



Forensic Evaluation of a Single Episode of a Disorder of Arousal in a Sleepwalking Defense: Cognitive Function Versus Prior Clinical History

Mark R. Pressman^{1,2,3,4}

¹ Pressman Sleep and Science Forensics, LLC, Ardmore, Pennsylvania, United States

² Lankenau Institute of Medical Research, Wynnewood, Pennsylvania, United States

³ Department of Medicine, Sidney Kimmel Medical College Thomas Jefferson University, Philadelphia, Pennsylvania, United States

⁴ Charles Widger School of Law, Villanova University, Villanova, Pennsylvania, United States

Address for correspondence Mark R. Pressman, PhD
(email: sleepwake@comcast.net).

Sleep Sci 2023;16(3):e354–e361.

Abstract

Keywords

- ▶ Disorder of Arousal
- ▶ sleepwalking
- ▶ prefrontal cortex
- ▶ executive function
- ▶ clinical diagnosis
- ▶ forensic

Introduction The clinical diagnosis of disorders of arousal (DOA) is based primarily on a clinical history including amnesia for episodes. The presence of amnesia means the patient cannot provide direct evidence. In a forensic setting, when the defendant has been charged criminally with violent actions or sexual related assaults allegedly during sleep, a sleepwalking defense may be presented. As opposed to clinical history, the prosecution generally focuses on the single episode of alleged DOA that resulted in the criminal charges against the defendant. The prosecution will argue that this episode of complex behavior was not consistent with a DOA. A past history of purported episodes is not proof that a recent single episode must be a DOA. However, most sleepwalking defenses rely heavily on standard clinical evaluations despite the fact they have no direct connection with the current criminally charged episode.

The International Classification of Sleep Disorders (ICSD-3) General Diagnostic Criteria C for DOAs that states “limited or no associated cognition” should be present. Recent real time studies of DOAs have shown that during DOA episodes the prefrontal cortex (PRC) is deactivated while the motor cortex remains active.

Conclusion The PFC is the location of almost all executive functions including inhibition, planning, memory, and many others. Thus, when the PFC is deactivated, these higher cognitive functions are not available. The presence of higher cognitive functions during an alleged episode of DOA would be inconsistent with a deactivated PFC and thus inconsistent with generally accepted brain activity during a NREM parasomnia. This would be direct evidence that the episode could not be a DOA but occurred during wakefulness.

Clinical trial No.

received
June 23, 2022
accepted
November 9, 2022

DOI <https://doi.org/10.1055/s-0043-1773787>.
ISSN 1984-0659.

© 2023. Brazilian Sleep Association. All rights reserved.

This is an open access article published by Thieme under the terms of the Creative Commons Attribution-NonDerivative-NonCommercial-License, permitting copying and reproduction so long as the original work is given appropriate credit. Contents may not be used for commercial purposes, or adapted, remixed, transformed or built upon. (<https://creativecommons.org/licenses/by-nc-nd/4.0/>)

Thieme Revinter Publicações Ltda., Rua do Matoso 170, Rio de Janeiro, RJ, CEP 20270-135, Brazil

Introduction

Clinical evaluations of disorders of arousal (DOA) such as sleepwalking differ from forensic evaluations for alleged acts of violence or sexual behavior in sleep. Clinical evaluations for DOA are most often based on a report of multiple past episodes usually beginning during childhood and adolescence, and reports of amnesia for the episodes.¹ Forensic evaluations focus primarily on a single, specific alleged episode of complex behavior in sleep associated with violence or aggressive sexual behavior that is the basis of criminal charges.² In court, the prosecution attempts to show that the alleged DOA or descriptions of past episodes do not meet diagnostic criteria or that the complex behavior did not occur in the midst of the alleged DOA. The primary aim of the defense is to demonstrate that this episode was an episode of DOA, often by relying on indirect evidence of past episodes or family history to demonstrate that the defendant has a predisposition for this type of behavior during sleep.²

Generally accepted diagnostic criteria for DOA can be found in the International Classification of Sleep Disorders, Third Edition (ICSD-3)¹ and in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5).³ An additional approach to the diagnosis of DOA is the 3P system. The 3Ps are Predisposition, Priming, and Provocation that are present prior to the onset of behaviors from slow wave sleep (SWS).⁴ The 3P system focuses entirely on factors other than the witnessed or inferred behaviors of a specific episode.

