Chapter 3

An Essay on Sleep-Related Sexual Behaviours and Offences Related to Sexual Behaviours

Chris Idzikowski

Additional information is available at the end of the chapter

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1. Introduction

The aim of this chapter is to consider mainly the deep sleep parasomnias associated with sexual behaviour (known variously as sexsomnia, sleep sex, etc, see below) that may lead to non-consensual behaviour resulting in criminal charges.

Most jurisdictions will acquit a defendant if a court accepts that the criminal behaviour occurred whilst they were asleep-that is they were 'sleepwalking' or in a 'somnambulistic' state. It is said that Hippocrates and Aristotle were aware of the condition; that Galen wrote in *De motu musculorum* "that he once spent a whole night walking about in his sleep, awakening only after he struck a stone in his way" and that the philosopher Diogenes Laërtius "was said to read, to write, and to correct his works while asleep" [1], similar to one of John Polidori's cases [2]. Umanath et al also note that Polish intellectual Joannes Jonstonus in his 1632 *Thaumatographia naturalis* had a section on "Of Walkers in the Night" [1]. In England King James II in the seventeenth century pardoned Colonel Cheyney Culpeper for shooting a guardsman and his horse with a blunderbuss [1, 3]. (It should be noted that blunderbusses are not very accurate though very effective at short range.)

Sexual relations are complex across a range of dimensions [4] which could impact on reporting of sexual crimes, both historically and now. Some may be clouded in confusion-as for example, with the 'Old Hag' (an *incubus*?) in sleep paralysis (when the muscles of the body are temporarily paralysed around the time of awakening) [5]. Schenck et al do cover sleep paralysis mainly in the context of narcolepsy though [6]. In their appendix they had to resort to quoting Tess's experience in Thomas Hardy's *Tess of the d'Urbervilles* (1891) [7] to provide some historical though literature-based context.

Putting forward a sleep-related sexual behaviour (SRSB) as a defence is relatively new and has emerged within the last two decades. Whilst the literature shows Bowden [8] reacting to Buchanan's report of a case of somnambulistic indecent exposure [9] by pointing out that Motet in an 1897 article in the *Annales d'Hygiène et de Médecine Légale* described a similar case, this is not the type of sexual offence considered in this chapter (the advice generally being wear pyjamas or nighties if you are a sleepwalker). As a side note, Motet's case was interesting as the court acquitted the defendant on the basis that a somnambulistic state was confirmed by hypnotism. Using the England and Wales Sexual Offences Act 2003 as a guide the type of offences considered are rape, sexual assault by penetration, sexual assault, *etc*, those offences where consent is as much of an issue as the behaviour. Both Shapiro (Canada) [10, 11] and Guilleminault (U.S.) [12] were the first to describe case series of SRSBs (though there had previously been sporadic case reports, e.g. Wong: masturbation [13] and forensic cases, e.g. Fenwick [14]), which eventually led to both Schenck et al's 2007 comprehensive, thorough and critical review of the whole area [6].

Legal procedures have evolved to deal with sleep-related violent behaviour but SRSB has only recently been described so existing laws have to be applied to these cases. Given that courts have no experience with these cases inevitably means that expert guidance is needed. There are, however, as this essay flags problems, e.g.1) laws are inconsistent with respect to sleep-related violence and 2) sleep research is in its infancy and has difficulty answering the questions that courts may pose. To examine these problems the recently published 2014 3rd edition of the International Classification of Sleep Disorders [15] will be used as a springboard to explore SRSB. This is followed by an examination of existing SRSB literature, and the professional guidelines that have evolved to manage these cases. The problem of matching the different possible medical (mainly psychiatric) models of these disorders with the different legal models of a defendant [16] and the lack of an ontological basis with which to link these two professional domains will be deferred to another essay.

2. The international classification of sleep disorders 3rd edition [2014] [15]

The International Classification of Sleep Disorders Diagnostic and Coding Manual, 3rd edition [2014] (ICSD3) [15] lists more than 60 different sleep disorders. This is a reduction to the number of disorders listed in the previous manual, published 2007, which had 80 but more than the original manual published 1990. The reduction reflects refinements in the classification and pooling some categories which were better covered by umbrella terms.

The sleep disorders are roughly classified into insomnias (inability to sleep), hypersomnias (inability to remain awake), sleep-related breathing disorders (SRBs) and the parasomnias (unwanted or abnormal behaviours during sleep) see Table 1. The parasomnias are the main group of interest in ICSD3 [17]. There are overlaps (e.g. treatment of SRBs may trigger the (re-) emergence of a parasomnia [18] or SRBs may mimic parasomnias [19], or hypersomnias like narcolepsy [20, 21].

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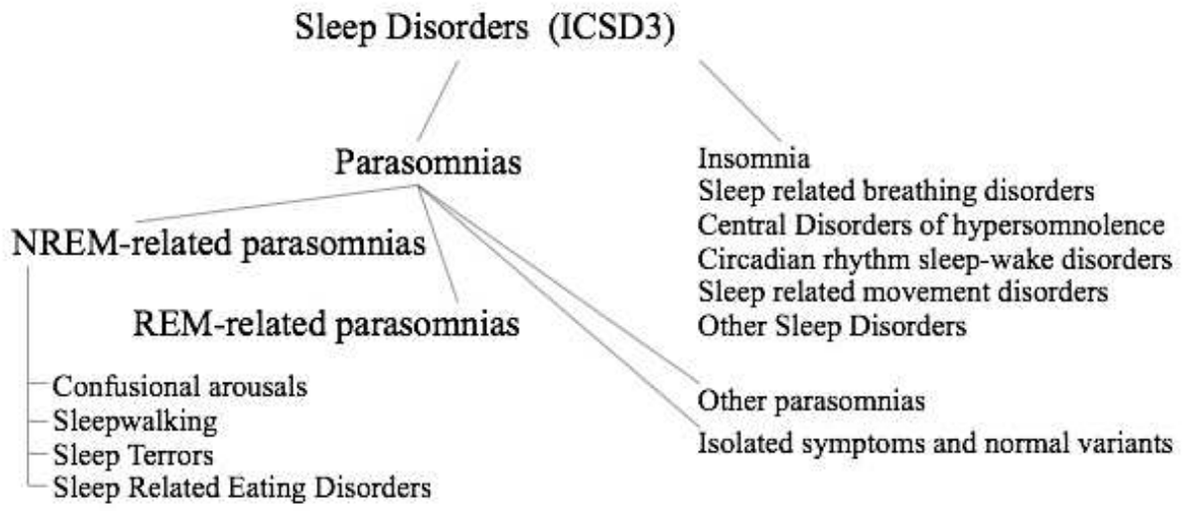

