant has banned the use of the QEEG in a clinical setting, and, in fact, it is used every day to correlate and corroborate clinical diagnosis. The AMEEGA endorsement provides sound medical support for the admissibility of QEEG for the purpose for which it is offered. As stated by some of the leading experts on the subject of QEEG, "When used appropriately by knowledgeable technicians and clinicians, the QEEG technique can provide unique information to identify and monitor the effects of mild traumatic brain injury."[27] "TBM (topographic brain mapping) is now in routine clinical use. It is proven to be beneficial for the

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[25] *People v. Cooper, supra*

[26] (1995) 35 Cal.App.4th 1488

[27] *Quantitative QEEG Analysis and Rehabilitation Issues in Mild Traumatic Brain Injury*, 1991, supra (Appendix No. 6)

diagnosis, monitoring, and treatment of a wide range of neurological and psychiatric disorders including stroke, epilepsy, dementia, organic affective disorders, depression and schizophrenia."[28]

CONCLUSION

The Supreme Court of California in *People v. Musselwhite* and *People v. Crittenden* has validated the use of QEEG evidence, including brain mapping. Defendant's objections merely go to the weight of the evidence. Plaintiff has amply demonstrated that QEEG is generally accepted in the relevant scientific community as a tool used to corroborate and correlate the clinician's diagnosis of traumatic brain injury. The testing conducted by Dr. Roger V. Bertoldi, a Board Certified Clinical Neurophysiologist was conducted with the utmost regard of the standards of all noteworthy medical commentators. QEEG testing, including brain mapping, is admissible evidence. Defendant's motion to preclude this evidence should be denied. There is no reason to conduct an *Evidence Code* §402 hearing in light of the Supreme Court's validation of QEEG evidence and all of the medical authority presented herein.

DATED: July 20,1998

STEINBRECHER AND ASSOCIATES

By: _____
EDWARD STEINBRECHER, ESQ.
Attorney for Plaintiff MERALIE ADAMS DODGE

[28] *Topographic Brain Mapping: An Overview*, supra. (Appendix No. 4)

DECLARATION OF ROGER V. BERTOLDI, M.D.

I, ROGER V. BERTOLDI, M.D., declare and state that if sworn as a witness I would and could competently testify as follows:

1. I am a medical doctor licensed to practice medicine in the State of California. I am Board Certified in Clinical Neurophysiology by the American Board of Psychiatry and Neurology which is the only EEG board approved by the American Board of Medical Specialties. I was trained as a Neurologist at UCLA and I continue as an Assistant Clinical Professor of Neurology at UCLA. In addition, I am fellowship trained in quantitative electroencephalography (QEEG) and I am an expert in the application of computer methods to analysis of the electroencephalography (EEG). In my clinical practice I have administered more than 2,000 QEEGs, including topographic brain mapping, EEG and evoked potentials, during the last five years. A true and correct copy of my curriculum vitae is attached as Exhibit "B."

2. I first saw Meralie Adams Dodge on May 14, 1996. She presented significant symptoms of traumatic brain injury. She related that she was unconscious for several minutes following the accident of February 21, 1996 and has subsequently had difficulty focusing, headaches, malaise, and fatiguability. For several months prior to being referred to me, she was under the care of Dr. Robert Hall, M.D. for symptoms related to post-concussion syndrome. She had presented herself to Dr. Robert Hall a day and a half after the accident with a history of her body having been violently jerked backward, striking the back of her head on the headrest. Subsequent loss of consciousness was followed by headache and nausea. Her symptoms have persisted.

3. Because of the severity and persistence of her post-concussion symptoms and the distinct possibility of traumatic head injury, a routine EEG and a quantitative electroencephalogram (QEEG), along with an MRI, were ordered by me. The MRI was normal for a structural defect of the head or brain, however the routine EEG, as well as the QEEG, demonstrated abnormality in the white matter of the brain consistent with diffuse axonal injury. The EEG and QEEG was first performed by me on June 21, 1996. A Pet Scan was performed at University of California at Irvine on October 17, 1996, which also confirmed abnormalities of the brain compatible with traumatic brain injury.

4. A neuropsychological exam was performed by Steven Ganzell, Ph.D., reported on January 7, 1997. The results of the neuropsychological testing confirmed significant impairment of brain functioning consistent with traumatic brain injury. On January 16, 1997, I performed a repeat EEG and QEEG which also indicated abnormalities consistent with traumatic brain injury. Additional neuropsychological testing was performed by Dr. Charles Furst which likewise confirmed significant impairments of brain functioning consistent with traumatic brain injury. I never base a medical opinion on QEEG alone, but take into consideration the results of all other tests as well. Based upon the clinical examination and all other tests, it is my opinion that Ms. Adams Dodge sustained a closed-head injury resulting in significant brain impairment.

