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Female impulsive aggression: A sleep research perspective

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ABSTRACT

The rate of violent crimes among girls and women appears to be increasing. One in every five female prisoners has been reported to have antisocial personality disorder. However, it has been quite unclear whether the impulsive, aggressive behaviour among women is affected by the same biological mechanisms as among men. Psychiatric sleep research has attempted to identify diagnostically sensitive and specific sleep patterns associated with particular disorders. Most psychiatric disorders are typically characterized by a severe sleep disturbance associated with decreased amounts of slow wave sleep (SWS), the physiologically significant, refreshing part of sleep. Among men with antisocial behaviour with severe aggression, on the contrary, increased SWS has been reported, reflecting either specific brain pathology or a delay in the normal development of human sleep patterns. In our preliminary study among medication-free, detoxified female homicidal offenders with antisocial personality disorder, the same profound abnormality in sleep architecture was found. From the perspective of sleep research, the biological correlates of severe impulsive aggression seem to share similar features in both sexes.

1. Impulsive aggression

Impulsive aggressive behaviour that includes physical aggression directed towards others, self-mutilation, suicide attempts, domestic violence, substance use and property destruction presents a challenge to both research and health care system. The economic and social cost of aggressive behaviour is huge (Scott, Knapp, Henderson, & Maughan, 2001), and so far both pharmacological and behavioural treatment interventions have been quite ineffective (Malone, Delaney, Luebbert, Cater, & Campbell, 2000). As a symptom, aggression overlaps a number of psychiatric disorders, but it is commonly associated with personality disorders, in particular antisocial (ASP) personality disorder (Eronen, Hakola, & Tiihonen, 1996). As ASP is linked with a pervasive pattern of disregard for and the violation of the rights of others, it is not surprising, that the highest prevalence rates of ASP are found in prisons and forensic settings (American Psychiatric Association, 2000). In a study by Fazel and Danesh (2002), as many as 47% of male prisoners had ASP.

1.1. Female aggression

Female violent behavior has been less studied than that of men. This is partly because women commit fewer crimes than men (Eisner, 2003; Harvey, Burnham, Kendall, & Pease, 1992, Steffensmeier & Allan, 1996), but also because female aggression is typically carried out in private and domestic areas (Rogde, Hougen, & Poulsen, 2000). It has also been postulated that the idealization of motherhood, the social taboo of female violence and the consequent denial thereof have possibly minimized concern with the phenomenon (Motz, 2001). However, in the US in 2003, female perpetrated aggravated assault increased by 14% between 1994 and 2003, other assaults by 32% (Crime in the United States, 2003). In Finland, the proportion of female arrestees for assaults increased from 7 to 15% during 1985–2004 (Honkatukia, 2005). Women seem to commit approximately one tenth of homicides in many countries. In Finland, the percentage of convicted female homicide offenders has varied yearly although a slight increase has been found during the past 20 years. The rates have varied between 9 and 11% (Statistics Finland, 2006). Pooled data indicate that one in five female prisoners has ASP (Fazel & Danesh, 2002) and the risk for homicide has been reported to be exceptionally high in women with ASP (Eronen et al., 1996).

2. Human sleep

Human sleep consists of two main components: rapid eye movement (REM) and non-REM sleep, the latter is divided into stages 1–4 (S1–S4). Stage 3 sleep (S3) and stage 4 sleep (S4) in non-REM sleep are defined as slow wave sleep (SWS), also called delta or deep sleep. The four non-REM stages roughly parallel a depth of sleep continuum, with arousal thresholds generally at their lowest in S1 and at their highest in S4. In normal sleep, REM and non-REM sleep periods alternate

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cyclically throughout the night so, that deep sleep predominates in the first third of the night, while REM sleep predominates during the last third of the night (Borbély, 1986). Although the exact functions of the different sleep stages are not known, it is generally accepted that SWS is the most important, refreshing part of sleep (Carscadon & Dement, 2000). Feelings of unwellness, either somatic or psychiatric, are frequently associated with decreased SWS. Psychiatric patients display significant changes in their sleep architecture (Benca, Obermeyer, Thistes, & Gillin, 1992), and one of the prominent features associated with psychiatric disorders is decreased amount of SWS.

According to a current and widely accepted model of non-REM sleep regulation, sleeping is controlled by two separate components: circadian process C, which affects the appropriate timing of sleep and homeostatic process S, which accounts for sufficient amount of sleep (Borbély, 1982). The circadian process C is mainly controlled by the rhythmic activity of the suprachiasmatic nucleus in the hypothalamus. In the case of the homeostatic process S, no single locus has been found in the central nervous system. It appears instead to be controlled by several neural systems, which are localized in the hypothalamus, basal forebrain, and brain stem nuclei (Borbély & Tobler, 1989).

2.1. Polysomnography

The gold standard for the evaluation of the patient's sleep structure is polysomnography, which includes the electrophysiological recording of brain cortex activity by electroencephalography (EEG), eye movements by electro-oculography (EOG), and skeletal muscle tone by electromyography (EMG). The recordings can be visually scored as either wakefulness or different stages of sleep (S1–S4, REM) in epochs of 30 s (Rechtschaffen & Kales, 1968) in order to draw a patient's histogram.