Figure 1. Sleep Disorders (ICSD3)

The parasomnias are further divided into REM (Rapid Eye Movement) and NREM (Non-REM) – Figure 1; and again there are overlaps such as Parasomnia Overlap Disorder. The NREM Disorders of Arousal include Confusional Arousals, Sleepwalking and Night Terrors. These disorders all have similar characteristics and are distinguished thus: **Confusional arousals** are characterised by mental confusion or confused behaviour that occurs while the person is in bed and there is an absence of terror or ambulation outside of the bed. **Sleepwalking** is associated with ambulation and other behaviours out of bed whilst **Sleep (Night) Terrors** are characterised "by episodes of abrupt terror, typically beginning with an alarming vocalization such as a frightening scream" and "There is intense fear and signs of autonomic arousal, including mydriasis, tachycardia, tachypnea, and diaphoresis during an episode.

Disorders of Arousal (From NREM Sleep) - confusional arousals, sleepwalking, sleep terrors (including SRSBs)	
share similar	
1	genetic and familial patterns
2	pathophysiology of partial arousals from deep sleep
3	priming by sleep deprivation and bio-psychosocial stressors
and are	
1	not secondary to psychiatric disorders
2	not generally secondary to neuropathology or head injury
3	associated with absent or minimal cognitive functioning
4	associated with amnesia for the prior episode
5	may be triggered by sound, touch, or other stimuli

Table 1. Disorders of Arousal (From NREM Sleep) — Confusional arousals, sleepwalking, sleep terrors (including SRSBs) share similar:

As with many diagnostic schemes the frequency of a sign or symptom leads to a classification rule. The problem in many legal cases is that all the signs and symptoms for a recognised (medical) mental disorder may be present but a single instance is insufficient to warrant a 'diagnosis'.

3. Disorders of arousal

Disorders of arousal lead to behaviours that are usually initiated during partial arousals from (deep) slow wave (N3) sleep. "Most episodes are brief, but they may last as long as 30 to 40 minutes [in some children]." ICSD3 notes that most sleepwalking occurs in *children*. "They are especially prevalent among children and adults younger than 35 years." Also: "The prevalence of confusional arousals in children three to 13 years of age in a large population-based study was 17.3%. Lifetime prevalence of confusional arousals has recently been reported as 18.5% (16.1-20.9 confidence interval). The prevalence among adults older than 15 years is 2.9% to 4.2%".

The behaviours can be simple or complex, well-learned or automated or instinctive behaviour of which the person is thought to be unaware and usually is completely amnesic; there is either no, or relatively sparse mental content. Actions are not necessarily completed. Awakening is difficult and slow-this effect is known as sleep inertia (and has been called sleep drunkeness). "Sleep talking and shouting may accompany these events. The eyes are usually open during an episode and, not uncommonly, are wide open with a confused "glassy" stare." Someone with "a disorder of arousal may be very difficult to awaken and, when awakened, is often confused. There is usually amnesia for these episodes, although adults may remember fragments of episodes. Dream-like mentation is sometimes reported in adults. Other high-level cognitive functions such as attention, planning, social interaction, and intent are absent."

Sleepwalking tends to run in families. A twin study looking at how genetic and environmental factors affect sleepwalking looked at 11, 220 subjects including 1, 045 monozygotic (genetically identical) twins and 1, 899 dizygotic (50% of gene factors shared) twins. Childhood sleep-walking was more frequent in women 9% saying they experienced it "sometimes" or "often" compared to 8%" of men. Childhood sleepwalkers can continue walking as adults. 24.6% of men and for 18.3% of women continued to walk if they had walked frequently as children [22]. Of adult men sleepwalkers 88.9% had a positive history of sleepwalking in childhood, and in women, 84.5%. For both men and women those who never walked in their sleep as children did so rarely has adults-0.6%.In a separate study, immediate relatives of sleepwalkers were shown to have at least a 10-fold increased likelihood of sleepwalking over that of the general population. There are no studies on genetic similarity. The highest correlations in both children and adults between parasomnias were between sleep talking with sleepwalking, nightmares, and bruxism (tooth grinding) [22].

It is not clear why sleepwalking should decline during adolescence. Certainly children have much more deep sleep than adults and the duration of deep sleep declines during adolescence.

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What triggers sleepwalking is also an area of debate. During deep sleep the thalamus which is the main sensory relay in the brain goes into an idling or neutral state so less sensory information is passed up to the cortex. The cortex reacts to stimuli so with less stimuli the less there is to respond to. As the areas of brain that handle automatic or well-learned behaviour have not shut down but are also in a neutral state, the person just continues to sleep. However, if there is an interruption of breathing or some other stimulus then the learned behaviour may be triggered. As the rational part of the brain is switched off there is nothing to prevent the behaviour, the walk, beginning. Recent research on adult sleepwalkers showed that sleepwalkers thought that stressful events during the day triggered sleepwalking 52% of the time. Other important triggers that were reported were: strong positive emotions 42%, prior sleep deprivation 27%, alcohol 12% and intense physical activity 5% [23]. However, it has been suggested recall bias may have affected these results [24].