Direct evidence via descriptions of the charged behavior is most often provided by family members or friends sleeping in the same room or in the general vicinity. The surviving victim of the violence or sexual assault is also in a position to provide a detailed description of the behavior of the defendant. Other details of the behavior of the defendant that were not witnessed can be sometimes inferred from evidence left at the scene. The defendant's own description of behaviors is not likely to be of use, as DOAs are almost always followed by complete amnesia.⁵ Thus, the defendant's knowledge of what happened has usually been provided from others at the scene or may be the result of confabulation or attempts to piece together what must have happened during the amnesic period.⁶

Direct evidence is by far the most valuable when available. However, many DOA criminal defenses rely instead on the traditional clinical history that is not directly associated with the index incident. The defense is thus based on the hypothesis that a past personal history of apparent DOAs as a child or adolescent is an indication of predisposition for such behavior, and therefore increases the probability that a later episode in adulthood of nocturnal violence or sexual behavior was likely to have also been a DOA. However, DOAs in young and older adults occur intermittently. Defendants may have gone months or years without a reported episode of a DOA prior to the index incident. In the interval between episodes of DOAs there is nothing to prevent an individual from attacking or sexually assaulting someone while under the influence of alcohol or drugs, or due to psychiatric disorders or neurological injury/illness, or by committing

an intentional criminal act for which they have no defense. Thus, if at all possible, the forensic evaluation should not make any assumptions based on prior history or family history alone.

For these reasons, additional factors can and should be examined.² The ICSD-3, but not the DSM-5 or 3P, presents an additional little used path to determine if the apparent sleep related behavior is consistent with what is known about DOAs. The general diagnostic criteria for DOA, criteria C, states that limited or no associated cognition is a requirement for diagnosis (page 228) (►Table 1).¹

The absence of certain higher cognitive functions in DOAs has been well described. The ICSD-3 notes DOAs are "devoid" of higher cognitive functions. More recent research has shown the absence of higher cognitive function in DOAs has a proven basis in functional and perhaps structural neurophysiology or neuropathology during sleep.^{7,8}

Starting with the seminal study of Bassetti et al., high powered imaging and EEG analysis techniques have captured episodes of sleepwalking and confusional arousals in real time (see ►Fig. 1).⁸

The general findings are consistent across multiple studies and different techniques. Namely, during a DOA, the prefrontal cortex (PFC) is deactivated while the motor cortex remains active.⁸⁻¹⁰ The motor cortex in sleepwalkers has been shown to be hyperexcitable even during wakefulness.¹¹ The thalamus, which plays an important role in gating sensory stimuli from reaching the cortex during sleep, is not functioning, allowing sensory stimuli to reach the deactivated cortex. Leading researchers in this area have concluded:

"Loss of the inhibitory function of the frontoparietal cortices, together with the activation of the motor and cingulate cortices, could explain the appearance of innate, complex motor patterns."^{9,10}

In this state of PFC deactivation, many higher cognitive functions are not available.^{12,13} This includes almost all executive functions. ►Table 2 shows the higher cognitive

Table 1 General Diagnostic Criteria for Disorders of Arousal

Criteria A-E must be met.
A. Recurrent episodes of incomplete awakening from sleep.
B. Inappropriate or absent responsiveness to efforts of others to intervene or redirect the person during the episode.
C. Limited (e.g., a single visual scene) or no associated cognition or dream imagery.
D. Partial or complete amnesia for the episode.
E. The disturbance is not better explained by another sleep disorder, mental disorder, medical condition, medication, or substance use.

Notes

1. The events usually occur during the first third of the major sleep episode.
2. The individual may continue to appear confused and disoriented for several minutes or longer following the episode.

