Section 9

Legal Topics in Sleep Medicine

Chapter 65

Sleep Forensics: Criminal Culpability for Sleep-Related Violence

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Chapter Highlights

- Sleep forensics is the application of neuroscience to somnology and sleep medicine to investigate unusual, irrational, or bizarre human sleep-related behavior associated with alleged criminal activity. This investigation is typically used to form the basis of an expert opinion for use in a criminal trial regarding a defendant's state of mind.
- Consciousness is not an all-or-none state but occurs on a spectrum. In addition, sleep and wakefulness are not mutually exclusive states of consciousness. Wakefulness, NREM sleep, and REM sleep may occur simultaneously or oscillate rapidly. This phenomenon is key to understanding the forensic implications of violent parasomnias.
- Consciousness can be dissociated from behavior. Neurophysiologic mechanisms can account for violent or other asocial behaviors associated with sleep.
- In a criminal proceeding, the offer of a clinical diagnosis alone is often insufficient to secure a conviction. Sleep medicine specialists have a role in legal proceedings to describe and address aspects of a defendant's consciousness and culpability.

To blame a person is to express moral criticism, and if the person's action does not deserve criticism, blaming him is a kind of falsehood, and is, to the extent the person is injured by being blamed, unjust to him.

Sanford Kadish, 2000[1]

Philosophers from time immemorial have grappled with the mind–body dilemma. Recent advances in neuroscience put us now on the verge of solving how our brains affect our minds and behavior.

THE DEVELOPMENT OF SLEEP FORENSICS

Sleep forensics is formally defined as the application of the principles and tools of neuroscience as applied to somnology and sleep medicine. These principles and tools have been widely accepted under international peer review as means for investigating unusual, irrational, or bizarre sleep-related behavior associated with alleged criminal activity. The investigation undergoes further examination in a courtroom pursuant to rules of criminal law.

The best application of sleep forensics involves an adaptable conceptual approach. An adaptable approach applies current neuroscientific concepts of consciousness and sleep-wake state dissociation to sleep medicine. This dynamic method is preferred to the approach set forth in the U.S. Model Penal Code (MPC), which uses static definitions and clinical disorder markers from which criminal behavior might be extrapolated.

Therefore a medical expert called on to investigate criminal allegations will need to do more than just evaluate for a possible sleep disorder. Ultimately the expert's determination of

the defendant's state of consciousness will prove pivotal. This requires an understanding of the neuroscience of consciousness, an awareness of relevant neuroscientific models for types of potential behaviors that may arise from sleep, as well as a determination concerning the appropriate application of consensus-driven clinical guidelines to assist in determining purported acts of violence arising from sleep.

The medical expert should also recognize the sleep specialist's primary role when interfacing with lawyers, judges, and law enforcement. The sleep specialist can help facilitate the discourse concerning advances in cognitive neuroscience and help develop the framework for further research, particularly in parasomnias.

EVOLUTION OF LEGAL THOUGHT ON CRIMINAL MENTAL STATES

General

Influenced by Sir Edward Coke, Chief Justice of the King's Bench (1613), Anglo-American law defines criminal offenses whereby a person must be in a certain mental state, called the *mens rea* (guilty mind), necessary to have committed a crime. Persons possessed of *mens rea* cannot be convicted absent a corresponding criminal act, called the *actus reus* (guilty act). Traditionally, intention is found within *mens rea,* and the physical part of the offense resides within *actus reus*. Proof of both is essential to secure a conviction.

Recognition that an impaired mental state might mitigate criminal punishment appears to date back to at least 1772 BC as recorded in the Code of Hammurabi. The Roman Empire also appeared to recognize a person's altered mental status to find defendants not guilty due to *non-compos mentis*, meaning without mastery of mind.[2]

In 1843 Sir Nicolas Tindal established what has become known as the *M'Naghten Rule*. These rules still provide the conceptual legal framework for excusing a person's criminal act committed while the defendant was suffering from a defect of reason or disease of the mind. For the defense to operate, the actor must be shown to be in a state of mind such that he did "not to know the nature and quality of the act he was doing; or, if he did know it, that he did not know he was doing what was wrong."[3,4]

From a neuroscientific perspective, the criminal act or *actus reus* component of the crime is of less interest than the essential *mens rea* element. Implementation of the M'Naghten Rule thereby becomes a watershed moment concerning the influence of neuroscience on criminal law because it is the state of the mind—or perhaps, more accurately, the brain—to which inquiry is focused.