Zadra has highlighted some misconceptions concerning somnambulism that have arisen over time: 1) that it has no daytime consequences; apparently there are, patients are more somnolent and have daytime functioning anomalies, 2) somnambulism is characterised by episodic amnesia-this appears not to be the case and 3) somnambulism is an automatic behaviour arising in the absence of dreamlike mental activity-again untrue, it has always been known that dream mentation is not exclusively related to REM sleep and Montplaisir's group has noted mentation in somnambulists [25]. These ambiguities lead to disagreements in classification and diagnostic committees. For legal cases this is a problem as factors that are considered as significant may in fact not be. There is also a problem with working clinician's experience, particularly those who are not engaged at sleep centres and even those have the difficulty of not actually knowing what patients do in their homes as patients, on the whole, do not have the capacity to walk in sleep centres.

3.1. Sleep-related violence

NREM Disorders of arousal are not inevitably associated with (criminally) violent behaviour. In a cohort of 64 of his patients Moldofsky noted with 89% sensitivity, 80% specificity and 81% diagnostic accuracy violence was associated with being male and having less than 2% stage 4 sleep (similar to N3, refer to table 4) [26]. Also associated was experiencing more stressors, drinking excessive caffeinated beverages and abusing drugs. A UK population study on 2, 078 men and 2, 894 women reported 1997 noted a frequency of 2% [27]. A larger sample of 19, 961 participants was polled 2010 in Finland, Germany, Italy, Portugal, Spain and the UK and found the frequency was 1.7% of the population [28]. The perpetrators were younger than 35. 61.5% noted vivid dreams during the episodes, though the highest frequency was observed with subjects suffering from sleepwalking and sleep terrors. It is notable that only 12.3% of these subjects reported their problems to a physician. Guilleminault reviewed his violent cases in 1998 comprising of 48 patients with REM Behaviour Disorder (who will not be discussed in this essay), 44 young somnambulistic patients (mean age 18+/-5 years) and 27 older subjects [29]. His review is preceded with pertinent questions for the forensic area:"*Is the subject ever 'asleep' during violent acts, do the events occur out of sleep, or is there an intermediate or borderland period between sleep and wake? At what point does full alertness occur? Is there a decrease or absence*

of judgment when violent actions occur within this ill-defined borderland between wake and sleep? Based on available data, if one accepts the existence of this borderland of sleep and abnormal states of alertness, how long could this "abnormal state" last? Is there some event during sleep that influences the violent behavior? Is the state of alertness during the abnormal behavior different from "normal" wake, and, if different, how and based on what objective information?" Perhaps the review not surprisingly could not answer the questions but characterise many of the behaviours that can occur and further noted instances of seizures, the impact of narcolepsy and sleep-related respiratory disorders. He does note:"*The pattern of violence against others is mostly an unconstructed violence against a bystander who may not be recognized by the wandering subject The most likely bystander, given the time these nocturnal episodes occur, is a caregiver or family member, often leading to a heart breaking situation for the perpetrator of the violent act*." Siclari *et al* recently (2010) reviewed the violence in sleep literature [30]. They noted that apart from the NREM parasomnias (Confusional Arousals, Sleepwalking and Sleep Terror) and REM parasomnias (RBD) that epileptic conditions such as Nocturnal Paroxysmal Dystonia and Epileptic Nocturnal Wandering, Confusional States, Psychiatric dissociative states and malingering could also account for (apparently) sleep-related violence. They also listed numerous court cases which perhaps is less than desirable (see below) but amongst other topics usefully provided a summary distinguishing between arousal disorders and nocturnal seizures in nocturnal frontal lobe epilepsy. Ebrahim & Fenwick [31] provide the most comprehensive listing for differential diagnosis (see Table 2) and controversially use an alcohol provocation test in their sample case. Their work has led to some controversy [32-40].

Organic medical and neurologic disorders
Vascular
Mass lesions
Toxic/metabolic
Infectious (limbic encephalitis).
Central nervous system (CNS) trauma.
Seizure disorders e.g. partial complex seizures.
Nocturnal seizures
Narcolepsy and idiopathic hypersomnia.
Sleep apnoea.
Sleep deprivation.
Sleep schedule/circadian rhythm disorder (including jet-lag).
Psychogenic disorders (Dissociative states, Fugues. Multiple personality disorder)
Psychogenic amnesia.
Post-traumatic stress disorder.
Malingering.
Munchausen by proxy.

Table 2. Ebrahim & Fenwick provide a comprehensive list of possible aetiologies to aid differential diagnosis [31]

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4. Forensic guidelines for sleep-related violence

In forensic psychiatry it not unusual to consider a behaviour in terms of predisposing (e.g. heredity), priming (e.g. sleep deprivation) and precipitating (e.g. touch) factors. Pressman in a series of papers has examined reviewed the literature to consider variables such as touch, sleep deprivation, febrile illness, etc. [37, 41] with a particular focus on sleep recording correlates [42] and alcohol [24, 38]. He has also questioned whether in cases that involve alcohol, whether the amnesia associated with the alleged event is caused by the putative parasomnia or is merely the result of an alcohol blackout [43] and whether the apparent association is a result of a methodological bias in the way the data has been collected (i.e. if a sleepwalker says they walk more often but are amnesic then how do they know, and how reliable is a third-party's information on the association) [24].