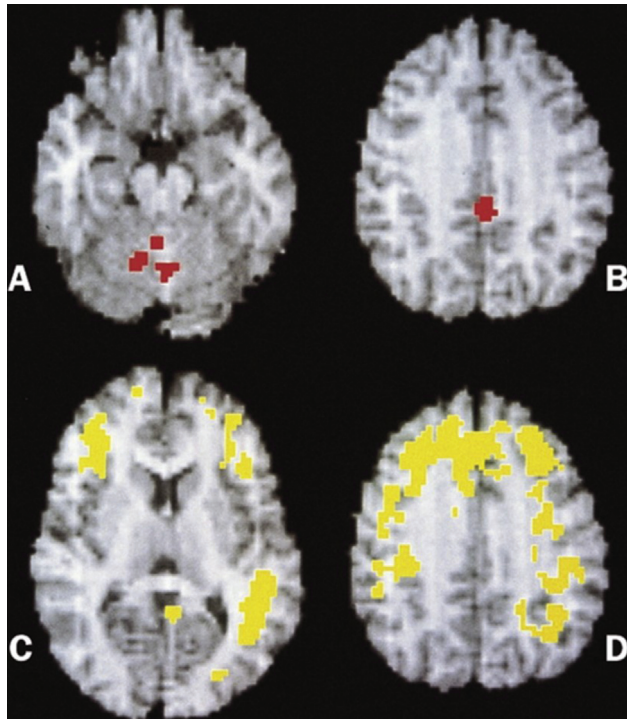


Fig. 1 SPECT findings during a sleepwalking episode. In relation to data from normal volunteers during wakefulness ($n = 24$), large areas of frontal and parietal association cortices remain deactivated during sleepwalking. SPECT findings during sleepwalking after integration into the appropriate anatomical magnetic resonance image. The highest increases of regional cerebral blood flow ($> 25\%$) during sleepwalking compared with quiet stage 3 to 4 NREM sleep are found in the anterior cerebellum – that is, in the vermis (A), and in the posterior cingulate cortex (Brodmann area 23 [Tailarach coordinate $x = 4, y = 40, z = 31$], B). Note the inclusion of the dorsolateral prefrontal cortex (C), the mesial frontal cortex (D), and the left angular gyrus (C) within these areas.

functions that are not available to the patient with a DOA when the PFC is deactivated.

As a result of these absent cognitive functions, the sleepwalker does not have access to intentions from before the episode and therefore behaviors cannot be driven by them. Broughton et al., who were the defense experts in the Parks case, have written:

“There is no evidence that a somnambulist during sleepwalking can either execute a conscious intent from prior wakefulness or create an intent” (page 262).¹⁴

This would exclude access to such presleep and pre-episode intentions/motivations as anger, revenge, sexual attraction/desire, or completion of unfinished business.

The absence of higher cognitive function in DOA allows for a type of direct behavior analysis of single episodes. Did the sleepwalker show signs of any type of higher cognitive function that could not occur during sleep with the PFC deactivated? If yes, this would constitute direct evidence that the episode was not consistent with sleepwalking. The clear presence of a higher cognitive function during a complex behavior in sleep should be sufficient to rule out a DOA even

Table 2 Cognitive Functions Not Available During Disorders of Arousal Due to Prefrontal Cortex Deactivation

1) inhibition including
a. self-control (behavioral inhibition)
b. resisting temptation
c. control of impulsivity
d. knowledge and application of social norms
e. delay of gratification
2) access to prior memory
3) formation of memory during the episode
4) true social action
5) recognition of others including faces
6) attention
7) decision making
8) integration of information
9) inductive reasoning
10) motivation
11) judgment

in the presence of indirect evidence such as past personal history or family history of DOAs.

A recommended method for the assessment of cognitive function is the construction of a detailed chronology of the episode bringing in evidence from the defendant, the victim, and any other witnesses. This chronology may also include evidence from the scene of the episode (see vignette #1).

Methods and Selected Vignettes from Forensic Cases

The majority of sleepwalking cases is not published unless they were appealed. A review of the published legal literature was conducted for cases that employed sleepwalking defenses. Additionally, the author's archive of 110 prior forensic sleep cases was reviewed to provide examples of constructing an extended chronology and evaluating behaviors for the presence of executive functions that should be inhibited by PFC deactivation. All vignettes are based on real criminal cases. Vignettes cases 1, 2, and 9 were followed by appeals. The author was consultant and expert witness in all cases except #2.

In cases 4, 6, 8, and 9 below, the overall defense presented was an alleged alcohol-induced or triggered episode of sleepwalking violence or sexual behavior in sleep. This defense continues to be presented despite the fact that there is a complete absence of empirical evidence to support it.^{15,16} Both the ICSD-3 and DSM-5 have removed all reference to alcohol as a trigger for DOAs. The ICSD-3 has stated that

“Disorders of arousal should not be diagnosed in the presence of alcohol intoxication” (page 237).¹

The issue of alcohol will not be addressed directly or in detail in the vignettes below. However, high levels of alcohol

can affect cognitive functions. Alcohol intoxication occurs during wakefulness and as opposed to sleepwalking,¹⁶ higher levels of cognition may be impaired but not absent. Alcohol blackout is an impairment of memory after the fact, but cognitive function may be intact during drinking but not remembered.^{17,18} The evaluation of alleged episodes of sleepwalking sometimes involves the evaluation of waking behavior during alcohol intoxication versus sleepwalking.

1. Arizona v Falater – Homicide 1996

Mr. Falater stabbed his wife 44 times and left the body lying in the back yard. He returned to the body some 20 minutes later to find she was still alive. He left the body and returned a few minutes later, dragged her to the swimming pool, pushed her in and held her head under water.