Sleep

With respect to criminal culpability, the inquiry surrounding sleep is whether a person in a sleep state possesses sufficient *mens rea* to support a conviction for the actor's behavior. The first appearance of the "sleepwalking defense" in an American court of law came in *Massachusetts v Tirrell*[5] in 1846. In this landmark case, Rufus Choate, a skilled orator and U.S. senator, successfully employed the "insanity of sleep" defense in the murder trial of Albert Tirrell. The evidence in that case proved that Tirrell brutally killed the victim with a razor, almost severing her head from her body, set the horrifically bloody crime scene ablaze, and then attempted to flee the country.[6] Choate, an innovative legal tactician influenced by the advent of the M'Naghten Rule in the United Kingdom, argued in part that Tirrell, a sleepwalker, murdered the victim in an unconscious sleepwalking state and was able to convince the jury to acquit the Tirrell on this basis.

Later, in the mid to late 1800s there were no plausible medical explanations to account for sleepwalking, let alone account for complex violent actions that apparently arose during sleep. Still, courts were willing to adopt and apply defenses to deadly crimes committed by persons in a sleep state by pleas of a temporary "defect of reason" or "disease of mind." See, for example, *HMS Advocate v Fraser* (1878)[7] and *Fain v Commonwealth* (1879).[8]

Until physiologic aspects of sleep could be objectively measured and verified using validated neuroscientific instruments, defending criminal behavior arising from sleep often meant associating such behavior with other, better-understood medical or psychiatric conditions such as insanity or automatism. For example, courts apply the insanity defense to excuse criminal actions resulting from a diseased mind incapable of knowing right from wrong. Where indicated, courts might also withhold criminal punishment for acts caused by a defendant's involuntary bodily movements exhibited even while in a conscious or sane state. Thus a defense of automatism may be appropriate for acts arising from epileptic seizures, fugue states, and limbic psychotic trigger reactions, whereas an insanity plea would be appropriate if the defendant acted in the throes of fulminant delusional paranoid schizophrenia.

The legal community's perspective toward sleep began to shift in 1968 with Roger Broughton's seminal publication characterizing the relationship among somnambulism, nightmares, confusional states of arousal, and rapid eye movement (REM) sleep.[9] By creating a clear demarcation between sleep disorders and other medical or psychiatric conditions, this appears to be the first scientific sleep-related publication with direct legal implications, as demonstrated by the 1992 Canadian criminal case of *Regina v Parks* (1992)[10] in which Broughton served as an expert witness on behalf of the defense.

The defendant in the *Parks* case claimed that while sleepwalking in the early morning hours he drove to the house of his wife's parents and, provoked to attack by his in-laws' physical contact, killed his mother-in-law with a kitchen knife and left his father-in-law seriously injured.[11] The defendant defended his actions on the basis of automatistic sleepwalking rather than insanity. Expert witnesses for the defense testified that sleepwalking is not a neurologic, psychiatric, or other illness but rather is a sleep disorder very common in children and also found in adults.

The jury acquitted the defendant on the basis of automatism, which is a complete acquittal, as opposed to finding the defendant not guilty by reason of insanity, which typically leads to some institutional incarceration. The Canadian Supreme Court took up the case to decide the single legal issue of whether sleepwalking should be classified as noninsane automatism or insane automatism arising from a "disease of the mind," giving rise to a special verdict of not guilty by reason of insanity. Based on the unchallenged expert testimony that sleepwalking is a sleep disorder rather than a mental defect, the court rejected the characterization of sleepwalking as a mental health disorder.

EVOLUTION OF CONSCIOUSNESS THOUGHT

Criminal law presumes that most human behavior is voluntary and that individuals are consciously aware of their acts. All criminal liability is based on a voluntary act, or an omission to engage in a voluntary act that the defendant would otherwise have been capable of performing. Voluntariness is the first step in establishing *mens rea*. If the state proves *mens rea*, then the state will assess liability according to four levels of culpability: purpose, knowledge, recklessness, and negligence. In criminal law, the level of culpability determines the category of homicide (murder, manslaughter, or negligent homicide), and the category directly influences the severity of punishment.

Because voluntariness is absolutely fundamental to *mens rea*, it is surprising that the MPC offers examples of involuntary acts in lieu of explicitly defining the term *voluntary acts*. One example of an involuntary act is bodily movement during unconsciousness or sleep. Thus the MPC equates sleep with unconsciousness and deems bodily movements performed in a sleep state to be involuntary and presumably excused from criminal punishment. The other three examples of involuntary acts in the MPC include reflex convulsion; bodily movement that is not otherwise a product of the effort or determination of the actor, either conscious or habitual; and conduct during hypnosis or hypnotic suggestion.[12,13]

Waking Consciousness

A comprehensive review of the neuroscience of consciousness is well beyond the scope of this chapter. However, consciousness involves awareness of our environment, awareness of our bodies, and introspection (self-awareness), and it can only fully occur when we are awake.

