Spectral EEG Analysis and Sleepwalking Defense: Unreliable Scientific Evidence

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In a recent publication in *JCSM*,¹ Drs. Cartwright and Guilleminault suggest that spectral analysis of the sleep EEG can be used to support a defense of sleepwalking in criminal cases. In particular the authors point to 3 publications that concluded that the sleep of sleepwalkers is defined by frequent arousals during SWS (slow wave sleep) as well as—or as a result of—lower % of SWA (slow wave activity).²⁻⁴ However, the authors of the study most often referred to have themselves concluded that spectral analysis of the sleep EEG in sleepwalkers is not suitable for forensic use. Gadreau and colleagues² write:

“Given the likelihood that results of our study could be used in medico-legal settings, it is worth noting that the presence or absence of a decrease of SWA early in the night and of awakenings from SWS in a given individual does not conclusively establish or refute a tendency toward sleepwalking” (pages 4-5).

The issue of frequent arousals and changes in SWS% in sleepwalkers as forensic evidence has also been previously reviewed in detail⁵ and was the subject of a series of letters to the editor of *Sleep Medicine Reviews* between Drs. Cartwright and Pressman in 2007-8 that readers might find of interest.⁶⁻⁹

As noted by Drs. Cartwright and Guilleminault, establishing a current diagnosis of sleepwalking for a defendant is not the same as establishing that the defendant was sleepwalking during the commission of a crime. Nevertheless, this article suggests that spectral analysis of sleep recorded months or years after the incident offense can be used to support such a sleepwalking defense. There are 3 scientific publications currently available that conclude that arousals from SWS sleep and hypersynchronous delta waves are not diagnostic for sleepwalking.¹⁰⁻¹² These published scientific studies analyzed arousals and SWS using standard visual methods and have reported a lack of statistical sensitivity and especially specificity as diagnostic markers. Further, there are now more than 7 published studies that report arousals indexes for patients with sleepwalking (see Table 1 in ref. 10). While they are often elevated compared to normal controls there is significant inter-study variability and there is no specific cutoff statistically or otherwise to assist in making the diagnosis. Additionally, the

results of a CAP analysis have failed to differentiate between sleepwalkers and patients with a diagnosis of upper airway resistance syndrome (UARS).¹³ Because of these methodological problems, the clinical diagnosis of sleepwalking does not require an objective PSG finding.

Drs. Cartwright and Guilleminault state that spectral analysis is a reliable method and cite 3 published studies.¹⁴⁻¹⁶ However, none of the cited studies were performed in patients with a diagnosis of sleepwalking. In 2 of 3 cited studies, there is high reliability only for consecutive nights of sleep, 2 and 5 nights, respectively.^{14,15} In the third study, PSGs were performed on non-consecutive nights with the younger group (x age = 22 years) undergoing PSG studies with a median interval of 11 days.¹⁶ Sleep studies performed as part of a forensic evaluation are most often performed months and even years after the date of the criminal act. In the case described by the authors, almost 9 months elapsed between the index incident and the conduct of the sleep study. There is no scientific evidence that spectral analysis of sleep of sleepwalkers or any other group produces characteristic and reliable EEG findings over this length of time. In many criminal cases, defendants spend months in prison before sleep studies are conducted. Sleep in prison often results in significantly different sleep/wake schedules and patterns, sleep durations, absence of drug and alcohol effects, and weight loss. Arousals scored in sleepwalkers are sensitive to sleep deprivation and not always in the expected direction. Guilleminault and colleagues have reported that 36 hours of sleep deprivation as well as 2 days with total sleep time limited to 2 hours reduced sleep fragmentation and complex behaviors in clinically diagnosed sleepwalkers.¹⁷ As noted by the authors, the occurrence of sleepwalking is episodic, suggesting that even if these features are present they are likely not related to the actual occurrence of sleepwalking.

Drs. Cartwright and Guilleminault repeatedly state in their article that sleep specialists have been warned not to testify in criminal cases presenting sleepwalking defenses.^{18,19} This does not reflect the actual content of the articles cited. Mahowald and colleagues make it quite clear in their recent publications that their criticism of expert sleep witnesses in court is directed at those experts who have based their testimony on out-of-date

and unreliable sleep science, usually labeled junk science.²⁰ We are in the era of Evidence-Based Medicine. Diagnostic methods and treatments now require proof that they are objectively effective, valid and reliable. Scientific evidence in court must also be based on generally accepted and reliable science.

Drs. Cartwright and Guilleminault describe a recent criminal case as an example of how CAP and spectral analysis might be used to establish a diagnosis of sleepwalking and assist the sleepwalking defense. Before discussing legal approaches to scientific evidence we wish to make clear that we are in no way suggesting anything improper occurred in this case. The presiding judge is the absolute gatekeeper for scientific evidence and may allow, limit, or exclude scientific evidence or expert testimony. The judge did decide to admit the spectral analysis data as evidence. However, the defense also had much to recommend it other than spectral analysis. The defense attorney in this case was highly experienced and had won an acquittal in another sleepwalking defense case. Dr. Cartwright is a well-known sleep and sleepwalking expert. Further, based on the description in this article and newspaper reports the defendant was clearly in an altered or confused state. This was evident to the victim who initially did not wish to proceed with criminal charges. We cannot know just how much weight the jury placed on the scientific evidence such as spectral analysis as opposed to other evidence. Studies of scientific evidence and expert witnesses in court often suggest jurors do not understand or consider complex scientific evidence. If and how spectral analysis influenced jury deliberation and the final judgment cannot be determined.

Although the judge is the absolute arbiter of what scientific evidence the triers of fact (the jury) are permitted to hear from expert witnesses, all jurisdictions in the United States, both state and federal, have laws related to expert witnesses and scientific evidence. The case described by the authors occurred in the state of Illinois. Expert witness qualifications as well as admissibility of scientific evidence are determined in this state by the Illinois Rule of Evidence 702. Admissibility of scientific evidence in this state follows the rules of *Frye v. United States*, 1923²¹—the standard used in 18 states in the United States. Illinois Rule of Evidence 702 reads as follows:

“If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise. Where an expert witness testifies to an opinion based on a new or novel scientific methodology or principle, ***the proponent of the opinion has the burden of showing the methodology or scientific principle on which the opinion is based is sufficiently established to have gained general acceptance in the particular field in which it belongs.***” (emphasis added)

Tests of any sort performed months or years after the index crime can tell us nothing about whether or not the criminal defendant was sleepwalking during commission of the crime act.

CITATION

Pressman MR; Mahowald M; Schenck C; Bornemann MC; Banerjee D; Howell M; Buchanan P; Avidan A. Spectral EEG analysis and sleepwalking defense: unreliable scientific evidence. *J Clin Sleep Med* 2014;10(1):111-112.

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SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication November, 2013

Accepted for publication November, 2013

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DISCLOSURE STATEMENT

This was not an industry supported study. The authors have indicated no financial conflicts of interest.