All of these behaviors were said by the defense to have occurred while Mr. Falater was sleepwalking. This evaluation had the benefit of an atypical witness and that much of the episode occurred in his back yard. The next-door neighbor heard screaming and went into his backyard and stood in the dark, quietly watching, not understanding what was happening.

- a. Concealing evidence: Following the attacks on his wife, Falater made two trips to the garage where he hid a bloody knife, bloody clothing, and other item from the attacks in the trunk of the car. This was evidence of a guilty mind and showed awareness that he had committed a crime. In the absence of an ability to form memory during an episode, Mr. Falater should not be aware of his attacks on his wife and thus unaware of the need to conceal evidence.
- b. Planning and memory: Reliance on memory and knowledge from before the incident. Reliance on memory that could only have been formed during the incident.
- c. Feel pain and apply first aid knowledge from before incident: While stabbing his wife 44 times, Mr. Falater also cut himself on a finger. He was noted to have cleaned and bandaged his cut.

Evaluation if victim was dead or alive: Mr. Falater walked directly to where his wife was lying after the first attack. He stood over her for several minutes and then returned to the garage. The next-door neighbor reported the victim was still moving despite 44 stab wounds. His next series of actions indicated he decided she was still alive.

Memory and planning: Returned to his wife. Acted on his prior assessment that the victim was still alive with a series of actions to move her to the swimming pool and finish the murder by drowning her. Followed through with his intention to kill the victim. This intention could only have been formed after the first attack during a time the defense claimed was during the sleepwalking episode.

Decision and sentence: Convicted of first-degree murder. Sentenced to life in prison without parole. Higher court appeals rejected.

2. R v Parks^{2,14}–Homicide, attempted murder 1985

After falling asleep while watching TV, he awoke, dressed, and went to his garage. He started his car and drove 18 miles to the home of his in-laws. Once there, he entered

the underground parking area and parked. He opened the trunk of his car and removed a tire iron. He then navigated from the garage to his in-law's home. He used his key for their home to enter. He picked up a kitchen knife, encountered his mother-in-law and stabbed her to death.

a. Drive 18 miles

a. Sleep driving has been established as a possible automatic behavior occurring in the sleepwalking state. He had driven between his home and his in-laws hundreds of times. However, in this case, the sleep driving has remained somewhat controversial. In addition to the distance there were 3 traffic lights along the route. As there were no witnesses to his driving, it is not known if he stopped for them or not.

b. Parked in underground lot.

a. This could be another example of automatic behavior. He not only repeatedly drove to their home, but he also repeatedly parked in the same spot. However, this appears to involve more complex behavior.

c. Removed tire iron from car trunk.

a. Most of the violence done to his in-laws was done with a knife, although his father-in-law did have injuries consistent with a blunt object. Removing the object from the trunk is harder to explain than the driving. He should not have had a memory or motive for removing the tire iron. However, in other cases of sleepwalking violence, primitive objects have been reported to be used. They were most often at hand. Could it have been a random act? Planned with intentions to do harm?

b. Brought key with him and let himself into apartment.

1. Was this planning? Or was his in-laws key on his key ring and used hundreds of times in the past? Automatic behavior?

c. Provoked attack? It is not known if his mother-in-law heard Mr. Parks in the house and came to investigate. If so, she may have accidentally provoked defensive aggressiveness and the fatal attack. If Mr. Parks sought her out and attacked her without provocation, this would not be consistent with a sleepwalking violence.¹⁹

d. Severely cut himself with the knife, including severing of several ligaments. However, he did not appear aware of his injuries and did not express pain consistent with dissociative analgesia, a common finding in sleepwalkers.²⁰

Decision: Acquitted. Appeals by Prosecution to Supreme Court of Canada rejected.

3. US v C. 2002 Attempted Murder

The defendant C and his victim D were army captains and friends taking an advanced course at an army base. They also lived on base with their spouses. One evening, C arrived at D's house late at night dressed all in black. As he was a friend, C answered the door and let him in. C requested to borrow a hammer. He went with D to his work room where a tool chest was located. D located the hammer and gave it to C. C then asked for a screwdriver. When D turned around to retrieve the screwdriver C suddenly attacked him with the hammer.

However, D managed to escape running out of the garage and down the street. C followed him with hammer in hand.