To neuroscientists, *consciousness* is a term that has varied meanings, although its definition in the legal realm has held steadfast. In science, for example, consciousness may be used to indicate whether an individual is in a conscious state, as in whether it has been altered, reduced, or even lost. On the other hand, consciousness may be a trait or an attribute of a psychological process, as in the ability to think, see, and feel consciously. With trait consciousness, further distinctions may be made between conscious representations, which are usually phenomenal, and required conscious access.

Unfortunately a direct objective marker for the neural basis of state and trait consciousness that is independent of a person's external expressions or behavior has yet to be determined. Nevertheless it is believed that the neuronal processes that mediate access to consciousness take place in a network of frontoparietal cortical regions of the brain. These networks play an important role in attentional and behavioral selection of incoming and stored information. Because the frontoparietal cortical regions govern behavioral selection, it is not surprising that this region becomes active when patients in a vegetative state recover or becomes further activated when healthy subjects perform demanding perceptual tasks.

Sleep is regularly and actively induced by a shift in neuronal activity and neurotransmitter balance in brainstem nuclei. Functional neuroimaging studies performed on sleeping subjects reveal that during both REM and non–rapid eye movement (NREM) sleep the prefrontal and parietal cortical regions become deactivated in comparison to the resting wakeful state.[14-16] The most active regions during the resting wakeful state include the left dorsolateral and medial prefrontal areas, the inferior parietal cortex, and the posterior cingulate and precuneus.[15] In REM sleep, despite overall increases in cerebral blood flow and energy demands, relatively low regional cerebral blood flow persists in prefrontal and parietal cortex.[17] Because consciousness can only fully occur when we are awake, the frontal cortex would appear to be indispensable to consciousness.

Another important region is the dorsal thalamus, the "gateway to the cortex," and its accompanying "guardian of the gateway," the reticular complex (part of which is often called the *perigeniculate nucleus*).[18-21] Francis Crick believed that the input and output gating of the reticular complex were topographically arranged to approximate a map of the entire cortex. In his searchlight hypothesis, the reticular complex thereby was able to heat up the warmer parts of the thalamus and cool down the cooler parts so that "attention" would remain focused on the most active thalamocortical regions.[22] Although the function of the thalamic reticular complex remains incompletely understood, it is essential for consciousness, whereas cerebellar circuits, in contrast, are not.

Consciousness as a Continuum

The modern concept of consciousness was perhaps first established by influential American scientific psychologist and pragmatist William James (1842–1910). Consciousness has been subdivided into nine distinct components (Table 65-1), all of which are seamlessly integrated into our own personal conscious experience.

From the notion that consciousness is graded and not dichotomous, J. Alan Hobson developed the AIM concept. This concept creates a four-dimensional "mind space" in time that is transformed by three variables: activation (A), input-output gating (I), and neuromodulation ratio (M) (as measured by the aminergic-to-cholinergic ratio). All of these determine changes in the state of consciousness, which in turn govern the oscillation from wake to sleep.

These variables account for the physiologic properties within each state.[23] The interaction of these variables can cause temporary nonhomeostatic conditions that, in turn, might trigger or cause undesirable behavior without consciousness or memory. Such behaviors might include violent outbursts related to REM sleep behavior disorder.[24]

The recurrent pattern of state-determining parameters is amazingly consistent. However, there are numerous clinical

Table 65-1 The Nine Components of Consciousness

Component	Function
Perception	Representation of input data
Attention	Selection of input data
Memory	Retrieval of stored representations
Orientation	Representation of time, place, and person
Thought	Reflection on representations
Narrative	Linguistic symbolization of representations
Instinct	Innate propensities to act
Intention	Representation of goals
Volition	Decisions to act

and experimental examples of dissociation of state components. Such dissociation can be explained as simultaneous mixtures of clinical and neurophysiologic elements of the three states of being—wake, NREM sleep, and REM sleep. These fall into three categories, as reviewed by Mahowald and Schenck,[25] and include neuroanatomic lesions or stimulation, pharmacologic mechanisms, and sleep deprivation. Neuroanatomic lesions or stimulation include hypothalamic, thalamic, and brainstem manipulation or stimulation inducing state dissociation. Pharmacologic mechanisms include manipulation of the cholinergic or glutamate neurotransmitter systems resulting in a variety of state dissociations. A consequence of general anesthesia is "cognitive unbinding," which further explains state dissociation.[26] As for sleep deprivation, recent studies by Montplaisir and colleagues suggest that sleepwalking results from a dysfunction of the mechanism responsible for sustaining stable slow-wave sleep and that sleepwalkers are particularly at risk when exposed to increased homeostatic sleep pressure.[27,28]

State dissociations are the consequence of timing or switching errors in the normal process of the dynamic reorganization of the central nervous system as it moves from one state (or mode) to another. Elements of one state persist or are recruited erroneously into another state, often with fascinating and dramatic consequences.

