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Laterality of Motor Activity During Normal and Disturbed Sleep

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Introduction

In a review, Gardner and Grossman (1976) discussed the possibility that small and large sleep movements may be of different neural origin. Small, usually distal, twitches are possibly due to bursts of spinal disinhibition, whereas large movements are more likely caused or timed by afferent stimuli. Jovanovic (1971) found that during sleep the nondominant hand is moved twice as much as the dominant, independent of the REM/NREM cycle. Nondominant hand movements while awake have been shown to reflect higher cerebral functions, spatial rather than verbal problem solving (Hampson and Kimura 1984), and possibly the personal use of visual imagery in verbal encoding (Sousa-Poza et al 1979). The significance of the nondominant activity for the psychophysiology of sleep is unclear because the laterality might be due to the preferred right-side sleeping posture. Movement activity might also consist of typical left hand movements, thus reflecting no difference in activity between wakefulness and sleep.

Many subtle forms of deviant lateralization have been found in psychiatric syndromes. Phenomenologically close to mental and physical aspects of panic disorder are consistent left-sided symptom findings in conversion symptoms (Galin et al 1977) and hyperventilation (Blau et al 1983). Deviant motor activity may be a fundamental feature of sleep disturbance in psychiatric disorders (Foster and Kupfer 1975; Kronholm and Hyyppä 1987) but little is known about the nature of these movements. In order to characterize movement activity in the sleep of panic disorder patients, and to test the hypothesis of different neuronal origin of small and large movements, we chose to examine their lateral distribution.

Materials and Methods

The unilateral head movements of nine patients suffering from panic disorder (PD) and hyperventilation syndrome (seven men, two women, aged 29–56 years, mean 44.6 years) and nine age-matched and gender-matched normal controls, were counted by infrared video recording and a Static Charge Sensitive Bed (SCSB). The SCSB is a sensitive and reliable movement detector. It has the unique ability to detect the smallest movement, as a motor event exceeding three times the amplitude of the ballistocardiogram, which is seen as background activity in the movement channel of the SCSB (Alihanka 1987; Polo et al 1991). The patients were referred from other hospital departments because of negative findings in medical and neurological

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examinations, and suspicion of hyperventilation syndrome or PD. The diagnosis of PD was made after psychological and psychiatric interviews using a symptom checklist filled out by the patient, in accordance with the DSM-III criteria. They had not previously been treated for PD, although six of them had occasionally used minor tranquilizers. The duration of symptoms ranged from 4 months to 12 years, median 2 years. The selected patient sample reflects the combination of many factors, such as patient compliance and laboratory availability. The control subjects, six men, three women (age range 25–54 years, mean 36.1 years) were nonpaid, voluntary acquaintances of the laboratory staff. A 10th male control subject was examined polygraphically (Table 1). Each subject reported negative history of left handedness in childhood, and used the right hand in writing, drawing, and hammering. All subjects were instructed to refrain from medications and alcohol for a minimum of 48 hr before the first night (i.e., 96 hr before the polygraphy). The subjects gave their informed consent.

On the first two nights only telemetric electrocardiograph (ECG) cables were attached to the subject. On the third night, the standard polygraphy electroencephalogram (EEG), electromyogram (EMG) and electrooculograph (EOG) were used. To make sleeping conditions as natural as possible, normal bed clothes were used: This posed a problem for analysis of movement, but helped the subject to feel normally relaxed, and promoted natural behavior. The screening of both the video SCSB graphs and the subject together provided a highly accurate and detailed analysis of the motor activity. The movements can be analyzed in less than real time as the videotape can be operated on "fast-forward" most of the time without losing any movement. Movements made during different stages of sleep and during wakefulness were first classified according to how well organized they seemed to be. The scorers who counted the movements were blind to the subjects' handedness and sleep stage. Because of low interrater correlation, the main source of which were problems in classifying the more complex movement patterns (e.g. during postural shifts), this method was rejected. For the first analysis, the only completely reliable category, hand touching the subject's head, face, or neck, was used as a sample of organized movements. The category "other movements" consisted of all the other single-hand movements, from little twitches to more or less organized movements in connection with postural shifts. Two movements were counted as separate if there was >5 sec interval in the signal of SCSB (Alihanka 1987). Seven of 54 night recordings were excluded because of their technical inadequacies.