- a. Social Behavior: Although the late-night timing and dark clothing was odd, C's other behavior in requesting tools appeared to be appropriate, at least until he attacked D. Sleepwalkers are not capable of exhibiting normal social behavior.
- b. Planning: Was asking for one tool that would become the weapon of attack and then asking for another tool to allow for the unprovoked, defenseless attack a complex plan inconsistent with sleepwalking?
- c. Verbal requests: Sleepwalkers may talk but generally do not make sense. Verbally requesting the first tool and then requesting a second is not consistent with known verbal skills of sleepwalkers.
- d. Following after D. When D was attacked, he escaped and was briefly out of sight of C. If C was sleepwalking, he could not have formed a memory of what had just happened, he should not have known he had attacked his friend and that D had been in the work room but had left. Chasing someone would require higher cognitive functions sleepwalkers do not have access to.
- e. No provocation: Sleepwalkers become violent only when they perceive they may be in danger. Sleepwalking violence is almost always provoked by the ultimate victim who approaches them, blocks them, touches them, or grabs them. It is clear that D did not constitute a danger to C.
- f. Navigation: Just when did this episode of alleged sleepwalking start? As sleepwalking typically comes out of SWS sleep, C would have had to be asleep in his home, aroused from deep sleep, gotten dressed in his black clothing if he had not been wearing them to sleep, left his house and navigated on foot in the dark to D's home elsewhere on the base. He would have needed to have a memory of where D lived and been able to form a mental map to follow.

Decision: Conviction, sentenced to prison

4. Mass v. C – Sexual Assault 2002

C was a 20-year-old cadet at a military style college. He was very sleep deprived after midterm exams and standing watch. At the end of exams, he went to a student dormitory at a much larger, nearby university. He was noted by several residents to be wandering the dorm occasionally entering open or unlocked dorm rooms. In one instance, he entered a room where a female student was in bed. He sat down on the bed, talked randomly and nonsensically with her, and briefly touched her. C had a personal history of complex sleepwalking when sleep deprived along with a three-generation family history of similar behaviors. In court, it was pointed out that he had used an elevator to move between floors of a dormitory. Can a sleepwalker use an elevator?

- a. Yes. But not intentionally. If the sleepwalker entered the elevator and randomly pressed buttons, this might be

considered an “automatic” behavior, something that C had experienced frequently in the past.

- b. No. If he pressed a specific elevator button with the intention of going to a specific floor this would require planning and memory of where he was going and a memory of how to operate an elevator.

Decision- Acquitted.

5. People v. G - Homicide 2010

13-year-old boy picked lock on a gun cabinet and removed a rifle and ammunition. He loaded the gun. He then navigated to his younger brother's bedroom and shot him in the head at point-blank range, killing him.

- a. Memory
 1. Retrieved rifle from gun locker
 - b. Knew where rifle was kept, navigated to that location.
 - c. Picked lock

Recalled that gun locker had a simple lock that he had managed to open in the past. Using a screwdriver, he opened the gun locker

- d. Load rifle
 1. Loaded rifle with ammunition. Could this be an automatic behavior?
- e. Navigate to brother's room
 1. Went from gun locker to brother's room
- f. Aimed and fired
 1. Recalled operation of the rifle

Decision- Sleepwalking Defense rejected. Remanded as a juvenile for evaluation of possible psychosis.

6. R v. H 2015–sexual assault

While at a party, significant alcohol was consumed by H and other partygoers. Some of the partygoers decided to sleep over on mattresses placed on the floor. H wandered over to where a man and woman were sleeping. The woman was fully dressed in jeans with a belt. H laid down next to her, eventually moved into a spooning position with him behind her and the victim's back pressing against his chest. In the dark and from the “spooning” position he reached around the victim and by touch unbuckled her belt, undid, and pulled down her pants before sexually assaulting her.

- Memory
 - a. Form and maintain a mental image of the location of belt buckle and pants from touch alone
 - b. Recall how to unbuckle a belt from touch alone.

Partially undressing the victim in an episode of sexual behavior in sleep is not unusual. What is unusual here is that he did it by touch using only memory and a mental image to guide him in the dark.

Decision –Convicted in initial trial in which sleepwalking defense was not raised. On appeal, granted new trial. In new trial, sleepwalking defense rejected, convicted.

7. TX v L 2019 Homicide

During a daytime nap in his bedroom, L retrieved a loaded handgun from near his bed. He exited the bed and navigated to the living room of his house. Once in the living room, he aimed and shot his wife 5 times in the chest.