Objective support for state dissociation is provided by depth electrode electroencephalographic studies demonstrating areas of wakefulness and sleep occurring simultaneously in humans.[29-32] This concept helps to explain such phenomena as sleep inertia, waking hallucinations, narcolepsy, REM sleep behavior disorder, lucid dreaming, out-of-body experiences, near-death experiences, repressed or recovered memories of childhood sexual abuse, alien abductions, and disorders of arousal (Figure 65-1).[33-39] The concept of state dissociation supports the notion that consciousness occurs on a continuum.

Fixed Action Patterns and Central Pattern Generators: A Neuroethologic Approach to Behavior

Ethology is the study of whole patterns of animal behavior under natural conditions in a manner that highlights the functions and the evolutionary process of those patterns. With an ever-increasing physiologic approach through the application of refined and elegant laboratory research techniques to animal behavior, neurobiology and ethology have coalesced to develop neuroethology.[40]

An important behavior type in ethology is the fixed action pattern (FAP). This is an instinctive indivisible behavioral sequence that when initiated will run to full completion. FAPs are invariant and are produced by a neural network known as the *innate releasing mechanism* in response to an external stimulus known as a *sign stimulus*.

FAPs are ubiquitous in the animal kingdom and are seen from invertebrates to higher primates. Movements resulting in FAPs may be initiated by central pattern generators (CPGs): "Movements are generated by dedicated network of nerve cells that contain the information that is necessary to activate the different motor neurons in the appropriate sequence and intensity to generate motor patterns. Such networks are referred to as *Central Pattern Generators*."[41]

Tassinari and coworkers recognized that motor events related to certain epileptic seizures and parasomnias share very similar features. This suggests a stereotyped inborn FAP, perhaps initiated by CPGs.[42] Tassinari recognized CPGs as genetically determined neuronal aggregates in the mesencephalon, pons, and spinal cord that, from an evolutionary perspective, were linked with innate primal behavior essential for survival (e.g., feeding, locomotion, reproduction).

In higher primates, CPGs are inhibited by the influence of neocortical control. Many of the CPGs are located in the brainstem and in close proximity to processes that govern the wake, NREM sleep, and REM sleep transitions. Despite diurnal neocortical inhibition, Tassinari provides a neuroethologic model whereby both epilepsy and sleep can lead to a temporary loss of control of the neomammalian cortex that is provided a pathway through a common arousal platform initiated by CPGs, which in turn triggers these FAPs (Figure 65-2), resulting in the abrupt onset of bizarre motor or

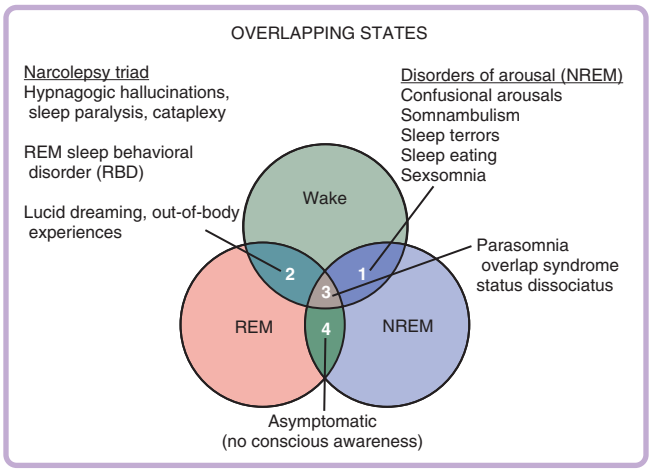

Figure 65-1 Areas of overlap among states of being. (Modified from Mahowald MW, Schenck CH. Dissociated states of wakefulness and sleep. *Neurology* 1992;42:44–52).