3. Daytime vigilance and impulsive aggression

The prefrontal cortex (PFC) plays a key role in the regulation of anger and violence. Recent brain imaging studies propose a link between ASP and both structural and functional disturbances in the PFC. A reduction in prefrontal grey matter volume in persons with ASP compared with controls in magnetic resonance imaging (MRI) was first demonstrated by Raine, Lencz, Bihrle, LaCasse, and Colletti (2000). In single photon emission tomography (SPECT), a reduction in prefrontal cerebral blood flow in subjects with impulsive violent crimes has been reported (Amen, Subblefield, Carmichael, & Thisted, 1996; Söderstrom, Tullberg, Wikkelso, Ekholm, & Forsman, 2000). PFC also plays a role in maintaining of wakefulness and non-specific arousal (Dahl, 1997; Horne, 1993).

3.1. Early EEG studies

Several studies from earlier decades have described abnormalities in the visual analysis of the waking EEG of antisocial persons. In a review of 1500 psychopaths, the most prominent form of EEG abnormality was the presence of delta and theta activity (Ellingson, 1954). In a study of severely aggressive psychopaths (Hill, 1952), the abnormal activity was localized in the temporal lobes of the cerebral hemispheres. Within the psychopathic group, the temporal abnormality was more severe in highly aggressive individuals. Among children with severe behaviour problems, including poor impulse control and inadequate socialization, the most frequent forms of waking EEG abnormality also included temporal theta and delta activity (Bayrakal, 1965). Forssman and Frey (1953) reported that antisocial boys with behaviour problems had difficulties in maintaining normal arousal levels during the EEG recording. These findings prompted Hare (1970) to formulate the slow arousal theory, which accounts for many aspects of the behaviour of antisocial persons, including impulsivity, aggressiveness and the desire for immediate gratification. He suggested that antisocial individuals, with their pathologically low level of cortical arousal, were hypoactive as compared with normal individuals and consequently existed in a chronic stage of “stimulus hunger”.

3.2. Recent EEG studies

Whereas earlier studies were generally more qualitative, waking EEG technology has increasingly allowed detailed quantitative computerized analysis clinical visual inspection. The diagnostic criteria of psychiatric disorders have also become more precise during times. In the study by Convit, Czobor, and Volavka (1991) of male psychiatric inpatients with violent behaviour, the number of instances of violence as well as the number of staff interventions were related to increased delta band activity and to decreased alpha band activity in the temporal and parieto-occipital areas. Furthermore, the results demonstrated that violence was very significantly related to the hemispheric asymmetry in EEG for the frontotemporal derivations. Wong et al. (1994), in examining nearly 400 male patients with a variety of axis I and axis II psychiatric disorders in a maximum-security mental hospital, found high violence rating scores to be associated with abnormal temporal electrical discharges. Raine, Venables, and Williams (1990) reported a retrospective study of 101 males, and showed that adult criminals at the age of 24 had significantly more slow-frequency electroencephalographic activity than non-criminals when measured at the age of 15 years. The authors speculated that, in addition to social and psychological variables, measures of central nervous system underarousal may facilitate the prediction of subsequent antisocial behaviour and may even elucidate the aetiological basis of criminality. In a quantitative EEG study in a forensic population with various psychiatric diagnoses, significant increases in slow-wave activity in the temporal lobes of persons charged with either murder or manslaughter were found (Gatzke-Kopp, Raine, Buchsbaum, & LaCasse, 2001). In our study (Lindberg et al., 2005) drug-free and detoxified male homicidal offenders with ASP as the primary diagnosis showed difficulties in maintaining normal daytime arousal as compared with age- and gender-matched controls.

4. Sleep and antisocial personality disorder

It is, of course, problematic to extrapolate findings from waking EEG to sleep EEG. However, in healthy volunteers, spectral profiles in the delta, theta, alpha and beta frequency bands of a subject's waking EEG have been found to be highly correlated with spectral profiles of the sleep EEG (Ehlers et al., 1998). These significant correlations between waking and sleeping EEG prompted the authors to suggest that the spectral signature of an individual's EEG may be found across sleep/wake states.

4.1. Sleep in antisocial men

The above-mentioned idea inspired our study group to focus on sleep EEG of antisocial persons. In our polysomnography study (Lindberg, Tani, Appelberg, Stenberg et al., 2003, Lindberg, Tani, Appelberg, Naukkarinen et al., 2003) 16 habitually violent, homicidal male offenders with ASP showed extremely increased amounts of SWS and in the spectral power analysis both the delta (0.5–3.5 Hz) and the theta (3.5–8.0 Hz) powers were significantly elevated as compared with healthy age-matched controls. Furthermore, the offenders with severe conduct disorder preceding ASP had higher amounts of deep sleep than did those with only mild or moderate conduct disorder preceding ASP.

4.2. Sleep in antisocial women

Female participants for our preliminary sleep study (Lindberg et al., 2006) consisted of three drug-free, detoxified female offenders ordered to a forensic mental examination in a maximum security state mental hospital after committing homicide or attempted homicide. Again, as can be seen in Table 1, the most striking finding was the increased