Feature	Violent behaviour	SRSBs	Comment
History	Corroborated	+	For violent behaviours there is usually a history of childhood sleepwalking or other deep sleep parasomnias. For adult onset there should also be some evidence in the clinical history or support from observers (ideally independent). For sexual behaviours previous bed partners may corroborate the behaviour.
Defendant asleep		+	There should be evidence that the defendant was asleep.
Asleep for how long	30 mins - two hours	?	For cases of violence it is rare for the behaviour to occur around the time of sleep onset. More usually around the time that deep sleep occurs (the first three hours of the night). For sexual behaviours - the behaviour may occur later in the night (as it may with sleepwalking - Mwenge et al, 2013 [44)]
Sleep exceptionally deep	Fatigue, drugs, alcohol, fever	?	Bonkalo[44] identifies this factor
Aroused/ (awoken)	Touch, etc	+	*cf [36, 44]*
Impulsive/short	Behaviours occurs on arousal	?	Most guidelines suggest durations of a few minutes to 30 minutes.
Victim accidental		?	The rarer form of sleep-related sexual assault is when the 'somnambulist' perambulates to the victim.
Amnesia	None, or marginal	?	Sexual 'RBD' (see Schenck et al 2007 review) [8]
Return to awareness	Incomprehension, possibly horror at act	?	In many cases both the victim and defendant remain asleep and the assault may not reported immediately.

Table 3. Forensic sleep guidelines [11, 12, 30, 31, 44, 46-49]

Guidelines as to how to assess these cases have been available at least since Bonkalo (1974) [44] reviewed the literature. His guidelines which had a strong focus on *Confusional Arousals* and cases of violence have been adopted and amended by various authors since. Table 4 summarises these guidelines. With minor variations these guidelines are the same.

For my own part before considering the guidelines that are available the questions that need to be answered are: 1) is the defendant capable of this behaviour whilst asleep (i.e. is there a compatible history) and not affected by confounding factors (e.g. medicines, drugs, alcohol, et) and 2) is the alleged behaviour compatible with a sleep-related disorder (i.e. a parasomnia)?

Sleepwalking — Simple behaviours turning into longer duration wandering?

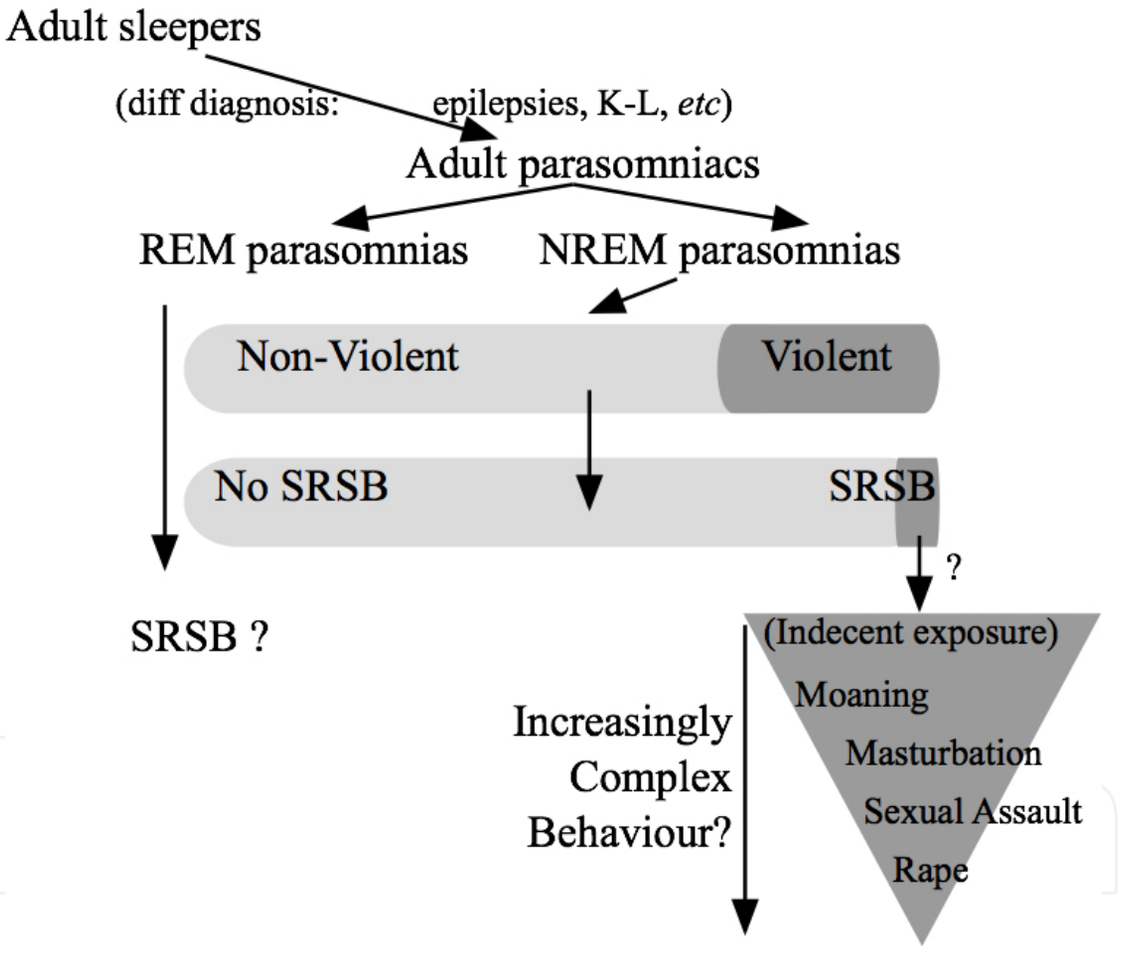

Figure 2. An illustration that attempts to show the decreasing incidence of a complex SRSB such as rape (though ejaculation is not noted).