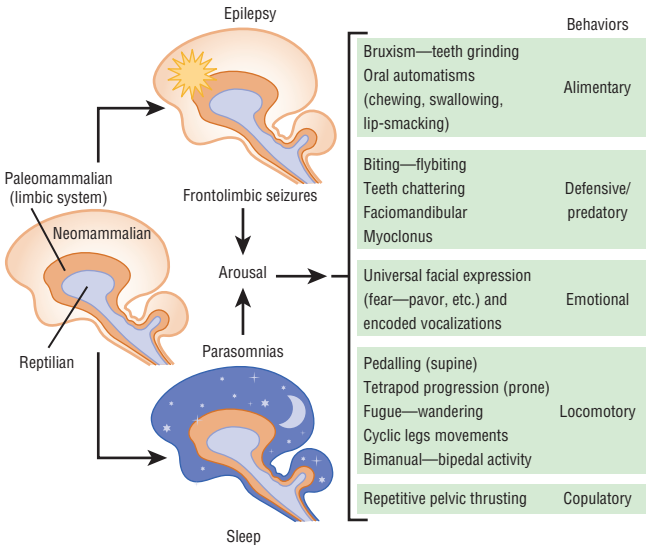

Figure 65-2 The emergence of innate primal behavior facilitated through central pattern generators from the arousal platform. (Modified from Tassinari CA, Rubboli G, Gardella E, et al. Central pattern generators for a common semiology in fronto-limbic seizures and in parasomnias: a neuroethologic approach. *Neurol Sci* 2005;26:S225–32).

emotional expressions that are uncharacteristic of awake neocortical-mediated diurnal behavior.

Tassinari's concept of the role of CPGs and FAPs provides a physiologic explanation for parasomnias. This concept is particularly useful in sleep forensics because parasomnias and epileptic seizures tend to have patterned stereotyped actions without conscious awareness. When addressing criminal allegations and their potential association with sleep-related conditions, the sleep medicine specialist can use behavior pattern recognition, applying neuroethologic concepts that indicate process fractionation, and neurobehavioral investigative techniques. Such an approach could be particularly beneficial and would be consistent with the direction of current mainstream neuroscience.

Dreaming Consciousness

It is obvious with sleep onset that sensory input is largely lost and our ability to interact with the external environment is curtailed. The conscious state paradigm outlined by J. Alan Hobson recognizes that all nine components of consciousness change to varying degrees as the brain changes state and does so in a repetitive and stereotyped manner over the sleep-wake cycle. Furthermore, consciousness is graded, and the state changes appear to be of such dramatic magnitude that strong inferences can be made about the major physiologic underpinnings of consciousness.[23] Sleep physicians on a daily basis appreciate, by interpreting polysomnographic studies, the state-determined uniformity of physiologic events that are consistent from patient to patient. To analyze the transitions in process, from wake to sleep or from NREM to REM, and isolate its individual components in order to deduce its underlying state, including its associated degree of consciousness, is a method called *process fractionation* (Figure 65-3). The application of the conscious state paradigm has led Hobson to declare three important principles.

First, consciousness rides on the crest of the brain activation process. Therefore, even a small perturbation in activation level leads to lapses in waking vigilance. Second, the brain remains highly active and capable of processing information even though consciousness may be largely deactivated. Functional imaging studies reveal that the brain remains about 80% active even when consciousness has largely subsided. Lastly,

	Wake	NREM	REM	Causal Hypothesis
Sensation & Perception	Vivid, externally generated	Dull or absent	Vivid, internally generated	Presynaptic inhibition, Blockade of sensory input
Thought	Logical and progressive	Logical and perseverative	Non-logical and bizarre	Loss of attention memory and volition leads to failure of sequencing and rule inconstancy; analogy replaces analysis
Attention	Intact, vigilant	Lost	Lost	Decreased aminergic modulation causes a decrease in signal to noise ratio
Orientation	Intact	Unstable	Unstable	Internally inconsistent orienting signals are generated by cholinergic system
Emotion	Inhibited	Weak	Episodically Strong	Cholinergic hyperstimulation of amygdala and related temporal lobe structures
Instinct	Inhibited	Weak	Episodically Strong	Cholinergic hyperstimulation of hypothalamus and limbic forebrain triggers CPG/FAP axis
Aminergic Inhibition (-)				Aminergic Inhibition (-)
Cholinergic Excitation (+)				Cholinergic Excitation (+)

Figure 65-3 Process fractionation: contrasts in components of consciousness between states. CPG, Central pattern generator; FAP, fixed action pattern. (Modified from Hobson JA. States of consciousness: normal and abnormal variation. In: Zelazo PD, Moscovitch M, Thompson V, editors. *The Cambridge handbook of consciousness*. New York: Cambridge University Press; 2007. p. 69.)

most brain activity is *not* associated with consciousness. In relation to its evanescence, consciousness "is a very poor judge of its own causation and of information processing by the brain."[23]

There have been seismic shifts in cognitive neuroscience that the legal system has yet to appreciate and incorporate into the legal arena. Rather confusingly, the terms *conscious* and *unconscious* are still used in the lexicon of neuroscience, but the ideas and principles behind these terms have been substantially altered and continue to be refined, with one such example being Tononi's information integration theory of consciousness.[43,44]

Advances in neuroscience since the 1980s support the existence of a continuum of conscious and unconscious processes, and neuroscience has largely dispensed with Freudian-influenced psychoanalytic concepts and theories. The boundaries between conscious and unconscious, as between wake and sleep, are permeable, dynamic, and interactive. As such, there is no valid scientific support for the sharp dichotomy between consciousness and unconsciousness currently held by the MPC and the legal community. It is this model of state dissociation that assists in the explanation of unusual, irrational, or bizarre human behavior in sleep forensics.