5. Dr. Sutherling on behalf of the defendant misconstrues the purpose and use of the QEEG as being used to clinically diagnose traumatic brain injury. The QEEG is not offered or used as a specific diagnostic device, but is used to provide additional physiological data to corroborate a clinical interpretation of the plaintiff's condition. The QEEG is used as a clinical aid in the assessment of the patient's medical problem and not for the purpose of diagnosis. The QEEG provides data just like a regular EEG. It is helpful to correlate and corroborate information in the comprehensive evaluation of patients. The QEEG is not intended nor advanced as a stand-alone diagnosis.

6. The QEEGs administered to Ms. Dodge are a direct extension of routine EEG testing. Careful clinical correlation was employed between the EEG and QEEG interpreted by me as a physician possessing skill, knowledge and board certified ability in EEG and QEEG. Recognition of technical problems, including artifacts and normal variance, are common to EEGs and QEEGs. These factors were taken into account.

7. The advantage of the QEEG over the conventional EEG is that it offers greater sensitivity to brain slowing and asymmetry than is usually possible by visual inspection of paper trace EEG readings. A physician is provided with information about brain activity in greater depth and dimension than possible with a conventional EEG. The QEEG takes brain data by the same conventions and techniques as the well-established EEG and then the computer further analyzes that data in terms of wave frequency, power and anatomical area. The color topographical

mapping and graphic displays extend the ability of the unaided eye to evaluate brain wave electrical data.

8. Both techniques, EEG and QEEG, are now commonly used by specialists in the field of neurophysiology and psychiatry at many major medical centers worldwide. In Southern California, the QEEG is used at UCLA Medical Center, County USC Hospital, Harbor General Hospital, and the Veterans Administration Hospital. QEEG is in daily use by the Department of Defense at many Veterans Administration hospitals and military hospitals. It is estimated that in 1990 there were more than 400 QEEG testing centers in the United States performing more than 50,000 QEEGs a year. In 1994, it was estimated that there are 500 to 600 testing centers in North America.

9. The electroencephalogram of man consists of complex waveforms. These waves provide great difficulties for the human eye to evaluate. Completely modern computers used in conjunction with conventional EEGs are able to resolve complex waves into their constituent component sine and cosine waves and quantify the frequency and energy distributions in the waves that contribute to the spectrum in a much more exact manner than can be achieved by the unaided human eye. The result is that QEEG technology is able to reveal features and patterns not discernable by the eye and thereby presents new knowledge to the physician. The *American Academy of Neurology Assessment* (1989) statement provides: "EEG brain mapping can help highlight or identify regional features of the EEG. Occasionally this will identify subtle features that escape identification by traditional inspection alone. . . Computer-based EEG processing can also calculate abstract features that cannot be visualized." (Exhibit "B" defendants' motion)

10. The catalog of problems raised by Dr. Sutherling imputed to the QEEG have virtually all been applied to the conventional EEG. These problems were recognized by me and taken into account. Such problems and their equivalence apply to virtually every test devised in medicine. The AAN Assessment, 1989 also states that "QEEG testing should be done in conjunction with analog EEG and that any abnormalities should be clinically coordinated." This is exactly what was done by me as a highly trained Board Certified Neurophysiologist skilled in QEEG. In 1994 the American Medical EEG Association (AMEEGA) stated: "QEEG is not a substitute for

standard EEG but a complex methodology that incorporates visual EEG inspection and serves to extend the clinical utility of data recorded from the scalp. . . . When used on proper equipment by physicians with appropriate training and certification, the committee believes that QEEG provides clinically relevant information that is additive to that obtained from standard EEG interpretation. . . . QEEG is clearly of clinical value when performed in concert with standard EEG and analyzed by clinicians with demonstrated competency and standard EEG followed by specialized training and demonstrated competency in QEEG. QEEG is not a simple substitute for a conventional EEG and cannot be seen as a substitute for clinical competence. Although continuing to develop, QEEG technology has matured sufficiently and is now well established." *Status of Quantitative EEG (QEEG) in Clinical Practice* (1994) Frank H. Duffy, et al., *Clinical Electroencephalography* (1994).[29] QEEG has been accepted by the American Medical EEG Association, the only medical and scientific body which provides specialized training and certification of this area of expertise.