- a. Memory of location of the gun
1. A sleepwalker should not be able to recall the location of a gun.
- b. Ability to identify object as a weapon
1. A sleepwalker should not be able to identify the gun as other than an object.
- c. Navigation to living room
1. Except for sleep eaters, a sleepwalker generally does not navigate deliberately to a particular destination.
- d. Recognition of wife or just a potential danger that provoked a defensive behavior.
- e. Aiming of gun
1. Aiming and firing the gun as well as hitting the target 5 times in the middle of the chest is not consistent with the out-of-control defensive behavior reported in other cases of sleepwalking violence
Convicted of Murder. Sleepwalking and REM behavior defense rejected.

8. R v L Homicide

Following the death of his father's long-time partner, he took his father to a local pub, and both got very drunk. He brought his father back to his house. During the night, he physically attacked his father at least four times and eventually threw him out of the house onto the front walk naked. His father got up, rang the doorbell. L answered the door. He also later attempted to clean up blood on floor. He stated he had no memory of any of these actions.

- a. Responded to doorbell ringing and opened the door.

Sleepwalkers lack any type of social knowledge and would not have any idea what a ringing doorbell meant, much less that the socially appropriate behavior would be to answer it.

- b. Mopped up blood.

As noted above, a sleepwalker would not know a pool of red liquid on the floor was blood and would not have known it was appropriate to clean it up

- c. Multiple attacks – as noted in the Falater case, there do not appear to be any bona fide cases in which the sleepwalker attacked the victim more than once.
Decision – Non-insane automatism. Sentenced to hospital and released after 8 months.

9. R v L 2008 Sexual assault

L attended a party during which he drank a substantial amount of alcohol. At some point, he entered a room in which several of the partygoers were sleeping. He climbed onto a couch on which a young woman who he did not know was sleeping. He removed some of her clothing as well as his own. He then removed a condom from his wallet. He put on the condom successfully. He sexually assaulted the woman. He later left the party and once home in his bathroom, found the condom was still on his penis. He had no memory of any of his actions.

1. Brought condom to party.

Bringing a condom to the party is not necessarily evidence of planning or conscious awareness as he may always have kept a condom in his wallet just in case a sexual opportunity presented itself.

2. Removed condom from wallet before sexual assault and putting it on.

Removing the condom and putting it on suggests an awareness of the situation – vaginal sex. Also, removing the condom from its wrapper and putting it on requires fine motor skills, especially when done in the dark.

Memory. Putting on a condom prior to the sexual assault and wearing it during the sexual assault suggests he was aware he might need protection from venereal disease and prevention of pregnancy. This would require that he have access to knowledge from before the episode and be able to apply that knowledge to the current situation.

3. Did not remove condom until he arrived home.

This suggests something was impairing his memory but appears inconstant with using a condom in the first place. Severe alcohol intoxication would appear to be a likely source of memory loss.

4. There are no published reports of an individual engaging in sexual behavior in sleep who used a condom.
Decision – Not criminally responsible
10. R v K 2005 Homicide

The defendant entered his former partner's apartment and stabbed her 9 times, leaving the knife in her chest. She was apparently asleep during the attack. He took their 4-year-old daughter from the house along with her suitcase and placed them in his car. Prior to the episode, he had drunk 18 beers over a period of a few hours, but nevertheless showed little obvious effect. He initially denied all responsibility, attributing the attack to unknown intruders. When the police searched the victim's apartment, they noted in their standard "scene log" that someone had recently vomited in the toilet. The vomit smelled of alcohol and postmortem on the victim showed no alcohol was present. Upon his arrest, C presented several different defenses, including intruders did it, alcohol induced sleepwalking violence, and provocation by the victim.

- a. Socially appropriate behavior: Vomiting in the toilet as opposed to the floor or elsewhere shows the individual

was acting appropriately under the circumstances. There are no published accounts of sleepwalkers vomiting. Based on the lack of consciousness, there is no reason to think a sleepwalker would have understood vomiting on the floor was not socially acceptable and made it to the bathroom on time. Based on the knowledge of his large intake of alcohol in the hours before the incident, this was incriminating evidence against the defendant.

- b. Lack of provocation or proximity, detailed planning: Detailed evidence eventually showed the defendant drove to the victim's apartment and let himself in, stabbed her while she was asleep. He then removed his daughter and a suitcase with her belongings and successfully navigated to his car and left. This showed significant planning. The victim could not have provoked him to attack.

Decision: Convicted. Life with no chance for parole for 20 years.

Discussion

A detailed examination of cognitive functions during an alleged episode of sleepwalking violence or sexual behavior in sleep is a rarely used form of diagnostic evaluation that can produce direct evidence that does not rely on signs or symptoms that occurred sometimes years prior to or after the index episode. The ICD-3 states DOAs are devoid of higher cognitive function.¹ Application of this criteria has the potential for producing evidence directly relevant to the question of whether the violent or sexual behavior occurred during wakefulness or during an episode of DOA.