COMPLEX BEHAVIOR ARISING FROM SLEEP

Increasingly, experts in sleep medicine are being called on by attorneys to assist in reviewing legal cases, most of which involve allegations of criminal behavior. The conventional path is to make an evaluation for parasomnias to explain a wide variety of sleep-related violent behavior. The typical defense strategy is to clothe the behavior as a parasomnia symptom and thus completely exonerate the perpetrator's actions. Case requests to review bizarre nocturnal activities as mere rage reactions attributed to pharmaceutical agents such as benzodiazepines and, particularly, nonbenzodiazepine drugs are not uncommon.

Incidents of violent sleep-related behavior have been reviewed in the context of automatic behavior in general, with many well-documented cases resulting from a wide variety of disorders. Conditions associated with violence during the sleep period fall into two major categories: neurologic and psychiatric (Box 65-1). Those actions arising from a primary neurologic condition can be explained by applying conceptual approaches based on models of evanescent consciousness, the overlapping physiology of clinical disorders, and the platform of CPGs supported by semiotic neuroethology.

CLINICAL GUIDELINES TO ASSIST IN DETERMINING PURPORTED VIOLENCE ARISING FROM SLEEP

Legal implications of automatic behavior have been discussed and debated in the medical and legal literature.[45-49] The identification of a specific underlying organic or psychiatric sleep and violence condition does not establish causality for any given deed.

To assist in determining the existence of an underlying sleep disorder in a specific violent act, practitioners should follow guidelines based on peer-reviewed international clinical experience. Several clinical guidelines have been proposed[50-53] that identify certain features occurring as a result of a sleep disorder:

- There should be reason by history to suspect a bona fide sleep disorder. Similar episodes, with benign or morbid outcome, should have occurred previously.
- There has to be some degree of interaction with the environment. This behavior cannot be entirely passive in nature.
- The duration of the action is usually brief (seconds), although action of longer duration (minutes) does not necessarily exclude a sleep disorder or a sleep-related behavior. The action is usually abrupt, immediate, impulsive, and senseless—without apparent motivation. Although ostensibly purposeful, it is completely inappropriate to the total situation, out of (waking) character for the individual, and without evidence of premeditation.
- The victim is someone who merely happened to be present, usually in close proximity, and who may have been the stimulus for the arousal. Sleepwalkers rarely, if ever, seek out victims.[53,54]
- Immediately following return of consciousness, there is perplexity or horror, and there is no attempt to escape, conceal, or cover up the action. There is evidence of lack of awareness on the part of the sleepwalker during the event. There is usually some degree of amnesia for the event, but this amnesia need not be complete.
- In the case of sleep terrors, sleepwalking, or sleep inertia, the act may occur on awakening (rarely immediately on falling asleep) and usually at least 1 hour after sleep onset. It occurs on attempts to awaken the subject. The action has been potentiated by sedative-hypnotics or by prior sleep deprivation.
- Lastly, the violent behavior cannot be better explained by another mental disorder, medical condition, medication, or substance use. Ultimately, to attribute a violent behavior with criminal implications to parasomnia is a diagnosis of exclusion with the explicit understanding that other conditions are often more statistically likely. Note that this final guideline is also in accord with the diagnostic criteria for parasomnias in the *International Classification of Sleep Disorders*, 3rd edition.

Box 65-1 CONDITIONS ASSOCIATED WITH AUTOMATIC BEHAVIOR ARISING FROM THE SLEEP PERIOD

Primary Sleep Disorders (Neurologic Conditions)

Disorders of arousal
- Confusional arousal
- Sleep-related abnormal sexual behavior (sexsomnia)
- Sleep terror
- Somnambulism

REM sleep behavior disorder
Nocturnal seizures
Compelling hypnagogic hallucinations
Somniloquy

Psychiatric Conditions

Dissociative states (may arise exclusively from sleep)
Posttraumatic stress disorder
Malingering
Munchausen syndrome by proxy
Psychopathy

The guidelines for determining the role of a sleep disorder in violence are not meant to be perceived as a rigid rule nor as a set of necessary criteria. They merely provide direction to gauge whether an argument in favor of a sleep disorder could be sustained in the formulation of a possible criminal defense. The strength of the argument should consider current neuroscientific models of consciousness and behavior as supported by the medical expert's specialized clinical experience.