4.1. Sleep-related sexual behaviour

ICDS3 lists SRSBs as a pathologic subtype under *Confusional Arousals* (A NREM parasomnia). However, not all SRSBs occur as NREM parasomnias (Table 5). SRSBs first emerged as a possible subtype of parasomnia with a description of masturbation by Wong [13]. This was

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followed by case reports of sleep-related sexual abuse of children [50] and subsequently more reports from Shapiro [10] and Rosenfeld [49] with Guilleminault [12] providing the largest, substantive, well-investigated case series with Shapiro [11] running roughly parallel. Schenck et al [6] subsequently provide the first major review of the area.

• Sleep sex, sexsomnia, sexual behaviour in sleep
• Sleep sex moaning, sleep sex talking, sleep-sex shouting
• Sleepsex snoring
• Hypersexuality with Kleine-Levin syndrome;
• Epileptic sleep sex/sexsomnia/SBS, sleep related sexual seizures
• Epileptic sleep sex moaning, sleep sex talking, sleep sex shouting
• Chronic, severe insomnia;
• Restless legs syndrome (RLS)
• Sexual hypnagogic or hypnopompic;
• Sexual REM-onset dream attack
• Cataplectic orgasm, peri-orgasmic cataplexy
• Sleep exacerbation of persistent sexual arousal syndrome
• Hypersexuality with sleep related painful erections (SRPE)
• Hypersexuality with sleep related dissociative disorders
• Hypersexuality during nocturnal awakenings
• Nocturnal sexual delusions and hallucinations
(Terms used for searching for SRSBs in the published research literature by Schenk et al [6] for their 2007 review)

Table 4. Sleep related abnormal sexual behaviours (alternate names)

It is notable that the largest number of cases was derived from patients suffering from Kleine-Levine Syndrome (78 cases), follow by parasomniacs [31] and sleep-related seizures (7 cases).

Schenck et al [6] note that neither the Kinsey [51, 52], apart from male nocturnal emissions, or Hite Reports [53, 54] note SRSBs. In the section on "Individual Variation, " Kinsey commented on the wide variety of human sexual behaviour which may have been a covert reference to nocturnal or sleep-related behaviour. They also note that their data, because of the sources contain cases that have led to criminal proceedings. Importantly they find that the greatest incidence of SRSBs is with patients suffering from Kleine-Levin syndrome, a rare disorder (probable incidence 1 in a million) characterised by periods of hypersomnia and mood changes, and with many patients suffering from hypersexuality and/or hyperphagia. Seventy-eight cases were reported. The next main group was the parasomnias-31 cases, followed by 7 cases of sleep-related seizures. Schenck et al [6] also question the existence of REM-related SRSBs or at least note there are no sleep laboratory confirmations of this behaviour and that the cases

they reviewed did not involve dream-enactment. Parasomnia Overlap Disorder (a mixture of NREM and REM parasomnia was noted).

Kleine-Levin syndrome
Sleep related sexual seizures
Severe chronic insomnia
Restless legs syndrome
Narcolepsy
Sleep exacerbation of persistent sexual arousal syndrome
Sleep related painful erections and increased sexual activity
Sleep related dissociative disorders
Nocturnal psychotic disorders
Hypersexuality after nocturnal awakenings
Miscellaneous
(naps; [REM] sleep erections and sexual vulnerability; medication-induced states)

Table 5. Sleep Related Disorders and Abnormal Sexual behaviours and Experiences

It is perhaps surprising that the published clinical literature has relatively few SRSB case studies, given that an internet survey [55-57] ? The answer may lie in dream mentation work. Nielsen found that the prevalence of various behaviours particularly sexual behaviours apparently increased if respondents were asked specific questions about the behaviour; subjects did not readily reveal their sexual behaviour without being asked. Overall Nielsen noted that "females reported more speaking, crying, fear and smiling/laughing than did males; males reported more sexual arousal" [58].

4.2. Sleep-related sexual violence

Andersen *et al* (2007) [59] provide a slightly more focussed review than Shenck *et al*, 2007 [6] on SRSBs but include the main datasets provided by Guilleminault [12] and Shapiro [11]. The total number of cases cited was 40 (9 women). If the cases that were involved in criminal or other legal proceedings are excluded the number falls to 22 (7 women) ; if alcohol is then excluded there remain 17 cases (6 women). Further, if cases of multiple substance abuse and indecent exposure are removed that leaves a dataset of 15 (6 women). Of these there were 3 cases of sexual intercourse (men). Interaction between two individuals which is an assault without consent occurred with 7/9 men, and 1/6 women. Moaning was reported for 3/6 women and 1/10 men; masturbation 3/6 women and 2/10 men.

It is now becoming clear that slow wave sleep consists of not only different types of slow wave but these types have different functions [103-109]. It follows that when generalisations are