11. The fundamental techniques of analysis of waveforms, be they generated by heat, ocean, geophysical process, stars or human brain, are owed to the French genius in mathematical physics, Jean-Baptiste Fourier, who, almost 200 years ago, demonstrated the transformation of waves can be done without loss of information. The mathematical techniques are known as spectral analysis in which the energy in waves is displayed across the frequency band being analyzed. Fourier's proofs were found essentially unassailable and his methods continue to be used in an encyclopedic list of disciplines. Spectral analysis is a cornerstone of the quantitative approach to the EEG. Its utility in the sciences proceeded the discovery of the EEG for nearly 200 years. Many of the facets associated with the techniques have been used by practitioners of other disciplines for years. The application of Fourier's techniques are not limited to the EEG. The images and MRI scans are very often Fourier transformations of the energy shifts and magnetic processes.

[29] See Appendix No. 3

12. An MRI, as well as a CT scan, measures structural defects in the anatomy of the brain as opposed to EEG which measures brain electrical activity. Using an MRI or a CT, it is not possible to tell whether the patient is dead or alive. It is well-known in the medical community that an MRI will not diagnose certain closed-head traumas, including undetected injuries which are microscopic or brain injuries that leave no gross structural anatomic scars. The fact that a brain-injured patient has negative MRI or CT findings and positive findings on EEG or QEEG is not surprising. Abnormal findings on an EEG or QEEG are not diagnostic any more than a thermometer showing an elevated temperature is diagnostic. The EEG and QEEG are not considered to furnish a free-standing diagnosis by those expert in this discipline. Abnormal findings on EEG and QEEG are used by physicians as correlative information in the comprehensive evaluation of the patient. In the everyday world of medical practice, the clinician has often already arrived at diagnostic considerations before ordering the EEG and QEEG. Therefore criticism of the use of the QEEG as a diagnostic tool misses the mark.

13. The EEG and QEEG are widely used as part of the armament in the assessment of head trauma producing head injury. QEEG techniques, including brain mapping, can highlight or identify regional and subtle features in the EEG in patients who have sustained craniocerebral trauma. Such identification of regional and subtle features, as well as localization of such features, has been well documented in the medical literature. Quantification of the so-called "slow alpha" rhythms is also well within computer capabilities. Quantification of EEG features can also aid in evaluating those present to an abnormal degree. All of these factors can exist in the EEG of patients who have sustained craniocerebral trauma. Aspects of them that evade visual detection can be revealed by computer calculation. Scientists who are involved in the various wave processes generated by nature, including brain tissue, are agreed that waves can be specified by their frequency, amplitude and phase. These quantities can be better measured by computer techniques than by the human eye. This is beyond dispute.

14. Many departments of neurology and other disciplines such as psychiatry and private EEG laboratories use QEEG on a fee-for-service basis across the United States. Nowhere is it derived that QEEG is not useful for the detection of the abnormalities and slow waves, nor is there any

suggestion that the use of QEEG be prohibited as correlative data. In fact, the 1991 report from the *American Psychiatric Association Task Force on Quantitative Electrophysiological Assessment* (Exhibit "C" to defendant's motion) indicates: "It (QEEG) has particular utility for the detection of abnormalities and slow waves which are a feature of many organic brain syndromes."

15. An EEG brain activity map is an image of the frequency distribution of electrical energy. Brain waves are electromagnetic in nature. The changing energies in magnetic residence (MRI) are rendered in exactly the same way as in EEG mapping displays. The computer calculates the energies, measures the frequencies and constructs images from them. Rejection of computed quantitative EEGs (QEEG) should therefore logically lead to the rejection of magnetic residence images which are obtained from identical computational processes. The application of Fourier's techniques to the EEG long preceded attempts in structural illustrations. The suggestion that an MRI should not be admissible on the grounds that it is the product of computer computation would rightly be regarded as calculated bias, yet the identical computer computation of the EEG is sought to be declared suspect so as to warrant exclusion. There is no scientific merit to this assertion. Even the assessment by the American Academy of Neurology 1989 (Defendant's Exhibit "B") did not outlaw the use of QEEG but rather specified two conditions for its use: (1) that it be used in conjunction with a conventional EEG, and (2) that it be conducted by those certified as expert in EEG and QEEG.

