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Understanding the sleep-aggression relationship in a forensic mental health sample

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ABSTRACT

The contribution of cognition to the sleep-aggression relationship is explored via three connected studies, involving adult male forensic patients detained in a high secure hospital. Study 1 included 31 patients, interviewed to examine their experiences of specific sleep problems. In Study 2, 42 patients completed a series of measures examining sleep dysfunction, aggression, and cognition, while Study 3 was designed to impact on sleep via a cognitive approach. In the latter, 48 patients were randomly assigned as part of a feasibility trial to one of three conditions: mindfulness (cognitive approach), sleep education, and treatment as usual. Collectively, the studies demonstrated the multifaceted nature of cognition in the sleep-aggression relationship, with a need to account fully for cognitive factors. A preliminary conceptual model is outlined - the Cognitive Sleep Model for Aggression and Self Harm (CoSMASH), as a direction for future research to consider.

1. Introduction

The association between sleep and aggression has received increased attention in recent years (Kamphuis, Dijk, Spreen, & Lancel, 2014), with an association highlighted between sleep difficulties and increased aggression (Ireland & Culpin, 2006; Kelly & Bagley, 2017; Randler & Vollmer, 2013), including aggression motivation (Barker, Ireland, Chu, & Ireland, 2016; Hunter, Durkin, Boyle, Booth, & Rasmussen, 2014). Acts of aggression capture *outward* directed (i.e. directed towards others) and *inward* directed aggression, namely self-injurious behaviour and ideation (Plutchik, 1995). The latter also appears associated with sleep difficulties (Liu, Chen, Bo, Fan, & Jia, 2017; Wong, Brower, & Zucker, 2011) and yet remains poorly explored.

1.1. Importance of considering the sleep-aggression relationship and a role for cognition

There has been recent growing interest in the factors that may contribute to the sleep-aggression relationship. It has been hypothesised that insufficient sleep inhibits an individual's ability to apply self-control (Kamphuis et al., 2014), which when experiencing negative emotions, may result in aggression (Krizan & Herlache, 2016). This, however, appears too simplistic a proposition when aligned with the aggression literature that cites several factors as important to aggression, in particular, cognition in the form of beliefs, thoughts and associated rumination (Anderson & Bushman, 2002; Gilbert, Daffern, Talevski, & Ogloff, 2013; Huesmann, 1998). A more cognitively informed perspective has, more recently, been proposed to explain the aggression-sleep association (Krizan & Herlache, 2016). Here, sleep disruption is thought to impact on negative interpretations being formed of others and to affect rational decision-making, leading to aggression (Krizan & Herlache, 2016). Arguably, any biases in interpretation that can promote aggression, such as hostility, become more accessible when sleep is disrupted, decreasing the ability to access prosocial scripts to apply to a challenging situation (Barker et al., 2016). Krizan and Herlache (2016) also argued that the sleep-aggression relationship is reciprocal, whereby each facilitates the other via repetitive negative thinking. Increases in repetitive thought, such as rumination and worry, have certainly been highlighted as contributing independently to both sleep (Nota, Schubert, & Coles, 2016) and aggression (Peled & Moretti, 2010). Caprara, Manzi, and Perugini (1992) highlight that such ruminative thoughts can occur *following* aggression due to concerns or worries about such behaviour. This could, in turn, perpetuate sleep difficulties.

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1.2. Sleep challenges and link to aggression in forensic populations

Sleep disruption is certainly considered an issue of importance in forensic settings, where prevalence rates of insomnia can reach 80% (Dewa, Kyle, Hassan, Shaw, & Senior, 2015), in this case in prisons. There is also a high prevalence of both inward and outward aggression in forensic populations, with almost 40% of patients committing one act of aggression towards others (Bowers et al., 2011) and almost 62% of patients being involved in at least one act of self-harm (Mannion, 2009). Thus, it is important to consider the association between sleep and aggression in a population where there appear raised elements of difficulties in both. Connected to this, there is a need to capture the theoretical and empirical underpinnings of sleep challenges, to identify how this could contribute to understanding an association between sleep and aggression, with a clear emphasis on cognition.

1.3. Models applied to sleep challenges

One conceptual model of potential value is the *Microanalytical Model of Insomnia* (MMI) (Morin, 1993). This integrative model aims to understand how sleep problems can become self-perpetuating, highlighting that insomnia occurs at some level due to physiological and emotional arousal. However, it is the impact of *cognitive* arousal that is emphasised (Marques, Allen Gomes, Clemente, Santos, & Castelo-Branco, 2015). Such cognitive arousal (or activation) mediates the other factors within this model, namely dysfunctional beliefs about sleep, maladaptive habits associated with sleep, and the appraisal of the negative consequences of sleep difficulties, leading to the self-perpetuation of difficulties. The MMI provides some insight into the role of increased cognitive activity prior to sleep onset, limiting an individual's ability to gain sleep. It further highlights how dysfunctional beliefs and attitudes about sleep are associated with sleep. Although there has been research supporting aspects of this model (e.g. Jin, Zhou, Peng, Ding, & Yuan, 2018), it remains poorly understood as to how these dysfunctional beliefs are developed.

A later model, the *Cognitive Model of Insomnia* (CMI: Harvey, 2002), attempted to focus more specifically on *how* dysfunctional beliefs serve to maintain symptoms of insomnia. This conceptual model argues that sleep problems are maintained by negative and excessive pre-sleep cognitive activity, whereby there is preoccupation with achieving and maintaining good quality sleep. This concern triggers physiological arousal and emotional distress, causing anxiety and leading to the individual monitoring night-time and day-time signals that indicate they have not slept well. The CMI outlines why sleep problems are maintained in some individuals but not others. It also considers the 'waking state', rather than focusing solely on the pre-sleep routine. However, the CMI does not provide an explanation as to the precipitating factors of sleep difficulties, other than noting excessive cognitive activity as a key component. In addition, although there is a single longitudinal study that indicates negative pre-sleep cognitive activity can predict sleep problems (Norell-Clarke, Jansson-Fröjmark, Tillfors, Harvey, & Linton, 2014), this considered only a general population sample.

The importance of cognition was further captured by a later model, the *Attention – Intention – Effort Pathway* (AIE) (Espie, 2007), which builds further on the importance of cognition in sleep, proposing that significant sleep problems are maintained by an increase in selective attention to sleep-related cues (*Attention*), which drives an individual to crave more sleep (*Intention* to sleep) and to focus their efforts on obtaining sufficient sleep (i.e. performing *Efforts* to sleep). When this is not achieved, the individual is more likely to direct their attention to the need for sleep, with the need for sleep becoming a threat and leading to increased monitoring of any stimuli considered a threat to sleep, which then contributes to dysfunctional beliefs about sleep.

A final area of important consideration is that of sleep-perception. Lichstein (2017), for example, proposed the term *insomnia identity*, whereby an individual is aware of the amount of sleep they have gained but perceives this to be an inadequate amount of time. This is thought fuelled specifically by a cognitive bias and linked to sleep misperception. Indeed, Lundh and Broman (2000) had proposed, via the *Integrated Model of Sleep-Interfering and Sleep-Interpreting* (IMSISI), how sleep problems could develop and be maintained due to two processes: Sleep-interfering processes (e.g. physiological, affective, and cognitive arousal) and sleep-interpreting processes.

However, despite the potential value that these models and interpretations can offer in terms of understanding sleep challenges as a cognitive process, none have been applied to a forensic population. Consequently, at present, they cannot account for how sleep challenges present in these samples. Equally, the association between sleep and aggression (outward and inward) is not captured within these models. All share cognition as a key challenging and/or causal feature that, as noted, is a core feature linked to aggression (outward or inward). An attempt to integrate these sleep models/interpretations with a specific challenging outcome, such as aggression, has not yet been achieved. Nevertheless, there appears value in considering how these factors may link. Using the outlined models can help move towards an applied focus.