Other criteria that may appear consistent with the absence of cognitive functions are based on the defendant's own reports. Disorders of arousal are almost always followed by amnesia. Amnesia may be consistent with the absence of memory functions in DOAs but, in criminal cases, malingering should always be considered. A variety of reports have found that between 10 and 70% of criminal defendants in homicide cases give a history of partial or complete amnesia.²¹ It is unknown but suspected that the report of amnesia in some sleepwalking defense cases may be false.

Certainly, the presence of other executive functions during the same episode would suggest this. The absence of memory but the presence of planning or other executive function is inconsistent with PFC deactivation. However, tests designed for detection of malingering have never been adapted for or used with sleepwalkers.²¹ Thus, this question can only be answered after an assessment of the defendant's credibility by the judge or jury.

However, sleepwalkers are thought to be able to manifest "automatic" behaviors. That is, behaviors that have been repeated numerous times so that conscious awareness does not appear to be necessary for their performance. Sleep driving is often noted as such an automatic behavior. Theoretically, certain automatic behaviors could be present in one individual and not others, depending on past experiences.

Additionally, some basic appetitive and reflexive behaviors such as defensive aggressiveness/violence, feeding, 15 and sex are considered to be "hardwired" in the lower levels of the brain and may be triggered in basic form even when the PFC is not active.^{22,23} It has been hypothesized that these behaviors are a type of automatic behavior as well, having been performed over millions of years in the name of survival, until they became reflexive and fast.¹²

An additional related phenomenon that is not technically an executive function, but can result in bizarre behaviors, is "dissociative analgesia." Lopez et al. have noted that 78.7% of sleepwalkers have reported dissociative analgesia during their episodes.^{20,22} As with executive functions, pain itself is moderated in different ways via the PFC and integrated with other executive functions. Controllable pain is inhibited via the PFC, although the exact mechanism has not been identified.²³ Studies of experimental pain often result in activation of the PFC and are more highly activated in the presence of chronic pain. The effects of deactivation of the PFC on pain during sleep and sleepwalking have not been studied but would seem to be likely to have a significant effect on analgesia.

Dissociative analgesia may prevent the sleepwalker from awakening during episodes. In forensic settings, the presence or absence of dissociative analgesia can support or detract from a sleepwalking defense. In the Parks' case, while wielding the knife that killed his mother-in-law, the defendant cut himself very badly, severely injuring ligaments in his hand. He appeared unaware of his injuries until they were pointed out to him. In the Falater case, the victim was stabbed 44 times. After the incident, the police noticed a fresh cut on the defendant's hand that had been cleaned and bandaged, indicating the defendant was aware of the injury, no doubt via pain. The lack of dissociative analgesia was significant evidence against his sleepwalking defense.

Limitations

The limitation of this method is the availability of observations and information regarding the episode in question. The best manner of assessing this is to put together a detailed chronology of the defendant's activities and behaviors starting if possible 1 to 2 days before the incident and at least 1 day after the incident. No detail is too small or insignificant. The victim, family members, friends, roommates, and anyone else who may be able provide data should be interviewed. Evidence of the defendant and victim can be comingled. Evidence left at the scene such as in the Falater case may be essential. Work schedules or the timing of movies or TV shows that were reportedly watched should also be determined. Even with this, many cases will have a scarcity of direct information demonstrating cognitive functions available and used. The Falater and Parks cases had a significant number of observations and information that could be examined. Most cases will have far less. In many cases, no evidence of this type may be available, and the sleepwalking defense may have to rely on clinical history. There may be

disputes between what is considered evidence of an executive function and what could be an automatic behavior.

The absence of higher cognitive functioning is also essential in explaining sleepwalking violence. Sleep-related violent behavior takes the form of defensive aggressiveness. Sleepwalkers do not seek out victims. Victims almost always come to the sleepwalker and trigger defensive violent behavior.¹⁸ Sleepwalkers lack the ability to evaluate situations or recognize faces of family members or friends. When strangers or family members approach them, block them, or grab them, they can react with defensive aggressiveness in the form of hitting, kicking, or throwing furniture. Occasionally, they make use of primitive objects found close at hand such as knives or blunt objects, although not guns. The sleepwalker cannot inhibit inappropriate defensive aggressiveness in the absence of a functioning PFC.

Conclusions

The presence of one or more executive functions during an apparent sleep related episode – that otherwise may appear similar to a DOA – should lead the clinician and the forensic expert to examine alternative diagnoses including epilepsy, various psychiatric and neurological syndromes, drug effects, and malingering.