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Variable	R&K 1968 [60]	AASM 2007 [61]	Comments	
Scoring page/ window length	15, 20 or 30 seconds	30 seconds (compulsory)	Originally sleep stages were scored on pages which consisted of 15-30 seconds data	
Stages	Wakefulness, stage 1 (drowsy), stage 2 (light), stage 3, stage 4, REM sleep, movement time.	Stages W, N1, N2, N3, and R	**Combinations and alternative names**: NREM = N1+N2+N3; REM sleep = Paradoxical sleep	
				Mental world
Wakefulness	EEG alpha activity for ≥50% of an epoch	Same (W)	Multiple variants	Awake (full range)
N3 **Deep sleep = Delta Sleep = SWS = Slow Wave Sleep, stages 3 and 4 combined.**	EEG slow-wave activity for ≥50% of the page for stage 4 sleep or ≥20% of the page for stage 3 sleep, 0.5-2.0 Hz and >75 μV	Same, except that stages 3 and 4 are combined to N3	Not all slow waves are the same. Some are very slow oscillations <1 Hz or classified according to different amplitudes	Nil or dark and threatening (usually associated with amnesia upon awakening)
N2 **Stage 2** **(light sleep)**	Sleep spindles or K-complexes; EEG slow-wave activity for <20% of the page	Same (N2)	Not all sleep spindles or K-complexes are the same	Identifies sleep onset in some systems.
N1 **Stage 1** **(drowsiness)**	Low-voltage, mixed-frequency activity; possibly slow eye movements; no sleep spindles or K-complexes; EEG alpha activity for <50% of the epoch	Same (N1)		Identifies sleep onset in some systems. Possible hallucinations
REM **REM sleep**	Low-voltage, mixed-frequency EEG activity; very low submental EMG activity; possible saw tooth EEG theta activity; >=1 rapid eye movement (unequivocal)	Same (R)	Phasic activity, sawtooth waves	Dreaming (full range of possible, nil, black & white, colour, etc). Dream incorporation, Dream enactment

AASM, American Academy of Sleep Medicine; EEG, electroencephalogram; EMG, electromyogram; R&K, Rechtschaffen and Kales [60].

Table 6. Showing classification rules and nomenclature of sleep staging systems.

made about deep sleep, those generalisations may not apply to all type of deep sleep. That degree of inaccuracy is below that usually required by courts that are seeking the truth. Spindles have the same problem [110-113].

The table is provided to enable comparison of older research with the new American Academy guidelines. That main point is that precisely what the sleep stages are is still a matter of research, debate and discussion. The original committee had difficulty in deciding on the stages (Oswald, personal communication, 1978 and others on the committee) and the 2007 still had similar problems. However it is notable that the professional sleep societies continue to monitor and refine the definitions (e.g. [62]). New 'stages' continue to be found, e.g. Koch et al [63]. For applied purposes like legal cases though the stages that cause most problems are REM and deep sleep. Further discussion in Idzikowski (2014) [64].

Sleep research and sleep medicine using electroencephalography ('brainwaves') as the primary measures grew with the discovery that 'dreaming' could be measured objectively [65]. Unfortunately, over time it turned out that the correlation between electrophysiological measures that lead to a particular classification of sleep stages was just a correlation (see Table 5 for definitions) ; dreaming generally occurs during REM but may occur in other stages, etc. Also, awkwardly both subjective appreciation, or behavioural responses do not directly map on to sleep stage. So in 'light sleep', (stage 2/N2) which is generally regarded as 'sleep' behavioural responses are still possible (depending on the time of night) [66].

The problem of identifying the stages accurately as indexed by the difficulties in producing automatic computer algorithms to do the staging and the disagreements between human scorers when sleep records are compared. Rosenberg et al, found sleep stage agreement averaged 82.6%. Agreement was highest for stage R sleep with stages N2 and W approaching the same level. Scoring agreement for stage N3 sleep was 67.4% and was lowest for stage N1 at 63.0% (the stages that are important with regard to NREM parasomnias. Scorers had particular difficulty with the last epoch of stage W before sleep onset, the first epoch of stage N2 after stage N1 and the first epoch of stage R after stage N2. Discrimination between stages N2 and N3 was particularly difficult for scorers [62].

In addition to compartmentalising sleep into page lengths of 20-30 seconds there have been other attempts to quantify sleep that are less reliant on page size and that may be important in the definition of sleep, deep sleep and sleepwalking. For example, spectral analysis (looking at the frequency domains) [67, 68, 69, 70] and Cyclic Alternating Pattern CAP [69].

In humans sleep has a 90 minute cyclicity [71, 72], and in normal individuals there is a preponderance of deep (N3) sleep early in the night, with progressively more REM sleep occurring late in the sleep period. The 90 minute cycle is punctuated with REM sleep and possibly wakefulness. Deep sleep is homeostatically controlled as is REM sleep, but REM sleep also has a circadian component with more REM sleep occurring in the morning.

It is important to note that when the hypothalamic and lower brain sleep centres are most active, the wake centres are generally quiescent. The interplay between the two orchestrates some of the changes seen in the brain. Loss of conscious awareness occurs some time during stage 2 when functional MRI signals decrease in the tale thalamic and hypothalamic regions, the cingulate cortex, right insula, nearby temporal regions, the inferior parietal lobules and the inferior/middle frontal gyri [78]. Bassetti *et al* [79] have observed in one subject during sleepwalking that a disassociation between an activation in thalamocingulate pathways

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AREA	*DEEP SLEEP*	*REM SLEEP*
Lateral frontal cortex	↓	↓
Medial prefrontal + orbitofrontal cortex		↑ ↓
Lateral parietal cortex	↓	↓
Medial parietal cortex +precuneus	↓	↓
Temporal-occipital cortices	↑	↑
Anterior cingulate cortex		↑
Medial temporal lobe, hippocampal regions, amygdala		↑
Thalamus	↓	↑
Basal ganglia	↓	
Pons, midbrain	↓	
Cerebellum	↓	

Table 7. Provides an overview of brain imaging studies that show both the decreases and increases in brain activity during the major sleep stages [73-77].

coupled with deactivation of thalamocortical arousal systems is associated with sleepwalking. It is almost important to note though that within cortical regions there can be both increases and decreases of activity within "sleep" which are presumed to reflect local energy requirements [80, 81]

Sleep is an orchestrated state with hypothalamic centres strongly controlling which areas of brain remain active and which become quiescent-see Table 7. Diminution of activity in areas such as the prefrontal cortex underpin the scientific arguments that the brain centres that might be involved in the determining whether a behaviour is 'right or wrong', appropriate or not are not active. That coupled with evidence from sleep deprivation work that points to degraded moral judgement with sleep loss [82].