1.4. Considering factors that impact on cognitions linked to sleep

Developing a more applied aspect to these models/interpretations can be achieved by further examining factors designed to specifically impact on the cognitive processes associated with sleep difficulties. This includes therapeutic intervention and the application of approaches known to utilise cognitive processes and improve sleep, to determine their impact. One such intervention thought to improve sleep disturbances is that of Mindfulness (Ong, Ulmer, & Manber, 2012), where clients are taught to place full attention on the present moment. There has been increased attention on the use of mindfulness-based therapies to improve sleep quality and quantity (Black, O'Reilly, Olmstead, Breen, & Irwin, 2014; Hülsheger, Feinholdt, & Nübold, 2015). It is also considered valuable for managing aggression, both inward and outward, in non-forensic/non-clinical samples (Heppner et al., 2008; Sharma, Sharma, & Marimuthu, 2016). The success of mindfulness-based therapies to improve sleep highlights the link between negative cognitions and sleep. It is therefore suggested that improvements in *both* sleep and aggression (inward and outward) would further call attention to the cognitive link between the two. In addition, previous research demonstrates the importance of cognition in sleep and aggression independently, but less is known about the role of cognition when these two sets of principles are brought together. As noted, although both insomnia and aggression models highlight a role for affect, it is the role of *cognition* that is arguably central to both maintaining sleep difficulties and to displays of aggression. Thus, cognition may be more salient than examining decreased levels of self-control or increased negative affect in trying to understand the impact on the sleep-aggression relationship.

2. Aims of the research

There has been a lack of attention to more complex and forensic populations, where aggression can be more prevalent and acute (Bowers et al., 2011; Mannion, 2009). For example, no published studies have captured forensic patients placed in conditions of raised security, where an increased risk for aggression to self and/or others is noted. Cognition is also a neglected variable when studying forensic patients. Consequently, the current research aims to analyse how cognition might influence the sleep-aggression relationship in a male forensic psychiatric sample, detained in conditions of high security. It does so via three linked empirical studies. These studies capture a qualitative review of sleep experiences, by interviewing patients regarding their perceptions of sleep (Study 1), by including a cross-sectional exploration of the sleep-aggression relationship using quantitative self-report measures (Study 2), including a feasiblity trial to explore whether a taught intervention can manage the cognitions associated with sleep and aggression, to

determine if this can lead to in improvements in sleep and reduced aggression (Study 3).

The following core predictions were made: 1.) Patients experiencing poor sleep quality, short sleep duration and night-time disturbances will report higher levels of aggression than those with good sleep indicators (Study 2) (e.g. Barker et al., 2016; Kamphuis et al., 2014); 2.) A higher presence of cognitive factors will contribute to sleep and aggressive outcomes (Study 2) (e.g. Barker et al., 2016; Littlewood, Gooding, Panagioti, & Kyle, 2016); 3.) Mindfulness will lead to improvements in the reduction of aggression and the cognitive factors associated with sleep difficulties (e.g. Black et al., 2014; Heppner et al., 2008; Hülsheger et al., 2015; Sharma et al., 2016), to a greater extent than a non-cognitive intervention (Sleep Education) or treatment as usual (Study 3).

3. Studies

3.1. Nature and quality of sleep in a forensic psychiatric population and consequences of disruption - a qualitative enquiry (Study 1)

3.1.1. Method

3.1.1.1. Participants. Participants were recruited from a high secure adult male forensic hospital. All were detained under the Mental Health Act with a diagnosis of severe mental illness and/or personality disorder and deemed a high risk to themselves and/or others. Paranoid schizophrenia and borderline/antisocial personality disorder were among the most commonly reported disorders in this population. Thirty-five participants (54% of those approached) consented to participate, with four later disengaging due to deterioration in mental health.

3.1.1.2. Materials. Participants completed a SORC functional assessment (Lee-Evans, 1994) with the researcher (LG), in interview form. This is a functional assessment framework that accounts for antecedents and potential factors reinforcing a chosen behaviour of interest, in this instance, sleep. A SORC was completed for an experience of good sleep and for an experience of poor sleep. The SORC comprises Setting conditions (e.g. triggers), Organism variables (e.g. beliefs, history), Response variables (e.g. behaviour), and Consequences (factors that followed and/or reinforced the behaviour). It was considered a simple framework for patients to follow, whilst also gathering the relevant information in a timely manner. The interviews lasted approximately 30 min. Participants were given a choice of whether to commence the interview by describing an example of good sleep, or commence it by describing an example of poor sleep.

3.1.1.3. Procedure. Ethical approval was obtained from a UK NHS Ethics Committee (16/NW/0669) and the University of Central Lancashire Ethics Committee. Participants were only approached by the researcher once written clearance to approach had been provided by their Responsible Clinician. All potential participants were approached individually and provided with a verbal explanation of the study and an information sheet. They were given one week to consider this information, whereupon the researcher returned to obtain their written consent. All interviews were conducted in a private ward based interview room.

3.1.2. Results

Following the steps as outlined by Braun and Clarke (2006), Thematic Analysis was employed to identify themes emerging from each section of the SORC. NVivo, a qualitative data analysis software tool (QSR International Pty Ltd, 2015) was also employed. One hundred and thirty-six initial codes were organised into components, relating directly to the areas of interest from the interview questions (i.e. behaviour, antecedents, and consequences). Main themes and subthemes were subsequently proposed in each of these categories. Each code was also

Table 1
Superordinate and subthemes from SORCs.

SORC	Superordinate themes	Subthemes
Behaviour	1. Personal experiences of sleep	
	2. Differences in sleep pattern	2.1. Difficulties in initiating sleep
		2.2. Difficulties maintaining sleep
		2.3. Sleep quality as independent of sleep duration
Antecedents	1. Factors preventing sleep/maintaining poor sleep	1.1. An increase in rumination and/or worry preventing sleep onset
		1.2. Physical aspects of the secure environment preventing sleep
		1.3 Exercising during the day prevents sleep onset
		1.4 Experiencing mental health symptoms at night preventing the onset of sleep
	2. Strategies used to facilitate sleep	2.1 Adopting cognitive strategies can help achieve sleep
		2.2. Substances used or avoided to facilitate sleep
		2.3. Reading and watching television to facilitate sleep at night-time.
Consequences of experiencing poor sleep	1. Poor sleep increased hostile perceptions of others	
	2. Poor sleep alters behaviour	
	3. Poor sleep increases symptoms of mental illness/personality disorder	
	4. Poor sleep can alter ensuing sleep patterns	
	5. Poor sleep increases negative affect	

independently organised by a second researcher and any discrepancies discussed until consensus was reached. The proportion of participants indicating each theme is noted in the following section. Table 1 provides an overview of the superordinate and subthemes.

3.1.2.1. Themes and subthemes. The SORC Behaviour component captured two emerging themes, *Personal experiences of poor sleep* and *Differences in sleep patterns*. The first comprises 29% of this component and was associated with examples such as, "I don't ever get a good sleep. Always feel on the cusp [edge of]. Always light sleep. The more I sleep the worse I am" (P13). "Still get 12 hours but quality [of sleep] is not good… getting to sleep is hard… The only time I've slept well is when taking a sleeping tablet" (P23).

The second theme (*Differences in sleep patterns*) comprises three themes; Difficulties initiating sleep (58%) such as, "Lying there and thinking of things - ruminating. Feel like wanting to get to sleep - can't switch off thoughts. I can't get to sleep at all". (P26); Difficulties maintaining sleep (58%) such as, "…waking up after falling asleep [a] couple of hours after sleep…wake up with nightmares – it's not easy to get back to sleep." (P2); and Sleep quality as independent of sleep duration (58%) such as, "Still 12 hours [of sleep] but quality is not good." (P23).

The SORC Antecedents component identified two themes, *Factors preventing sleep/maintaining poor sleep* and *Strategies used to facilitate sleep*. The first theme (*Factors preventing sleep/maintaining poor sleep*) comprised four subthemes; An increase in rumination and/or worry preventing sleep onset (74%), such as, "Brain wanted me to ponder that. Torturing itself" (P12); Physical aspects of the secure environment preventing sleep onset and maintenance (26%) including, Don't like the idea of being watched at night [referring to night time checks]… Shine torch directly on you or leaving blinds open – has actually woken me up in the past." (P12); Exercising during the day prevents sleep onset (29%) such as, "Football makes me not sleep as well – adrenaline wires me up." (P31); and Experiencing mental health symptoms at night preventing the onset of sleep (22%) such as, "Feel like I'm being punished – punished for evil voices…uncomfortable voices – disrupt sleep" (P10).

The second theme (*Strategies used to facilitate sleep*) comprised three subthemes; Adopting cognitive strategies can help achieve sleep (29%) such as, "Ambient noise CDs (rain, waves - want to get more). Used to calm down and focus. So useful to sleep." (P17)"; Substances used or avoided to facilitate sleep (58%) such as, "Take medication. Fall sleep really quickly… Medication - sleepy - Clozapine." (P10); "Drugs - choosing not to sleep so don't waste money -keep self awake….used drugs to forget." (P11); Reading and watching television to facilitate sleep at night-time (77%) including examples such as, "Try to read book - sleep comes better…. Read bible (P28); "Watch TV until about 12 and turn TV off [before sleeping], always."