16. Quantitative analysis of a digital EEG is a procedure widely and often used in the medical community to have a designated CPT Code No. 95957, Digital Analysis of Electroencephalogram. The CPT code was instituted through the American Medical Association for the purpose of quantitative analysis of a digital EEG (see *American EEG Society Newsletter, Winter 1995*—now the *American Clinical Neurophysiology Society—ACNS*).[30] The inclusion of a code for brain mapping in the CPT book demonstrates widespread use and medical acceptance.

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[30] See Appendix No. 11

17. Evaluation of the effects of head injury is intended to rule out brain tissue damage ("organic impairment") which would reasonably be expected to be accompanied by slow wave activity in the EEG. This is widely accepted and well documented. "It has particular utility for the detection of abnormalities in slow waves, which are a feature of many organic brain syndromes." *APA Task Force on Quantitative Electrophysiological Assessment* 1991 (Exhibit "C" to defendant's motion). "The method is most helpful in cases of low voltage delta activity, which may elude visual inspection of the raw EEG." (*Clinical Utility of EEG Topography* by Ernst Rodin, M.D., *Electroencephalography*, Neidermeyer and Lopes da Silva 1993)[31]

18. The 1994 position paper from AMEEGA[32] was intended to provide sufficient detail to those wishing to inform themselves about the clinical usefulness of QEEG. This published article contains the following key points:

- "An informal survey of QEEG manufacturers suggests an installed base of over 1,000 units worldwide with approximately 500 to 600 in North America."
- "A major use of the QEEG is in organicity detection including whether there is evidence to suggest focal or global encephalopathy—excessive slowing, etc."
- "A major goal of QEEG therefore is to provide objective measures that aid in the search for global or focal abnormality which, if present, may signal an underlying organic process. In QEEG the search is extended beyond visual EEG inspection by the use of spectral analysis, long latency EPs and the SPM process."
- "Selected diagnosis is where QEEG may be of use include epilepsy, cerebral vascular disease, learning disability, attention deficit disorder, head injury and headache."
- "However, when the head injury is mild, the traditional test normal, but the patient continues to be symptomatic, the outcome of a QEEG study may greatly assist patient management."

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[31] See Appendix No. 12

[32] See Appendix No. 3

- "The general utility of QEEG in organicity detection has been described in many publications."
- "DISCRIMINATE FUNCTION ANALYSIS. When they are used by clinicians with appropriate training and as an adjunct to organicity detection including EEG examination, they can be of substantial value."
- "In expert hands, the utility of discriminate functions has been amply demonstrated."
- "Indeed in 1992 Salinsky, et al., performed a similar study in which EEG and spectral analysis were compared. They concluded that the two techniques were 'complimentary' with each demonstrating abnormalities not shown by the other and concluded that spectral analysis may be useful as an extension of conventional EEG interpretation."
- "Thus, spectral analysis is a sensitive and reliable process that if properly used significantly augments classic EEG."

19. *Applications of Quantitative EEG/EP in Psychiatry*, Johnstone and Giannini, *Contemporary Psychiatry*, (1990) *(Psychiatric Annals)*[33] points out that post-concussion syndrome following minor head injury is a common psychiatric presentation. Patients often complain of irritability, memory loss, concentration difficulty, depression, blurred vision, headache and dizziness. Quantitative EEG analysis was successful in discriminating patients with minor head injury from normal patients with 94% sensitivity. "The quantitative EEG/EP study including auditory and visual evoked potentials can provide documentation for subjective complaints, allowing more appropriate intervention and more effective patient management."

20. Frank Duffy, M.D., of Harvard Medical School, Department of Developmental Neurophysiology, The Children's Hospital, commented on the importance of QEEG clinical mapping studies and its clinical value, "It is our opinion that the goal is not to diagnosis patients solely on the basis of topographical data, but to provide important pieces of information useful in establishing a diagnosis. It is commonly taught that one does not diagnosis epilepsy by the EEG but by the entire clinical picture of which EEG—derived data play an important part. In the same spirit we

[33] See Appendix No. 5

feel that mapping data are not necessarily diagnostic but may be diagnostically useful." Duffy. *Issues Facing the Clinical Use of Brain Electrical Activity Mapping*.[34]

21. Further evidence of the clinical value of QEEG in the clinical setting is stated in *Quantitative EEG Analysis In Rehabilitation Issues In Mild Traumatic Brain Injury*, Johnstone, Thatcher. *EEG Analysis and Rehabilitation in TBI* (1991).[35] "The quantitative EEG technique has been reviewed in regard to general assessment of cerebral function as well as with respect to evaluation of mild traumatic brain injury. The discriminative analysis as described by Thatcher, et al. (1989), was shown to be an objective, nonevasive, and reliable technique for evaluation of diffuse axonal injury characteristic of MTBI (Minor Traumatic Brain Injury). In contrast to other available imaging modalities, the QEEG technique is unique in providing high temporal resolution of cerebral function while being highly cost effective. Use of the QEEG procedure requires considerable sophistication with technical aspects of the study such as artifact rejection, signal processing, and statistical analysis, as well as professional interpretation by an experienced clinician. When used appropriately by knowledgeable technicians and clinicians, the QEEG technique can provide unique information to identify and monitor the effects of mild traumatic brain injury."