However, the presence of even a single higher cognitive function that should not or could not be present when the PFC is deactivated is sufficient to rule out a DOA even when the clinical history appears to support the presence of a DOA – at least in the past. Sleepwalking defenses sometimes acknowledge that a higher cognitive function was present but treat this as only one piece of evidence to be weighed equally against other pieces of evidence. The presence of an executive function during a purported episode of sleepwalking is the direct “smoking gun” type of evidence that disproves the sleepwalking defense.

Note

No off-label or investigational use.

Funding

None.

Conflict of Interests

The author has no conflict of interests to declare.

References

1 Academy_of_Sleep_Medicine A. International Classification of Sleep Disorders Version 3: Diagnostic and Coding Manual. 2014

2 Pressman MR. *Sleepwalking, Criminal Behavior and Reliable Scientific Evidence: A guide for experts*. Washington, D.C.: American Psychological Association; 2018

3 American_Psychiatric_Association. Diagnostic and Statistical Manual of Mental Disorders DSM-5 volume 5, 2013

4 Pressman MR. Factors that predispose, prime and precipitate NREM parasomnias in adults: clinical and forensic implications. *Sleep Med Rev* 2007;11(01):5–30, discussion 31–33

5 Pressman MR. Sleepwalking, amnesia, comorbid conditions and triggers: effects of recall and other methodological biases. *Sleep* 2013;36(11):1757–1758

6 Kopelman MD. Two types of confabulation. *J Neurol Neurosurg Psychiatry* 1987;50(11):1482–1487

7 Heidebreder A, Stefani A, Brandauer E, et al. Gray matter abnormalities of the dorsal posterior cingulate in sleep walking. *Sleep Med* 2017;36:152–155

8 Bassetti C, Vella S, Donati F, Wielepp P, Weder B. SPECT during sleepwalking. *Lancet* 2000;356(9228):484–485

9 Terzaghi M, Sartori I, Tassi L, et al. Evidence of dissociated arousal states during NREM parasomnia from an intracerebral neurophysiological study. *Sleep* 2009;32(03):409–412

10 Terzaghi M, Sartori I, Tassi L, et al. Dissociated local arousal states underlying essential clinical features of non-rapid eye movement arousal parasomnia: an intracerebral stereo-electroencephalographic study. *J Sleep Res* 2012;21(05):502–506

11 Oliviero A, Della Marca G, Tonali PA, et al. Functional involvement of cerebral cortex in adult sleepwalking. *J Neurol* 2007;254(08):1066–1072

12 Miller EK, Cohen JD. An integrative theory of prefrontal cortex function. *Annu Rev Neurosci* 2001;24:167–202

13 Diamond A. Executive functions. *Annu Rev Psychol* 2013;64:135–168

14 Broughton R, Billings R, Cartwright R, et al. Homicidal somnambulism: a case report. *Sleep* 1994;17(03):253–264

15 Goodwin DW. Alcohol amnesia. *Addiction* 1995;90(03):315–317

16 Pressman MR, Caudill DS. Alcohol-induced blackout as a criminal defense or mitigating factor: an evidence-based review and admissibility as scientific evidence. *J Forensic Sci* 2013;58(04):932–940

17 Pressman MR, Mahowald MW, Schenck CH, Bornemann MC. Alcohol-induced sleepwalking or confusional arousal as a defense to criminal behavior: a review of scientific evidence, methods and forensic considerations. *J Sleep Res* 2007;16(02):198–212

18 Pressman MR. The neurophysiological and neurochemical effects of alcohol on the brain are inconsistent with current evidence based models of sleepwalking. *Sleep Med Rev* 2019;43:92–95

19 Pressman MR. Disorders of arousal from sleep and violent behavior: the role of physical contact and proximity. *Sleep* 2007;30(08):1039–1047

20 Lopez R, Jaussent I, Dauvilliers Y. Pain in Sleepwalking: A Clinical Enigma. *Sleep* 2015;38(11):1693–1698

21 Bourget D, Whitehurst L. Amnesia and crime. *J Am Acad Psychiatry Law* 2007;35(04):469–480

22 Bräscher AK, Becker S, Hoeppli ME, Schweinhardt P. Different Brain Circuitries Mediating Controllable and Uncontrollable Pain. *J Neurosci* 2016;36(18):5013–5025

23 Seminowicz DA, Moayedi M. The Dorsolateral Prefrontal Cortex in Acute and Chronic Pain. *J Pain* 2017;18(09):1027–1035