The SORC Consequences of experiencing poor sleep were captured via five themes, *Poor sleep increases hostile perceptions of others, Poor sleep alters behaviour, Poor sleep increases symptoms of mental illness/personality disorder, Poor sleep can alter ensuing sleep patterns* and *Poor sleep increases negative affect*.

The first theme (*Poor sleep increases hostile perceptions of others*) comprised 16% of this component and included examples such as, "Don't want to be cooperative. Default - I'm a violent person…If someone says something I don't like [its] harder to rationalise" (P12) and "Ratty with people - snap at them. A lot more short with people – things that wouldn't effect me. (P23).

The second theme (*Poor sleep alters behaviour*) made up 61%, with examples including, "Thoughts- I shouldn't have woken up. Felt like missed part of the day. Don't want to face the world…. Put duvet over head if still tired so don't interact with others" (P5) and "Might not want to talk to anyone - feel less sociable" (P7).

The third theme (*Poor sleep increases symptoms of mental illness/personality disorder*) comprised 19%, with examples including, "Starving brain of sleep creates problems - harder to control symptoms. More aggressive, more irritable, more callous, more cold. Tolerance levels go down. More susceptible to own disorder. Harder to fight psychopathic disorder… If slept well - can control personality disorder symptoms" (P12) and "A bit depressed as always tired when first wake - don't like talking much" (P19).

The forth theme (*Poor sleep can alter ensuing sleep patterns*) comprised 61%, with examples including, "Sleep in afternoon as I'm tired. Oversleep to get back to normal sleep. Sometimes won't get up for meds - staying up all night the next few nights" (P11). The final theme (*Poor sleep increases negative affect*) (54%), included examples such as, "Feel miserable if not slept well" (P5) and "Annoyed - not having peaceful night's sleep" (P10).

3.2. Exploring the cognitive processes in the sleep-aggression relationship (Study 2)

To further understand the role of varied cognitions associated specifically with the sleep-aggression relationship and to provide a clinical basis for the intervention arm of this programme of research, this cross-sectional study investigates self-reported sleep and objective and subjective measures of aggression. It will also extend to cover attributions (e.g. hostile), as a result of what emerged in Study 1.

3.2.1. Method

3.2.1.1. Participants. Participants were recruited from the same high secure male forensic hospital as for Study 1. Forty-eight patients provided written consent to participate, six of which ultimately decided not to engage (two became unwell and four did not disclose a reason). Of the remaining 42 patients, 35 had a primary diagnosis of severe mental illness, and the remaining seven for personality disorder. Of the 35 patients with severe mental illness, 29 were diagnosed with schizophrenia, four with schizoaffective disorder, one with bipolar affective disorder with manic psychotic symptoms, and one with unspecified non-organic psychosis.

3.2.1.2. Materials. Data were collected using self-report questionnaires and patient records. This included capturing incidents of inward and outward aggression across the previous five years, with the latter including verbal and physical aggression. The following questionnaires were also considered:

Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds 3rd, Monk, Berman, & Kupfer, 1989), a 19-item measure to assess sleep quality and quantity over the past month. It has been widely used across a range of samples. It excluded the five items rated by a bedpartner or roommate, as the participants do not share bedrooms. The PSQI combined items to form seven component scores (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction), rated from 0 to 3. Example items include, 'how would you rate your sleep quality overall' and 'how often have you had trouble sleeping because you wake up in the middle of the night or early morning?' Component scores are combined to yield one global score to a maximum of 21 points, meaning more sleep difficulties.

Aggression Questionnaire (AQ; Buss & Perry, 1992), comprising 29 items to assess trait aggression, with each item relating to one of four subscales: physical aggression, verbal aggression, anger, and hostility. Example items include, 'I have become so mad that I have broken things' (physical), 'I can't help getting into arguments when people disagree with me' (verbal), 'I sometimes feel like a powder keg ready to explode' (anger), and 'when people are especially nice to me, I wonder what they want' (hostility). Participants were asked to rate each item on a five-point Likert scale, with higher scores indicating higher levels of trait aggression. One item was removed from the original 30 item scale as it did not apply to this population (i.e. it asked about frequent moves). The

AQ has been used extensively across populations, including forensic.

The Suicide Behaviour Questionnaire – Revised (SBQ-R, Osman et al., 2001). This comprises four items covering suicide ideation/attempt, frequency of ideation in the past 12 months, threat of a suicide attempt and likelihood of attempting suicide in the future. An example item is, 'how likely is it that you will attempt suicide someday?' Higher scores indicate increased suicide ideation. It is included in the current study due to the raised levels of self-injurious behaviour (inward aggression) in high secure psychiatric samples, and due to its consideration as self-directed aggression. The SBQ-R has also been developed in both clinical and non-clinical samples.

The Perseverative Thinking Questionnaire (PTQ; Zetsche et al., 2009), consisting of 15 items representing rumination and negative thinking (e.g. 'the same thoughts keep going through my mind again and again'). It has been developed for application across clinical and non-clinical samples. Participants are asked to rate the extent to which each item applies, when thinking about negative experiences or problems, on a five-point Likert scale. High scores equate to higher perseveration.

Dysfunctional Beliefs and Attitudes about Sleep (DBAS-16; Morin, Vallières, & Ivers, 2007), a 16-item questionnaire used widely across samples, including prisoners and psychiatric settings. It is used to assess sleep-related cognitions relating to consequences of insomnia, worrying about sleep, expectations of sleep, and sleep medication attribution. It included items such as, 'I am worried that I may lose control over my abilities to sleep'. Participants were asked to rate the extent to which they agreed with each statement on a ten point Likert scale, with higher scores indicating more dysfunctional sleep-related cognitions.

Making Judgements Questionnaire (MJQ from the Affective, Cognitive, and Lifestyle Questionnaire; Ireland & Ireland, 2012). The MJQ consists of ten hypothetical situations to assess attribution biases, developed for use with high secure forensic patients. It captures both positive and hostile attributions. Participants were presented with each scenario and asked to select one response from four possible options. Of the four responses available, one answer was hostile, one answer was prosocial, and two answers were illogical. A greater number of hostile responses indicate more hostile attributions.

Table 3
Means and frequencies of good and poor sleep (PSQI) and recorded aggressive incidents.

	Mean (SD)	Good sleep	Poor Sleep
		n (%)	n (%)
Pittsburgh Sleep Quality Index Global Score	7.2 (3.3)	9 (21.4)	33 (78.6)
Subjective Sleep Quality Score	1.1 (0.83)	31 (73.8)	11 (26.2)
Sleep Duration Score	1.7 (0.93)	17 (40.5)	25 (59.5)
Sleep Disturbances	1.3 (0.64)	28 (66.7)	14 (33.3)

	M (SD) of recorded incidents	Recorded incident n (%)	No recorded incident n (%)
Verbal aggression	18.36 (30.44)	32 (76.2)	10 (23.8)
Physical aggression towards objects	4.57 (9.88)	23 (54.8)	19 (45.2)
Physical aggression towards others	3.02 (4.47)	23 (54.8)	19 (45.2)
Self-harm	4.17 (8.62)	17 (40.5)	25 (59.5)

3.2.1.3. Procedure. Ethical approval was obtained from a UK NHS Ethics Committee (16/NW/0669) and the University of Central Lancashire Ethics Committee. The procedure was followed as for Study 1. Participants were restricted to those who could read and write in English as the measures were not validated for use with interpreters. The nature of the study was explained verbally and participants were provided with a written information sheet to aid their decision. This followed approval

Table 2
Descriptive statistics and Cronbach's α for all measures.