Whilst this section and sleep classifications describe sleep states as mutually exclusive, in reality they are not. The stages are an amalgam of different physiological signs that have been lumped together as stages (by committee and consensus). That does not mean that all aspects associated with a particular stage will necessarily remain within that stage. For example a penile erection which is usually associated with REM sleep may continue, for a period of time, into light sleep or wakefulness? Moreover, there is still debate as to what the functional significance of sleep stages. Pharmacological disassociations have occasionally been noted, e.g. changes in deep sleep duration without apparent impact on waking function [83]. Mahowald and Schenck [84] describe the extreme states of wakefulness whilst apparently asleep (according to electrophysiological characteristics). Mahowald and Schenck identify the three basic states of being as wakefulness, NREM sleep and REM sleep.

5. Alcohol and sleep

Bonkalo notes alcohol amongst factors that may increase deep sleep and thus facilitate violent confusional arousals [44]. ICSD3 explicitly states [17] "… Disorders of arousal should not be diagnosed in the presence of alcohol intoxication. The behavior of the alcohol-intoxicated individual may superficially resemble that of the sleepwalker. …" This is within a section on differential diagnosis but it also may have an undue impact in the forensic area. Why this sort of policy statement should be placed in a scientific document is not entirely clear. It is correct to note that there are difficulties, but an instance of a behaviour that may occur without alcohol could be repeated within sleep, irrespective of whether alcohol is present or not? However, there is confusion in the literature as alcohol has been suggested as a priming factor, partly on the basis of self-reports, rejected by Pressman *et al* [24] because of recall bias, and partly as early hypotheses noted that: 1) deep sleep is associated with sleepwalking, 2) alcohol facilitates deep sleep (not currently, wholly accepted) and 3) they hypothesis, so alcohol must promote sleepwalking? No formal experiments have been published either refuting or accepting this hypothesis and in fact given the reported complex effects of alcohol on sleep [36] and the variables involved, e.g. Carskadon and colleagues [85-88], it may be quite some time before an adequate experiment on sleepwalkers is conducted. Answering the question as to how alcohol might affect sexual response [89, 90] during sleep exacerbates the complexities.

6. Wakefulness and violence

Sleep and wakefulness are two sides of the same coin. Sleep-related legal cases need to be balanced by considering what can happen when a person is awake. Humans are inherently a violent species, both in terms of physical aggression and aggression directed sexually [91]. Sleep-related violence has only a loose overlap with WHO's typology of violence. The overlap is interpersonal violence which may be physical or sexual. It is unknown whether self-directed violence in the form of suicidal behaviour occurs during sleep as it is assumed that sleepwalkers who have perished did not intend to commit suicide. The links between violent assaults and wakefulness are broad and will not be considered here.

6.1. Wakefulness and sexual violence

There are multiple risk factors that increase the risk of a man committing rape. These include individual factors such as alcohol and drug use; coercive sexual fantasies, attitudes and beliefs supportive of sexual violence; impulsive and antisocial tendencies; preference for impersonal sex; hostility towards women; history of sexual abuse as a child; witnessing family violence as a child. Additionally, relationship factors (e.g. associating with sexually aggressive and delinquent peers), community factors (e.g. lack of employment opportunities, general tolerance of sexual assault within the community) and societal factors (e.g. societal norms supportive of sexual violence, male superiority and sexual entitlement). Conservative estimates suggest that at least 25 percent of American women have been assaulted in adolescence

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or adulthood and that 18 percent have been raped. Furthermore, at least 20 percent of American men report having perpetrated sexual assault and 5 percent report having committed rape [92].

In the United Kingdom (North London, 1993) 6% assaulted in the past 12 months, and 23% attempted or completed forced sex by an intimate partner [93, 94]. The comparable figures for the U.S. are 0.7% and 7.7% but these may be skewed as the sample group did not include women who had been in a relationship [91].

6.2. Alcohol and sexual violence

The biological links between alcohol and violence are complex. Even the impact of alcohol on sexual potency needs further research as results currently still need clarification-e.g. high doses of alcohol which might render some men impotent do not appear to have the same effects on rapists [95]. Alcohol does though have a disinhibiting role in sexual assaults, it reduces inhibitions, clouds judgements and impairs ability to interpret cues [91]. As lack of reporting causes a problem in identifying the precise incidence of alcohol being associated with rape, the estimates are similar to violent crime in general and range between 34-74% [92]. The role of alcohol is complex [96].

7. Discussion

It is perhaps not surprising that there are calls for more considered opinions and further research into the whole area of sleep-related violence, let alone sleep-related sexual violence [97]. Extrapolating what is known about parasomnias, given the limited evidence base, which at best is still only at the data-collection phase, to applied situations such as legal cases have to be fraught. There are varying degrees of certainty with respect to what we know: 1) in NREM deep sleep, associated with short-duration somnambulism (within the confines of one sleep cycle), there is a) limited or fragmentary connection with the external world, b) some mental activity that may be concordant with behaviour, and c) behaviours including ambulation that are relatively simple. 2) It is not clear, particularly with longer duration, more complex behaviours, whether deep sleep continues, or whether sleep either moves into a more wakeful but disassociated state, or to drowsiness and/or light sleep but still possibly in a disassociated state. 3) The normal cyclicity of sleep is disturbed. The main hypotheses dealing with sleep control posit an interaction between a sleep homeostat and the circadian system. There is curiously little evidence that the circadian system is involved, other than most (if not all) NREM parasomnias occur at night? However, circadian displacement is being increasingly implicated [115]. The homeostat increases the pressure for sleep, particularly deep sleep, in parallel with the duration of prior wakefulness. However, in sleepwalkers this system appears to be faulty [25], with their deep sleep being more broken with arousals and wakefulness (which could be a circadian system effect, with circadian time being affected by the sleep deprivation?).With SRSBs there is a range of possibilities ranging from simple caresses to sexual intercourse, all of which may lead to legal action if occurring inappropriately and without consent. The current database of recorded sexual activity is sparse and what there is has been with consenting adults

dressed for sleep. Apart from sexual intercourse rape may involve unclothing a possibly unfamiliar victim, and also possibly in unfamiliar circumstances. Whilst erection and ejaculation are underpinned by primarily reflexive mechanisms, more complex control is required to achieve full intercourse with ejaculation.