22. There is much literature that suggests that structural damage at microscopic levels could not be detected by CT or MRI in many patients with mild head trauma. This appears to be especially true in the case of diffuse axonal injury (DAI) in which shear-strain forces of rapid acceleration and deceleration result in injury to axons. The classic electrograph sign of a focal disturbance in cerebral function is focal delta activity. Focal slow waves are present from the beginning of cerebral infarcts and develops soon after head injuries. Rarely do slow waves persist after neurological signs have cleared. A persistence of slow waves indicates persistent cerebral damage. Head injuries may lead to focal slow waves in addition to the more common and initial decrease of amplitude and subsequent widespread slow waves. Spehlmann's *EEG Primer*,

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[34] See Appendix No. 13

[35] See Appendix No. 6

Fisch (1993).[36] The detection of focal slow waves gives the QEEG a distinct advantage over MRI and CT Scans in the recognition of these lesions. *Clinical Utility of Topographical EEG Brain Mapping*, Jerrett and Corsak, *Clinical Electroencephalography* (1988),[37] commented on the utility of topographical brain mapping in providing "better detection of low amplitude slow activity not easily discernable by routine EEG. It also provides faithful correspondence with localization of many lesions on neuroimaging procedures and at times distinguishes abnormalities not immediately definable by CT/MRI. Topographical EEG mapping is a valuable adjunct to a routine EEG."

23. *Comprehensive Predictions of Outcome in Closed Head-Injured Patients, The Development of Prognostic Equations*, Thatcher, Annals New York Academy of Sciences (1991),[38] confirms the importance of QEEG in detecting diffuse axonal injury which is the predominate pattern of injury in cerebral trauma resulting from rapid acceleration and deceleration which accompany high velocity impact. "However, CT and MRI do not reliably image mild DAI and hence cannot provide quantitative measures of neurophysiologic consequences of DAI. In contrast, EEG coherence and phase (QEEG) have been shown to reflect the topographical patterning of human corticocortical fiber bundles. Based upon these studies, the most concise explanation of the consistently strong prognostic features of EEG phase and coherence on the one hand and the latency of brain stem auditory evoke potentials on the other hand is that these measures reflect, to some extent, the magnitude of diffuse axonal injury in the cerebral cortex and brain stem." In conclusion, the authors found "the best single predictors of outcome in both the discriminate analyses and the regression analyses were EEG coherence and phase."

24. The seminal textbook entitled *Electroencephalography, Basic Principles, Clinical Applications and Related Fields*, Neidermeyer, Lopes, da Silva, Chapter 23, *Craniocerebral Trauma*, Rumpl

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[36] See Appendix No. 14

[37] See Appendix No. 10

[38] See Appendix No. 9

(1993),[39] states that "In mild head trauma discriminating EEG power spectral analysis (QEEG) indicated three classes of variables which are attributable to mechanical head injury: (1) increased coherence and decreased phase in frontal and frontotemporal regions; (2) decreased power differences between anterior and posterior corcortal regions; (3) reduced alpha power in posterior cortical regions. . . Topographical brain mapping can demonstrate asymmetries subtle and lateralization and localization effects more efficiently than standard EEG, when the recording is done properly from a technical standpoint. . . Topical brain mapping appears to provide better detection of low amplitude slow activity not easily discernable by routine EEG."

25. In summary, QEEG, including brain mapping and discriminate analysis provide a valuable tool to correlate and corroborate clinical diagnosis by the physician. QEEG is a reliable method of detecting diffuse axonal injury if used by a well-trained, competent clinician skilled in the art of EEG and QEEG. The QEEG testing performed by me met and exceeds all requirements to conduct said testing with the highest degree of reliability and accuracy. QEEG testing is generally accepted in clinical practice as corroborative evidence of the clinical diagnosis of closed-head brain injury.

Executed under penalty of perjury under the laws of the State of California, on this 7 day of July 1998 at Culver City, California.

ROGER V. BERTOLDI, M.D.

[39] See Appendix No. 15