Measure	Variable	N	M	SD	Observed Ranged	Potential Range	A
Aggression Questionnaire	Total	42	61.36	19.77	31–99	29–145	0.95
	Verbal	42	11.79	4.65	5 – 25	5 – 25	0.84
	Physical	42	18.13	7.61	9 – 39	9 – 45	0.86
	Anger	42	15.13	5.11	7 – 27	7 – 35	0.77
	Hostility	42	16.90	6.20	8 – 31	8 – 40	0.81
Suicide Behaviour Questionnaire	Total	42	8.04	3.77	3 – 16	3 – 18	0.69
	Lifetime	42	3.03	1.25	1 – 4	1 – 4	–
	Frequency	42	2.00	1.28	1 – 5	1 – 5	–
	Threat	42	1.59	0.85	1 – 3	1 – 3	–
	Likelihood	42	1.50	1.92	0 – 6	0 – 6	–
Dysfunctional Beliefs and Attitudes about Sleep Scale	Total[1]	42	84.65	29.39	20–141	0 – 160	0.89
	Consequences	42	27.91	12.12	5 – 50	0 – 50	0.86
	Worry	42	30.19	12.44	10–55	0 – 60	0.79
	Expectation	42	14.05	4.92	2 – 20	0 – 20	0.80
	Medication	42	12.50	6.26	3 – 25	0 – 30	0.38
Making Judgements Questionnaire*	Hostile	41	3.83	2.29	0 – 9	0 – 10	–
	Prosocial[2]	41	5.68	2.20	1 – 10	0 – 10	–
Perseverative Thinking Questionnaire	Total	42	43.62	12.48	17–69	15–75	0.95
	Core	42	27.24	8.05	11–44	9 – 45	0.92
	Unproductive	42	8.12	2.65	3 – 13	3 – 15	0.77
	Mental Capacity	42	8.26	2.76	3 – 15	3 – 15	0.80
Pittsburgh Sleep Quality Index	Global	42	7.17	3.35	0 – 15	0 – 21	0.64
	Subjective Sleep Quality	42	1.12	0.83	0 – 3	0 – 3	–
	Sleep duration	42	1.74	0.94	0 – 3	0 – 3	–
	Night-time Disturbances	42	1.29	0.64	0 – 3	0 – 3	–

NB: [1]denotes a significant finding at p = .004; [2]denotes a significant finding at p = .03; *One participant did not complete the measure.

to approach by the Responsible Clinician.

3.2.2. Results

A Kolmogorov-Smirnov test of normality demonstrated that the DBAS was the only measure with a normal distribution ($D(42) = 0.097$, $p = .20$). Consequently, non-parametric analyses were performed. Scores across measures, including internal reliability, are indicated in Table 2.

3.2.2.1. Main variables. A cut-off score of five is applied to differentiate between good and poor sleepers (Buysse et al., 1989). Subjective sleep quality, sleep duration, and night-time sleep disturbances were dichotomised, with good and poor sleep being defined by a score of 0 or 1 (indicating good sleep) and 2 or 3 (indicating poor sleep). The means and frequencies of those reporting good and poor sleep on the PSQI are presented in Table 3. The frequencies of aggressive incidents – i.e., derived from patient records – are also indicated in Table 3.

3.2.2.2. Sleep and recorded incidents of aggression (outward and inward). The relationship between recorded incidents of aggression and sleep variables were explored using Spearman's rank-order correlations. Correlations were found between subjective sleep quality and recorded incidents of self-harm ($rs\ (42) = 0.36$, $p = .02$), indicating that individuals reporting better sleep quality reported more incidents of self-harm. No further correlations were found between recorded incidents of aggression and the sleep variables (all $rs \leq 0.23$).

3.2.2.3. Subjective sleep quality, cognition, and reported incidents of aggression. Mann Whitney *U* tests were performed with subjective sleep quality dichotomised as the independent variable and the PTQ as the dependent variable. This revealed no significant findings ($U = 61.00$ ns). Sleep related cognitions were also explored. Those with more sleep-related negative cognitions, as determined by the DBAS, were less likely to rate their sleep quality as good ($U = 71.500$, $p = .004$). To examine whether those with poor subjective sleep quality were more likely to perceive hostility in a situation than those with good sleep quality, a Mann Whitney *U* test was performed on the Moral Judgements Questionnaire; those with poor sleep quality were less likely than those with good sleep quality to make positive attributions in presented situations ($U = 85.00$, $p = .03$). There were no further significant differences.

3.2.2.4. Subjective sleep quality, sleep disturbance, trait aggression and self-reported suicidal behaviour. Bivariate Spearman's rank-order correlations between the four sleep variables (PSQI Global, subjective sleep quality, sleep duration, and sleep disturbances), the AQ and the SBQ-R were performed (see Table 4). Sleep disturbances were correlated with AQ total aggression, AQ physical aggression, SBQ-R total suicide, suicide frequency, and suicide threat. PSQI Global correlated with suicide frequency but did not correlate with any other aggression variable (all $r_s \leq 0.30$). There were no further significant correlations.

3.3. Exploring the cognitive processes in the sleep-aggression relationship: A feasibility trials for intervention (Study 3)

In order to explore a role for sleep and aggression further, this study will directly address cognitive factors, using a mindfulness intervention, in an attempt to increase sleep quality and reduce subsequent aggression in individuals with expected high levels of sleep problems and aggression. This was conducted in a setting where there was no intervention in place for sleep treatment other than medication.

3.3.1. Method

The study explored a mindfulness intervention intended to improve sleep in a high secure forensic psychiatric population. It compares a brief mindfulness intervention, aimed at overcoming the cognitive factors of sleep, with a sleep hygiene (education) intervention as a comparison, and treatment as usual control.

3.3.1.1. Participants. Detail on recruitment and the characteristics of patients is indicated in Table 5 across each feasibility trial arm. Forty-eight male patients were recruited from the same hospital. For those engaging, the most common primary diagnosis was paranoid schizophrenia (59.5%) or a personality disorder (16.7%).

3.3.1.2. Procedure. Ethical approval was obtained a UK NHS Ethics Committee (16/NW/0669) and the University of Central Lancashire Ethics Committee. The procedure for approaching participants is detailed earlier. The rate of attrition from baseline to four weeks post-intervention was 7.1%, from baseline to eight-week follow-up 14.3%, and from baseline to twelve-week follow-up 26.2%.

3.3.1.3. Intervention design. The study adopted a three-arm parallel feasibility trial to explore whether a mindfulness intervention could be successfully conducted with forensic psychiatric patients. Participants were randomly assigned to mindfulness, sleep education, or treatment as usual (control) in a 1:1:1 ratio. Randomisation was conducted using Excel to generate a random sequence order for the interventions. In relation to each arm:

Mindfulness: Mindfulness is a way of training the mind to focus on the here and now, rather than being distracted by thoughts (Williams & Penman, 2011). Each participant was provided with three mindfulness sessions, which included practicing the mindfulness of sounds, of an object and of the soles of the feet, along with a refresher to check core learning and answer any clarifying questions. Sessions also captured information on the usefulness of practicing mindfulness on their

Table 4
Correlations between sleep variables and trait aggression variables.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. AQ Total	–												
2. AQ Verbal	0.86**												
3. AQ Physical	0.86**	0.73**											
4. AQ Anger	0.92**	0.74**	0.79**										
5. AQ Hostility	0.90**	0.70**	0.62**	0.77**									
6. SBQ Total	0.48**	0.60**	0.48**	0.41**	0.35*								
7. SBQ Lifetime	0.23	0.34*	0.34*	0.21	0.07	0.70**							
8. SBQ Frequency	0.38*	0.40**	0.33*	0.32*	0.31*	0.71**	0.32*						
9. SBQ Threat	0.18	0.15	0.22	0.21	0.20	0.38*	0.24	0.24					
10. SBQ Likelihood	0.46*	0.58**	0.46**	0.40	0.33*	0.80**	0.41**	0.45**	0.05				
11. PSQI Global	0.03	0.01	0.07	0.05	0.06	0.30	0.09	0.42**	0.09	0.20			
12. PSQI Quality	0.15	0.13	0.06	0.14	0.22	0.25	0.09	0.30	−0.15	0.18	0.68**		
13. PSQI Duration	−0.13	−0.13	−0.14	−0.17	0.01	0.17	0.06	0.24	0.18	−0.03	0.73**	0.42**	
14. PSQI Sleep disturbance	0.31*	0.16	0.34*	0.29	0.28	0.33*	0.16	0.38*	0.08	0.34*	0.17	0.06	0.02

* $p < .05$; ** $p < .01$; AQ = Aggression Questionnaire; SBQ = Suicide Behaviour Questionnaire; PSQI = Pittsburgh Sleep Quality Index.

Table 5
Participant characteristics across sample.