It is perhaps not surprising that the emerging (sub-?) speciality of 'forensic sleep' or 'forensic sleep medicine', given the limited database, ambiguities over the function of sleep or its staging, that the area has little theoretical underpinning. Perhaps though the time has come to start theorising or creating testable models against which to run hypotheses? This has already started thought at a basic level. Cramer Bornemann and Mahowald [114] leaning on the concept of central pattern generators provide some ideas as to how simple, reflexive and instinctive behaviours may arise in humans during sleep. Zadra et al [25] consider the existing evidence to assemble a model describing somnambulistic behaviour. This suggests that there are two main dimensions to sleepwalking: a dysfunctional "deep sleep" system, and b) a dysfunctional arousal (wake-promoting) system.

7.1. What can sleep science & sleep medicine tell the law?

Sleep research has identified various stages of sleep though there are still debates as to scoring of the stages and their functional significance. As noted earlier, there are also ambiguities as to when sleep onset actually occurs and very little work on what cognitive capacity remains-(insight, problem-solving, etc.) (dreams are a special case, where a mixture of brain imaging and self-report identities what brain regions appear inactive, and provides more information e.g. reduced firing in the locus coeuruleus would lead external stimuli having less impact on attention-which may account for a dream narrative incorporating external stimuli as opposed to breaking the narrative (and awakening the subject?) [98].

For forensic work the main issues are how (particular stages of) sleep can affect cognitive capacity, and control of behaviour. The impact of sleep deprivation and sleep restriction on waking sleepiness and cognitive capacity is not dealt with in this chapter. This needs further consideration as the complexity of behaviour in an alleged crime is important, e.g. what capacity is required for a defendant to appreciate consent, what capacity is required for a 'sleeping?' rapist to seek out and locate a victim? At which point does apparent capacity preclude the possibility that the defendant is in fact not asleep (they may be awake but may be in a different state, a disassociated state of some sort (not necessarily sleep-related)).

In normal REM sleep the muscles are paralysed so movement is more or less impossible. However penile tumescence is normal and in some circumstances the meaning of an erection can be misconstrued (leading to legal action). Given that sleep is a usually coordinated state the tumescence would normally subside prior to or when entering other stages, like wakefulness (with the possibility of sleep inertia) or drowsiness or light or even deep sleep. At sleep onset, the precise determination of the onset of mental sleep is unclear, occurring sometime during N2 (light sleep). 'Wet dreams' are not regarded as pathological, when ejaculation occurs during [REM?] sleep. Clearly, some movements occur during sleep to maintain comfort (either avoiding pain or maintaining an appropriate temperature, etc), but even these if someone is

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sleeping nearby, these movements may accidentally impact on the other sleeper which in some circumstances can lead to complaints of assault.

Sleep medicine can describe somnambulistic episodes only roughly (virtually no helpful home recordings), quite roughly-both duration and timing of episodes are subject to dispute. Consider Mwenge et al's sleepwalker whose latest episode was 06.45-using home recordings [45].

7.2. What can the law tell sleep science and medicine?

Judicial systems have had to manage sleep-related states considerably a lot longer than the time that sleep science and medicine have existed (considerably longer than the Royal College of Psychiatrists!). Understanding the nuances where they are not policy driven can be a useful area to explore. Unfortunately though, reliable data as to individual cases is rarely available. Media misreporting is common. Attention demanding headlines or misreporting by legal correspondents creates difficulties that may ultimately influence professional opinions and misguide the opinions experts may give in court. Furthermore, publishing of case studies is fraught with difficulty if reference is made to court proceedings. Case material acquired during a court case is not in the public domain. A defendant whether convicted or not retains their human rights and although the confidentiality between practitioner and client is broken in relation to the court, that does not necessarily (arguable) make the material available to the public domain.

8. Future agendas

Basic science research: arousal thresholds, sensory/cognitive processing capability, classical/operant conditioning potential. Better models of human sexual behaviour. Development of home recording equipment (video, ambulatory systems (e.g. like the Zeo [99-102]. There is also a need for better models of describing the relationship of sleep and wakefulness with cognition and behaviour (the subject of another paper).

Clinical science research: improved classifications systems; the need to distinguish between somnambulism, sleep inertia and disassociated states.

Forensic: Some definition of standards and methodologies driven not only by a reaction to legal needs but also by consideration of basic pathophysiology. The effect of alcohol needs to be explored both in a laboratory and non-laboratory setting (initially outside of a legal context).

Legal: Reform and uniformity across jurisdictions with respect to insanity and automatism laws. Ideally a mechanism to record accurately court proceedings and the data associated with these cases, so that it is possible to court cases as data.

9. Conclusion

This essay focused on NREM parasomnias that might lead to SRSB that in turn might lead to legal proceedings. A considerable amount of work needs to be done so that expert opinion in court is based on science that has substantive forensic value.

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Author details

Chris Idzikowski*

Address all correspondence to: chris.idzikowski@neuronic.com

Innis Court, Holywood House, Holywood, Co Down, BT18 9HF, Northern Ireland

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