THE ROLE OF THE SLEEP MEDICINE SPECIALIST

To address the problem of junk science in the courtroom, some professional societies have developed guidelines for expert witness qualifications and testimony. The American Academy of Sleep Medicine's stance on expert witness testimony is to accept opinions held by the American Medical Association in its 2004 Report of the Council on Ethical and Judicial Affairs.[55] Similarly, influenced by both the American Academy of Neurology and the AMA, the following guidelines should serve as a compass.

Expert Witness Qualifications

Expert witnesses should have a current, valid, unrestricted medical license. Expert witnesses testifying about sleep medicine should be diplomats of the American Board of Sleep Medicine or should have passed the American Board of Internal Medicine specialty examination in sleep medicine. Membership in the Sleep Research Society is strongly encouraged. An expert witness in sleep medicine must be a recognized resource within the sleep medicine community and should have been actively involved in clinical practice in a manner consistent with the requirement of the criminal case at the time of the event. Given the essential position of *mens rea* in criminal law and the pivotal role of levels of consciousness, an expert witness should have significant direct experience in either neurology or neuroscience.

Guidelines for Expert Testimony

Expert testimony must be impartial. The ultimate test for accuracy and impartiality is a willingness to prepare testimony that could be presented unchanged for use by either the plaintiff or the defendant. Fees should relate to time and effort and should not be contingent on the outcome of the claim. Fees should not exceed 20% of the practitioner's annual income. The practitioner should be willing to submit such testimony for peer review. To establish consistency, the expert witness should make records from his or her previous expert witness testimony available to the attorneys and expert witnesses of both parties. The expert witness must not become a partisan or advocate in the legal proceeding.

It is not the role of the medical expert to win the case for a client, although it is not uncommon to use irrelevant disingenuous technicalities in an attempt to deceive so as to attain an advantage to secure the decision. Instead, the salient ethical decision for those who assume this mantle of medical expert witness is to recognize and value the privileged position given within our society as an educator inside the legal system by promoting current published peer-reviewed science and minimizing bias while rendering an opinion. The goal of the expert witness is not to simply ascertain or promote an argument addressing "reasonable doubt" in any given case because this is best deferred to legal parlance most often provided during counsel's closing statements. Instead, the role of the expert witness is therefore to attempt to succinctly and clearly communicate scientifically valid information without bias within the context of the case to the jury, who in turn determines culpability based on this information. The weight of the decisions of either guilt or innocence should never rest in the hands of medical experts, whose task is to contribute to the due process of an efficient and functional legal system by ensuring that the jury is educated and well informed.[56]

CLINICAL PEARLS

In a court of law, the undisciplined use of scientific technical data is a real concern, especially given the public misperception that science is a field that deals with absolute certainties when in actuality it is a field that reflects probabilities of occurrence. In many ways, the legal community has misrepresented the nature of science for many years and continues to attempt to do to so in an admittedly adversarial environment.

One problem with presenting results of scientific research is a condition called *brain overclaim syndrome*.[57] In general, the public has an overfascination with new developments in science and often assumes statements of scientific evidence are true, even when the statements cannot be conceptually or empirically sustained. Studies have shown, for example, that the results of a simple experiment in cognitive psychology are more positively evaluated and considered important if a brain scan is included in the report of the results.[58] The limitations of neuroscience data in the courtroom must be appreciated.[59]

In a sleep-related example, a review has clearly established that polysomnography performed after the fact is of absolutely no value in determining whether the accused was sleepwalking at the time of the criminal activity. On very infrequent occasions, polysomnography may be considered to assess potential mitigating influences, such as obstructive sleep apnea. Even sleepwalking during a formal sleep study would only indicate that the person was a sleepwalker, not that sleepwalking was involved at the time of the crime.[60]

SUMMARY

Advances in neuroscience are increasing our understanding of how the brain enables action, including everything from simple movement, to thought, to the diurnal and nocturnal variability of sleep-wake processing.

The societal and cultural implications of these scientific advances have yet to be understood or even conceived.[61] However, the legal community is aware of the implications of this new neuroscience because science directly challenges the law's currently held constructs of consciousness as defined by *mens rea* and the voluntary act requirements. To study these problems, the John D. and Catherine T. MacArthur Foundation has established the Law and Neuroscience Project in 2007 (www.lawandneuroscienceproject.org) comprising 40 neuroscientists, legal specialists, and philosophers.[62] Two important concepts to be incorporated into the legal community are that consciousness is not all-or-none but occurs on a spectrum and that consciousness can be dissociated from behavior.