Primary Diagnosis	Total		Mindfulness		Sleep Education		Treatment as Usual	
	n (%)		n (%)		n (%)		n (%)	
Paranoid schizophrenia	25 (59.5)		11 (68.8)		7	(46.7)	7	(63.6)
Dissocial personality disorder	3	(7.1)	0		1	(6.6)	2	(18.2)
Emotionally unstable personality disorder	2	(4.8)	1	(6.3)	1	(6.6)	0	
Schizoaffective disorder (manic type)	2	(4.8)	0		2	(13.3)	0	
Schizophrenia (unspecified)	2	(4.8)	2	(12.5)	0		0	
Schizoaffective disorder	2	(4.8)	0		1	(6.6)	1	(9.1)
Bipolar affect disorder current episode with manic psychotic symptoms	1	(2.4)	0		1	(6.6)	0	
Hebephrenic schizophrenia	1	(2.4)	1	(6.3)	0		0	
Personality disorder (unspecified)	1	(2.4)	1	(6.3)	0		0	
Schizoid personality disorder	1	(2.4)	0		0		1	(9.1)
Undifferentiated schizophrenia	1(2.4)		0		1	(6.6)	0	
Unspecific nonorganic psychosis	1	(2.4)	0		1	(6.6)	0	

thoughts. The first two sessions lasted approximately 45 min and the refresher session, approximately 15 min.

Sleep Education: Participants attended three sleep education sessions, which covered factors that could be helping and/or hindering their sleep, including the environment and unhelpful lifestyle choices. It also included a refresher of knowledge. The first two sessions lasted approximately 45 min and the refresher/knowledge-check session, approximately 15 min. It was included as an additional comparison for the potential effects of Mindfulness.

Treatment as usual: Those in the treatment as usual condition were not required to attend any sessions. However, to avoid withholding potentially valuable treatment for sleep, those assigned to this condition were offered the most effective treatment following completion of the research phase. None ultimately took up this offer.

All measures (see later section) were completed at four time points: one week before the intervention (baseline), one week after the final session of the intervention/four weeks after baseline (post), eight weeks after baseline (follow up 1), and twelve weeks after baseline (follow up 2).

3.3.1.4. Intervention measurement. Self-report measures, identical to those outlined in Study 2, were completed. For these, baseline measures were taken from Study 2 and participants recompleted them at the follow up time points (four, eight and 12 weeks). In addition, the following were considered at all points:

Hostile Expectation Bias (Rule, Taylor, & Dobbs, 1987), with two hypothetical scenarios from this measure used to assess hostile expectation bias (i.e. the tendency to assume that others will react to potential conflicts with aggression). Participants were asked to freely answer what they expected to happen after being given two scenarios. In the current study, responses were then coded as hostile, prosocial or illogical. The measure has been widely applied in aggression research.

Essen Climate Evaluation Schema (EssenCES; Schalast, Redies, Collins, Stacey, & Howells, 2008), which was developed for and is used to assesses patient perceptions of the social atmosphere of their ward. It is a 17 item measure, addressing three components; patient cohesion and mutual support (i.e. 'the patients care for each other'), therapeutic hold (i.e. 'on this ward, patients can openly talk to staff about all their problems'), and patient perceptions of safety (i.e. 'Some patients are so excitable that one deals very cautiously with them'). For the current study, the overall α =0.71. This measure was employed to capture intervention impacts more broadly.

Social Problem-Solving Inventory –Revised: Short (SPSI-R:S; D'Zurilla & Nezu, 1990). This assesses strengths and weakness in social problem solving, which is linked to social cognition. It comprises 25 items associated with five subscales: positive problem orientation (PPO), negative problem orientation (NPO), rational problem solving (RPS), impulsivity/carelessness style (ICS), and avoidance style (AS). These scores are combined to yield a global score, with higher scores indicating poorer social problem-solving ability. The overall Cronbach's α =0.73. This measure has been applied across a wide range of populations, clinical and non-clinical, and is sensitive to clinical change.

Mindfulness Attention Awareness Scale (MAAS; Brown & Ryan, 2003). This 15-item measure is designed to assess dispositional mindfulness (i.e. the core characteristic of being attentive and aware), and to assess the specific Mindfulness arm of the intervention. Participants are asked to respond to the frequency in which they experience each item on a six-point Likert scale. An example item is "I break or spill things because of carelessness, not paying attention, or thinking of something else". Lower scores on this measure indicate higher levels of trait mindfulness. The overall Cronbach's α = 0.85.

3.3.2. Results

3.3.2.1. Treatment effectiveness. The original sample of patients that consented to participating in the study was 48 (out of 102 who were approached following Responsible Clinician consent), with 16 allocated to each condition. Due to attrition there was a final sample of 31 participants at the 12 week follow up (10 Mindfulness, 31%; 14 Sleep Education, 45%; seven Treatment as Usual, 23%). Table 6 provides detail on numbers at each data point.

Baseline differences between intervention allocations

Using Kruskal-Wallis H analysis of variance, significant differences were found between groups for total aggression (X^2 (2) = 0.93, p = .014), hostile (X^2 (2) =6.96, p = .031) and prosocial (X^2 (2) = 8.99, p = .011) of the Hostile Expectation Bias Questionnaire (Rule et al., 1987); Specifically, Mann Whitney *U* tests found that those in the Mindfulness condition reported significantly lower levels of trait aggression than those in Sleep Education (U = 44.5, p = .013) and Treatment as Usual (U = 28.0, p = .011). Hostile responses were significantly lower (U = 31.5, p = .011) and prosocial responses were significantly higher (U = 22.0, p = .002) in those assigned to the Treatment as Usual condition compared to those assigned to Sleep Education. There were no further significant differences found.

Differences in scores to each time point

Group differences for each variable are presented at each time point (see Table 6), which also provides participant numbers for each measurement point.

Differences in scores from baseline to four weeks post-intervention

Wilcoxon Signed-Rank Tests were performed to explore the differences between baseline to post-intervention score. Those assigned to the Mindfulness intervention had significantly lower PSQI scores following the intervention than at baseline [z = −2.167, p = .03, r = 0.42], and thus had less sleep difficulties. Participants in the Sleep Education

Table 6
Reported outcomes for baseline, post, and follow up measures.

Measure	Baseline			Post			Difference		r	Follow up (8 weeks)			Difference		r	Follow up (12 weeks)			Difference	r
	n	M (SD)		n	M (SD)		M (SDpooled)			n	M (SD)		M (SDpooled)			n	M (SD)		M (SDpooled)	
Aggression Questionnaire																				
MD	15	48.77	(13.50)	12	46.69	(13.66)	2.08	(−0.16)	0.31	11	41.62	(15.16)	7.15	(7.17)*	0.44	10	44.73	(12.49)	4.04 (5.17)	0.22
SED	15	67.68	(23.16)	15	63.39	(17.84)	4.28	(5.33)	0.18	14	64.07(25.24)		3.61	(12.10)	0.03	14	65.86	(23.99)	1.82 (8.82)	0.01
TAU	12	70.00	(20.04)	11	64.73	(19.87)	5.27	(0.17)	0.35	10	63.45	(24.41)	6.55	(11.11)	0.29	7	66.50	(24.24)	3.50 (7.79)	0.12
Suicide Behaviour Questionnaire																				
MD	15	7.08 (3.57)		12	6.85 (3.26)		0.23 (0.31)		0.26	11	7.42 (3.32)		−0.34 (1.72)		0.00	10	7.64 (2.80)		−0.56 (1.32)	0.14
SED	15	8.60 (3.81)		15	8.00 (3.64)		0.60 (0.17)		0.11	14	7.36 (3.05)		1.24	(1.72)	0.08	14	7.43 (3.13)		1.17 (1.38)	0.05
TAU	12	8.68 (4.65)		11	10.36	(5.28)	−1.69 (−0.63)		0.40	10	8.40 (5.50)		0.28	(2.54)	0.04	7	7.00 (4.56)		1.68 (1.80)	0.15
Dysfunctional Beliefs and Attitudes about Sleep																				
MD	15	86.72	(31.98)	12	78.08	(28.91)	8.64	(3.07)**	0.58	11	75.08	(29.44)	11.6 (15.4)***		0.65	10	74.00	(28.39)	12.7 (11.8)**	0.57
SED	15	79.47	(28.55)	15	71.57	(28.08)	7.90	(0.46)	0.56	14	69.14	(27.78)	10.32 (14.08)		0.23	14	66.29	(29.90)	13.18 (10.66)	0.31
TAU	12	81.62	(27.40)	11	80.35	(27.50)	1.26	(−0.10)	0.09	10	79.90	(22.78)	1.72	(12.55)	0.12	7	68.67	(21.82)	12.95 (9.99)	0.15
Essen Climate Evaluation Scale																				
MD	15	31.69	(5.48)	12	40.92	(11.35)	−9.23 (−5.9)**		0.52	11	32.66	(5.76)	−0.97 (2.81)		0.38	10	32.50	(5.72)	−0.81 (2.07)*	0.52
SED	15	27.53	(6.75)	15	33.71	(6.23)	−6.18 (0.52)**		0.49	14	28.86	(6.14)	−1.33 (3.22)		0.16	14	29.86	(4.77)	−2.33 (2.49)	0.24
TAU	12	29.73	(7.73)	11	31.45	(12.05)	−1.73 (−4.32)		0.09	10	27.60	(5.06)	2.13	(3.20)	0.09	7	27.33	(6.41)	2.39 (2.73)	0.09
Making Judgements Questionnaire (Hostile Responses)																				
MD	15	3.31 (2.02)		12	3.69 (2.50)		−0.38 (−0.48)		0.17	11	3.17 (2.08)		0.14 (1.02)		0.03	10	3.36 (2.29)		−0.06 (0.76)	0.18
SED	15	4.47 (1.92)		14	3.40 (2.03)		1.07	(−0.11)	0.32	14	3.86 (1.79)		0.61 (0.93)		0.25	14	4.00 (2.04)		0.47 (0.71)	0.15
TAU	12	3.55 (3.11)		11	3.00 (2.79)		0.55 (0.32)		0.32	10	2.90 (2.60)		0.65 (1.43)		0.30	7	2.67 (2.66)		0.88 (1.13)	0.21

Measure	Baseline			Post			Difference		r	Follow up (8 weeks)			Difference		r	Follow up (12 weeks)			Difference	R
	n	M (SD)		n	M (SD)		M (SDpooled)			n	M (SD)		M (SDpooled)			n	M (SD)		M (SDpooled)	
Making Judgements Questionnaire (Prosocial Responses)																				
MD	15	6.15	(1.63)	12	5.77	(2.20)	0.38 (−0.58)		0.17	11	6.67	(2.02)	−0.51 (0.91)		0.23	10	6.45	(2.21)	−0.30 (0.63)	0.15
SED	15	4.87	(1.85)	14	5.07	(2.66)	−0.20 (−0.81)		0.06	14	5.79	(1.97)	−0.92 (0.95)		0.24	14	5.64	(2.13)	−0.78 (0.70)	0.19
TAU	12	6.18	(3.09)	11	6.73	(2.83)	−0.55 (0.26)		0.32	10	6.70	(2.95)	−0.52 (1.51)		0.21	7	7.00	(3.35)	−0.82 (1.15)	0.05
Hostile Expectation Bias (Hostile Responses)																				
MD	15	1.08	(0.95)	12	0.69 (0.75)		0.38 (−0.58)		0.25	11	0.58	(0.67)	0.49 (0.41)		0.30	10	0.60 (0.70)		0.48 (0.34)	0.32
SED	15	1.00	(0.39)	15	1.00 (0.39)		−0.20 (−0.81)		0.48	14	0.79	(0.58)	0.21 (0.24)		0.21	14	0.50 (0.52)		0.50 (0.16)*	0.40
TAU	12	0.36	(0.50)	11	0.55	(0.52)	−0.18 (−0.02)		0.21	0.20	0.20	(0.42)	0.16 (0.23)		0.30	7	0.17 (0.41)		0.20 (0.18)	0.41
Hostile Expectation Bias (Prosocial Responses)																				
MD	15	0.92	(0.95)	12	1.31	(0.75)	−0.38 (20)		0.25	11	1.33	(0.78)	−0.41 (0.43)		0.25	10	1.20	(0.63)	−0.28 (0.35)	0.18
SED	15	0.79	(0.43)	15	1.46	(0.52)	−0.68 (−0.09)		0.48	14	1.14	(0.53)	−0.36 (0.24)		0.27	14	1.43	(0.51)	−0.64 (0.17)*	0.44
TAU	12	1.64	(0.50)	11	1.27	(0.65)	0.36 (−0.14)		0.30	10	1.80	(0.42)	−0.16 (0.23)		0.30	7	1.83	(0.41)	−0.20 (0.18)	0.41

Measure	Baseline			Post			Difference		r	Follow up (8 weeks)			Difference		r	Follow up (12 weeks)			Difference	R
	n	M (SD)		n	M (SD)		M (SDpooled)			n	M (SD)		M (SDpooled)			n	M (SD)		M (SDpooled)	
Mindfulness Attention and Awareness Scale																				
MD	15	54.46	(14.78)	12	55.77	(15.51)	−1.31 (−0.73)		0.04	11	57.67	(15.12)	−3.21 (7.47)		0.14	10	58.82	(14.90)	−4.36 (5.56)	0.32
SED	15	48.57	(9.94)	15	53.93	(12.98)	−5.36 (−3.04)		0.18	14	55.50	(13.61)	−6.93 (5.89)		0.19	14	56.71	(13.58)	−8.14 (3.96)	0.27
TAU	12	54.69	(10.81)	11	52.93	(11.81)	1.77 (−0.99)		0.38	10	53.20	(12.76)	1.49 (5.89)		0.22	7	55.50	(14.73)	−0.81 (4.18)	0.43

(*continued on next page*)

Table 6 (*continued*)

Measure	Baseline		Post		Difference	r	Follow up (8 weeks)		Difference	r	Follow up (12 weeks)		Difference	R
	n	M (SD)	n	M (SD)	M (SDpooled)		n	M (SD)	M (SDpooled)		n	M (SD)	M (SDpooled)	
Perseverative Thinking Questionnaire														
MD	15	37.77 (11.31)	12	33.46 (10.60)	4.31 (0.71)	0.31	11	33.67 (12.72)	4.10 (6.01)	0.18	10	32.30 (14.28)	5.47 (4.33)	0.16
SED	15	47.47 (11.92)	15	45.50 (12.38)	1.97 (−0.46)	31	14	44.71 (12.70)	2.75 (6.15)	0.27	14	42.86 (12.95)	4.61 (4.52)*	0.40
TAU	12	43.73 (13.26)	11	41.36 (10.14)	2.37 (3.12)	0.40	0.20	40.90 (10.32)	2.83 (5.90)	0.17	7	40.67 (12.11)	3.06 (4.79)	0.08
Pittsburgh Sleep Quality Index														
MD	15	8.00 (3.58)	12	6.69 (3.86)	1.31 (−0.28)*	0.42	11	6.33 (3.60)	1.67 (1.80)*	0.52	10	7.09 (4.41)	0.91 (1.34)	0.38
SED	15	7.00 (2.90)	15	5.19 (2.98)	1.80 (−0.08)**	0.49	14	6.14 (2.82)	0.85 (1.43)	0.33	14	5.36 (2.50)	1.64 (1.08)**	0.52
TAU	12	6.73 (4.24)	11	8.27 (4.94)	−1.55 (−0.70)	0.22	10	6.00 (2.36)	0.73 (1.65)	0.06	7	6.83 (4.02)	−0.11 (1.47)	0.18
Social Problem- Solving Inventory - Revised: Short form														
MD	15	12.23 (2.29)	12	11.47 (2.86)	0.76 (−0.57)	0.12	11	11.70 (2.72)	0.53 (1.25)	0.01	10	12.10 (3.26)	0.13 (0.89)	0.03
SED	15	10.57 (3.62)	14	10.39 (2.86)	0.18 (0.76)	0.01	14	10.13 (2.55)	0.44 (1.54)	0.34	14	9.59 (2.48)	0.98 (1.29)*	0.40
TAU	12	12.94 (2.64)	11	12.64 (2.88)	0.30 (−0.24)	0.24	10	11.96 (2.95)	0.98 (1.40)	0.10	7	12.27 (2.24)	0.67 (1.01)	0.00

NB: MD – Mindfulness; SED = Sleep Education; TAU = Treatment as Usual; *p < .05; **p < .001; ***p < .002.

condition also showed significant improvements in this regard [z = −2.613, p = .009, r = 0.49]. There were no significant improvements from baseline to post- intervention scores for those assigned to the Treatment as Usual condition. Significant differences on the DBAS were only found for those assigned to the Mindfulness intervention, meaning that dysfunctional sleep-related cognitions decreased [z = −2.936, p = .003, r = 0.58]. Significant differences on the EssenCES were found in those assigned to the Mindfulness condition [z = −2.63, p = .009, r = 0.52] and those assigned to Sleep Education [z = −2.609, p = .009, r = 0.49], where improvements in ward atmosphere were noted. No further significant differences were found from baseline to post-intervention.