Sleep forensics does more than provide medical expert testimony in individual legal cases. The growth of cognitive neuroscience will continue to change our understanding of what it means to be human, and as a result the law will have to change in conformity with it.

The conceptual approach to sleep forensics encourages further research to define and characterize mixed states of wake and sleep and the parasomnias. Understanding all of these is beneficial in understanding the spectrum of complex human behavior. Close collaboration among basic neuroscientists, sleep medicine clinicians, and the legal community will facilitate the development of a commonly shared concept of consciousness and culpability.

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REVIEW QUESTIONS

1. Which sleep disorder is most often associated with forensic issues?
   A. Obstructive sleep apnea
   B. REM sleep disorder (RBD)
   C. Disorders of arousal
   D. Nocturnal seizures
2. Which statement is true?
   A. Sleep and wakefulness are mutually exclusive
   B. Sleep is a whole brain phenomenon
   C. Parts of the brain can be awake while other parts are asleep
   D. Consciousness is an all-or-none phenomenon
3. In a given act (criminal allegation), which of the following is necessary to prove to secure a conviction?
   A. *Actus reus* is sufficient.
   B. *Mens rea* is sufficient.
   C. Both must be present.
   D. Only reasonable doubt needs to be secured.
4. Which statement is *not* true?
   A. Formal sleep studies may provide valuable information to confirm that sleepwalking accounted for the illegal act in question.
   B. Automatic behavior during an alcohol-induced blackout may perfectly mimic sleepwalking.
   C. There is little evidence that sleepwalking in adults is associated with significant psychiatric disease.
   D. The ingestion of significant amounts of alcohol at the time of a possible sleepwalking event severely limits the use of sleepwalking as a defense.
5. Which of the following is *not* a factor in disorders of arousal?
   A. Family history
   B. Sleep deprivation
   C. Alcohol ingestion
   D. Sedative-hypnotic medication ingestion
6. *True or false:* Polysomnography performed after a purported sleepwalking-related criminal act is of forensic value.
7. Which of the following is the primary determinant of injury to a victim in sleepwalking-related violence?
   A. Motive on the part of the sleepwalker
   B. Psychiatric disease on the part of the sleepwalker
   C. Proximity
   D. Use of a weapon by the sleepwalker
8. Most complex behaviors occurring during sleepwalking are generated by which of the following?
   A. Dorsolateral prefrontal cortex
   B. Amygdala
   C. Hippocampus
   D. Central pattern generators
9. The most useful technique in determining *mens rea* (conscious intent) of someone accused of possible sleep-related violence is which of the following?
   A. Functional magnetic resonance imaging
   B. Polysomnography performed under simulated conditions
   C. Psychiatric evaluation
   D. Process fractionation and neurobehavioral investigative techniques
   E. Finding a "hired gun" medical expert

ANSWERS

1. **C.**
2. **C.**
3. **C.**
4. **A.**
5. **C.** Sleep deprivation, sedative-hypnotic medication, and family history are known factors in some cases of sleepwalking. Alcohol has not only been shown *not* to be a factor, but its presence in a given case of apparent sleep-related violent behavior also precludes use of the sleepwalking defense.
6. **False.** A polysomnogram performed after a purported case of sleep-related violence is of absolutely no value in determining the state of the perpetrator at the time of the event. In countries where criminal law is largely derived from English common law, criminal convictions are secured on adequately addressing the principles of *mens rea* (guilty mind) and *actus reus* (the committed act). A polysomnogram could never replicate the conditions of the state of mind of the perpetrator at the time of the alleged event. Even if sleepwalking were to occur during the polysomnogram, it would not document that the subject was sleepwalking during the event in question.
7. **C.** Sleepwalkers do not act on motivated behaviors and are no more likely to have psychiatric disease than nonsleepwalkers. The injured party is usually someone who is in close proximity to the sleepwalker. Sleepwalkers rarely, if ever, seek out the victim.
8. **D.** Integrated primitive or overlearned behaviors arise from central pattern generators located in the brainstem. Inactivation of the dorsolateral prefrontal cortex and the hippocampal memory system explains the lack of awareness and lack of recall of these behaviors if they arise during sleep.
9. **D.** Physiologic process fractionation and behavior pattern recognition are helpful in determining states of consciousness and, hence, whether there may have been motivation. This highlights the concept that sleep forensics is as much a study in cognitive neuroscience as it is sleep medicine when used as a resource for criminal investigation. Functional magnetic resonance imaging might hold promise in the future; however, the current state of the art precludes its use in the courtroom. Polysomnography is of no utility after the fact. There is little evidence that psychiatric disorders play a role in sleepwalking.