Differences in scores from baseline to eight week follow up

The only significant differences found at the eight week follow up phase were for those assigned to Mindfulness; scores on the PSQI significantly increased at eight week follow up [z = −2.422, p = .02, r = 0.52], indicating more sleep difficulties. AQ (trait aggression) scores significantly decreased [z = −2.041, p = .04, r = 0.44], however, indicating lower aggression. Scores on the DBAS also showed a significant decrease [z = 3.066, p = .002, r = 0.65], and thus again there was a decrease in dysfunctional sleep-related conditions. No further significant differences were found.

Differences in scores from baseline to twelve week follow up

Significant differences at twelve week follow up were only found with those assigned to either Mindfulness or Sleep Education. However, only those assigned to Sleep Education showed improvements, namely less sleep difficulties, on the PSQI [z = −2.772, p = .006, r = 0.52]. Participants in the Sleep Education intervention also showed significant differences from baseline to twelve week follow up in both hostile [z = −2.121, p = .03, r = 0.40] and prosocial [z = −2.333, p = .02, r = 0.44] responses to the Hostile Expectancy Bias questionnaire, with fewer hostile responses and more prosocial responses. Those assigned to Sleep Education also showed significant improvements in scores on the PTQ [z = −2.135, p = .03, r = 0.40] and SPSI-R:S [z = −2.333, p = .02, r = 0.40], namely less perseveration (PTQ) and improved problem-solving (SPSI-R:S). Individuals assigned to the Mindfulness intervention showed significant improvements on the dysfunctional sleep-related cognitions on the DBAS [z = 2.536, p = .01, r = 0.57] and on their perception of the ward environment, as assessed via the EssenCES [z = −2.316, p = .02, r = 0.52]. There were no further significant differences, although these results must be interpreted with caution due to the underpowered sample.

4. Discussion

The research considered the contribution of cognition to the relationship between sleep and aggression, demonstrating diversity in the cognition impacting on this relationship. Perceptions of sleep quality, dysfunctional beliefs, (hostile/prosocial) evaluations of others and the environment, all had relevance. However, their contribution appears complex, associating with different types of aggression and sleep problems. Regardless, the diversity in cognition and the *perception* of sleep quality ultimately appeared key in the sleep-aggression relationship in a complex forensic population.

The first study provided confirmation that cognition was an important variable in understanding sleep disturbance in a population deemed at high risk for aggression towards self and/or others, that it had considerable diversity in its nature, and that poor sleep impacted on behaviour and increased hostile perceptions of others. This allowed for a more detailed examination of the sleep-aggression relationship in a cross-sectional study (Study 2) of forensic psychiatric patients detained in high security, where there was a direct examination of self-reported sleep - of the cognitive themes that emerged from Study 1 - and objective and subjective aggression.

Findings from Study 2 found a high prevalence of sleep disturbances, with the majority of participants experiencing sleep problems. Such findings were consistent with previous research with individuals in

forensic settings, reporting poor sleep quality (Kamphuis et al., 2014). The link between sleep and objective incidents of aggression was also interesting. Those defined as poor sleepers (using PSQI cut-off scores) were not more likely than good sleepers to have been involved in an incident of aggression (objective), which did not support the prediction and contrasts with previous literature (Kamphuis et al., 2014). Yet, when participants were separated by their subjective sleep quality (i.e. whether they rated their sleep quality as good or poor), those with poor sleep quality were *less* likely to be involved in an incident of self-harm than those with good sleep. This was contrary to the prediction that poor sleep quality would be associated with increased inward aggression and did not support findings indicated with other populations (Liu et al., 2017; Wong et al., 2011).

However, Study 2 revealed relationships between sleep and aggression that were more consistent with the literature when considering *subjective* (self-reported) aggression. Higher PSQI scores were associated with higher levels of suicidal thoughts, within the past year. Such findings appear unsurprising considering a substantial body of literature suggests sleep difficulties are associated with suicide ideation (Littlewood, Kyle, Pratt, Peters, & Gooding, 2017). The current research now notes that this also translates to a high secure psychiatric population. Sleep difficulties were also associated with higher levels of overall trait aggression and trait physical aggression, which was consistent with the prediction and prior research (Barker et al., 2016; Kamphuis et al., 2014). In addition, there was clearly a role for dysfunctional beliefs in the perception of poor sleep quality; those with more sleep-related negative cognitions were less likely to rate their sleep quality as good.

Study 2 also noted the importance of positive attributions being associated with perceptions of good quality sleep, with this identified as a cognitive variable; those in the current study with good subjective sleep quality were more likely to make prosocial (and not hostile) attributions in ambiguous situations than those with poor sleep quality, supporting previous research (Barker et al., 2016). It illustrates further a role for sleep perceptions, and in this instance how perceptions of good sleep may actually be protective against aggression cognitions. This further supported a role for cognition, as predicted, which was further explored, and confirmed, in the final study.

Indeed, the feasibility trial for intervention (Study 3), indicated that dysfunctional beliefs concerning sleep could demonstrate improvements when sleep quality improved, but only in those assigned to the Mindfulness condition. This may indicate that Mindfulness may be able to overcome dysfunctional cognitions to improve sleep whereas an intervention that does not tackle cognitions (i.e. Sleep Education) does not. Both the Mindfulness-based intervention and the Sleep Education intervention were able to improve sleep, although due to the small sample sizes, it is difficult to determine whether the Mindfulness Intervention showed improvements above and beyond the Sleep Education intervention. However, what is key to note is that those assigned to Treatment as Usual did not demonstrate significant improvements to their sleep. These findings are interesting as they suggest that both cognitive and behavioural strategies alone are sufficient to improve subjective sleep quality in participants.

Interestingly, only Mindfulness showed some improvements in trait aggression (outward). Mindfulness was used to target potential maladaptive cognitions experienced by participants. It could be that it was able to impact participant's affect and/or ability to inhibit their impulses for aggression in ways that Sleep Education could not. The literature certainly highlights the importance of affect and self-control on aggression (Finkenauer, Engels, & Baumeister, 2005; Situ, Li, & Dou, 2016). Recent literature also suggests that Mindfulness can increase self-control by increasing the likelihood that individuals will acknowledge their own thoughts and feelings, in a given situation (Elkins-Brown, Teper, & Inzlicht, 2017). All of this points to the importance of cognition in this process. However, it is also noted that improvements in trait aggression were only seen at the eight-week follow-up, suggesting that the Mindfulness intervention was not able to *sustain* the improvements, which suggests other factors are likely of value to consider (such as ongoing adherence to/use of mindfulness by participants). It could also represent an artefact of the population under study and the implications in terms of mental health and/or personality presentation. This could represent a direction for future research to consider. It also suggests that any altered cognitions are likely therefore to be dynamic and arguably subject to change.

In addition to dysfunctional beliefs about sleep and evaluations of the ward environment, repetitive negative thinking also appears key, which consolidated the findings of the earlier studies. Indeed, interviews with forensic psychiatric patients (Study 1) revealed that the content of worry and rumination was diverse. It ranged from rumination about obtaining sufficient sleep to ruminating about their offence and their family. The content of such repetitive negative thinking could be relevant to a range of affective states (e.g. anger, depressive, anxiety), which was not specifically explored in the current research. It was nevertheless clear, from the interviews, that negative affect was particularly relevant in the sleep-aggression relationship. However, it remains unclear which dynamic affective states are salient in influencing this relationship. This was not examined in the later studies and thus may be an important future consideration for research, since affect is clearly important in understanding rumination (Anderson & Bushman, 2002). The fact that negative affect may moderate the contribution of rumination to the sleep-aggression relationship is a likely valuable consideration. In addition, future research may also benefit from assessing problems in the cognitive processing of negative affect (i.e. alexithymia), as studies have found such problems linked to maladaptive forms of rumination, sleep difficulties, and aggression independently (e.g. Di Schiena, Luminet, & Philippot, 2011; Murphy, Wulff, Catmur, & Bird, 2018; Velotti et al., 2016).

Accounting for the cross-sectional study (Study 2), there is support for findings that sleep difficulties may lead to aggression by reducing the likelihood of accessing prosocial scripts (for adult male forensic patients), when in potentially aggressive situations. This is also consistent with the findings of Barker et al. (2016). The results from the cross-sectional study indicated that subjective sleep quality rated as good was associated with an increase in recorded incidents of self-harm, which was contrary to expectations and perhaps highlights this as another area for further research. However, the findings also revealed that those with good subjective sleep quality were more likely to make positive attributions to ambiguous situations. It is therefore suggested that having a *Positive Sleep Attribution Bias* may increase positive attribution biases, which could potentially be protective for outward aggression. Fewer positive attributions and increased hostile attributions are typical in aggressive individuals (Anderson & Bushman, 2002), yet hostile responses were not associated with the sleep-aggression relationship. Given that many of the participants reported good subjective sleep quality, it is speculated that this made prosocial attributions more accessible, highlighting the potential for this *Positive Sleep Attribution Bias* to reduce aggression. This is currently speculative and should be explored in future research.

In trying to understand further the contribution of cognition on the sleep-aggression relationship, negative appraisals presented as a recurrent theme. This may also be relevant to the perceptions of the environment and of threats. For example, findings from the qualitative interviews, noted a reported change in patient behaviour. They reported becoming more aggressive, but more avoiding of others. This warranted further exploration into how they evaluated their current environment. The inclusion of the Essen Climate Evaluation Schema in Study 3 revealed that both improvements *and* recoveries in positively evaluating the ward environment were evident in those assigned to either sleep intervention. This suggests that following an improvement in both sleep indicators and subjective sleep quality, participants were more likely to positively view their current social environment. Perceptions of the social environment are key components driving aggression (e.g. Anderson & Bushman, 2002), with the current study extending their

relevance to the sleep literature. Equally, as noted, hostility has been presented as a key factor in understanding aggression. Previous literature has repeatedly highlighted the potential role of hostility in the sleep-aggression relationship but the findings here did not support this. Importantly, the measures of hostility required participants to respond to hypothetical scenarios and may not necessarily represent how they would react in a true situation, but how they believe others would react. This would indicate that those with aggressive tendencies, such as those in the current research, are aware of non-aggressive outcomes but may not necessarily apply these themselves.

4.1. Proposing a preliminary conceptual model

Overall, the research has highlighted the importance of cognition in the sleep-aggression relationship. Its distinct contribution is perhaps in noting the diversity of cognition that is relevant. Such cognitions include rumination, worry and hopelessness, and dysfunctional beliefs about sleep. The findings appear to highlight evidence for a potential *Sleep Attribution Bias* and how positively attributing good sleep may be protective for aggression. The role of repetitive negative thinking is further key in understanding how sleep problems are maintained but further research is needed to identify the appropriate techniques required for improved sleep. Findings additionally indicated that positive sleep attributions might help to increase access to prosocial attributions that, in turn, may lead to more positive views of the environment, reducing aggression.

Collectively the results can be applied to propose a preliminary conceptual model – the *Cognitive Sleep Model for Aggression and Self Harm* (CoSMASH). This outlines a possible conceptual understanding of the role of cognition in the sleep-aggression relationship that incorporates the core findings (see Fig. 1). The causal mechanisms by which each component is ultimately linked remains unclear but directions are indicated as a means of suggesting areas for future research to focus on and confirm and/or disconfirm.

This CoSMASH is further influenced by insomnia models, such as the CMI (Harvey, 2002). However, the latter fails to capture the diversity in sleep or the range of potentially relevant cognitions, which the current research has demonstrated. Independently, insomnia models highlight dysfunctional cognitions, the role of rumination, and misperceptions of sleep but do not consider a multifaceted approach to cognition. Consequently, treatment recommendations for sleep difficulties arguably do not target all relevant cognitions. This could explain why some individuals appear treatment resistant: the cognitive factors relevant to their sleep disruption are simply not being targeted. This would further explain why Mindfulness and Sleep Education appeared to improve some cognitive factors (such as evaluations of the ward environment and dysfunctional beliefs about sleep), but not others (e.g. repetitive negative thinking). The proposed CoSMASH attempts to offer a preliminary conceptualisation of how experiencing poor sleep can lead to both inward and outward aggressive thoughts, acknowledging the contribution of a range of cognition types. The model attempts to explain how cognitive errors, or unhelpful cognitive patterns, in evaluating personal sleep can contribute to an increase in aggression via two sleep pathways: 'experienced problems sleeping' and 'having a negative Sleep Attribution Bias'. It also aims to highlight a potential protective pathway, whereby intervening using cognitive strategies to reduce repetitive negative thoughts serve to increase prosocial scripts and schemas and positive views of the environment, thereby decreasing aggression.

4.2. Limitations

The current research only included male forensic psychiatric patients, limiting generalisability. A failure to account for women should be acknowledged since, arguably, women are more likely than males to experience sleep disturbances (Mallampalli & Carter, 2014). However, the hospital where the study took place houses only men, with high secure psychiatric women a very unique and limited population in the UK. There were also restrictions placed via ethical approvals on the nature and extent of demographic information that could be acquired. This is a result of the nature of the population and need to maintain security of patient information. The samples in the current studies were also small to moderate in size, imposing the need for non-parametric analyses, in some cases. There would be clear advantages with a larger sample, where a mediation analysis to understand the salient cognitive variables in the sleep-aggression relationship to determine their direct and/or indirect influence could be considered. This could

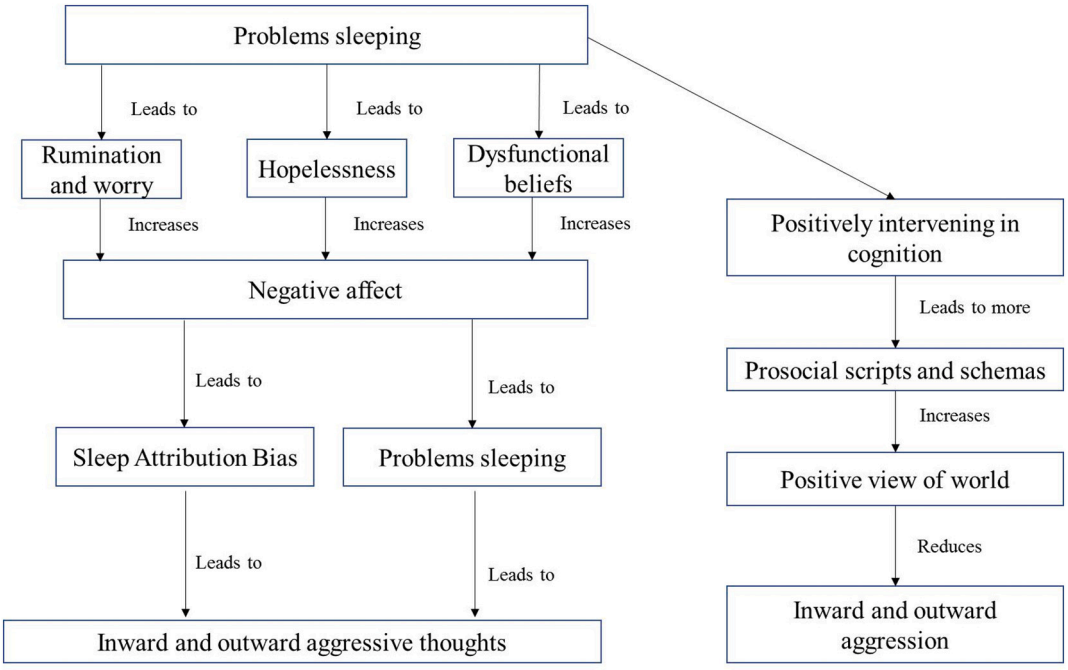

Fig. 1. The Cognitive Sleep Model for Aggression and Self Harm (CoSMASH): A preliminary conceptual model.

represent an aim for future research. In relation to sleep, whilst each study explored the sleep quality of patients either qualitatively or quantitatively, there was no attempt to measure sleep objectively. Given that the current research highlights the importance of sleep *perception*, without a thorough investigation of the actual sleep experienced, it is difficult to determine whether the *indicators* of sleep are merely a perception. On a final note, we could also have considered using a measure of response style to ascertain to what extent the presented findings were affected by a reporting style/bias.

4.3. Conclusion

The current findings provided some insight into the complex and multifaceted role of cognition in the sleep-aggression relationship. In doing so, it has proposed a preliminary conceptual model for understanding more fully the link between cognition, sleep, and aggression in a complex forensic population, which captures the diversity of cognition, pathways through sleep to aggression and protective factors (e.g. such as a Positive Sleep Attribution Bias). Clearly this is only a conceptual model, but there is scope to apply it as a framework for forthcoming research. This should be focused on testing this model and determining replication of findings. For example, whilst an attempt has been made in the CoSMASH to incorporate specific cognitions and describe their contribution, there are elements where cognition appears key but the current research is unable to capture the full contribution or the causal element. What the research has established is that cognition extends further than decreased cognitive ability following sleep disruption. The findings clearly demonstrate the variation in the cognitive contribution to the sleep-aggression relationship and the value in exploring these issues in detail with forensic populations.

Declaration of Competing Interest

The authors declare no competing interests for this paper.

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