Results

The sleep stage analysis was made according to Rechtschaffen and Kales (1968) and is presented in Table 1. There were no differences between

Table 1. Sleeping Time and Sleep Stage Percentages during the Third Night[a]

	Patients (n = 9)	Controls (n = 10)	$p<$
Sleeping time (min)	488.4 + 61.6	492.2 + 42.0	0.01
REM-Latency (min)	116.8 + 54.0	116.3 + 41.0	NS
Wake (%)	11.6 + 8.95	3.5 + 4.64	0.001
NREM-I (%)	12.32 + 10.93	2.57 ± 1.83	0.001
NREM-II (%)	41.47 + 12.5	55.22 + 7.03	NS
NREM-III/IV (%)	15.29 + 5.84	16.49 + 4.36	NS
REM (%)	19.34 + 5.75	22.20 + 5.63	NS

p denotes significance of difference between the two groups in t-test.
[a]Mean ± SD.

the patients with and those without the history of occasional drug use. Using the videotapes, 2143 unilateral hand movements were analyzed during sleep, 615 in control group and 682 in PD group. During short periods of nocturnal awakening, the corresponding numbers were 257 and 589. The lateral differences are presented in Table 2. The left/right ratio of 2:1 was the same in REM and NREM sleep as well as short periods of nocturnal wake. There were differences of lateralization between movement categories, but the difference between controls and the patients in lateralization of movement activity in neutral (prone and supine) positions was insignificant ($p < 0.08$, Mann-Whitney two-sample rank sum test).

Discussion

The differences of sleep between PD and normal groups were similar to those of Mellman and Uhde (1989) with regard to normal REM latency, and to those of Hauri et al (1989) with regard to increased movement time, but with no difference in short movements. The laterality results may be somewhat blurred by the absence of handedness data other than the subjective report. The difference between lateral distribution of clearly organized and other movements is intriguing. The difference might be even more distinct if the category "unorganized" could be reliably used. In our classification, rater bias is highly improbable but the category "other" movements consists partly of organized movements.

Physiologically, the two movement categories may be different in a fundamental way: organized movements consist of complex sequences of finger positions that depend primarily on the purely contralateral motor system of the precentral gyrus, whereas axial movements depend on several other systems, the outflow of which is bilaterally distributed. As the nondominant preference is not dependent on the REM/NREM cycle in our study nor in the study of Jovanovic (1971), it may reflect a neural process different from that indicated by Gaillard (1989). There is no reason to believe that hand touching face would be a typical nondominant hand function when both hands are free. The findings of Sousa-Poza et al (1979) showed no asymmetry in self-touching during speech, and those of Hampson and Kimura (1984) revealed only slight preference of the left hand in self-touching at the same time the right hand was active in block manipulating. Most recent findings confirm the link between hemisphere-specific information processing and simple hand movements (Ashton and McFarland 1991). During sleep, the left preferences may be formed, we suppose, by right hemisphere advance in replicating spatial locations (Carnahan and Elliot 1987) and interhemispheric differences in the execution of finger movements, based on different modes of information processing (Balfour et al 1991). In light of our findings, it might

Table 2. Percentage of Left Hand Use for Unilateral Hand Movements in Sleep during 3 Nights[a]

	Clearly organized (hand to face)	Other unilateral	All movements in neutral positions
Controls ($n = 9$)	72.1 + 22.1 ($p < 0.04$)[b]	56.5 + 19.6 (NS)[b]	73.5 + 15.1 ($p < 0.008$)
Patients ($n = 9$)	64.9 + 18.5 ($p < 0.04$)	55.9 + 22.0 (NS)	58.0 + 23.7 (NS)
All subjects ($n = 18$)	68.5 + 20.3 ($p < 0.002$)[c]	56.2 + 20.3 (NS)[c]	65.7 + 20.9 ($p < 0.006$)

p (two-tailed) denotes significance of difference between left and right in Wilcoxon-Pratt one-sample rank sum test.
[a]Mean ± SD ($p <$).
Significant difference of lateralization between organized and other movements: [b]$p < 0.04$; [c]$p < 0.02$. Wilcoxon-Pratt test.

be important to determine the nature of movement more closely when using the movement parameters in assessing the motor aspect of sleep in various disorders.

Conclusions

1. The results obtained using a new method confirm that the lateral distribution of motor activity during sleep is usually the opposite of that expected on the basis of day-time handedness, with no evident differences between REM and NREM sleep. The basic left to right ratio of 2:1 was the same as in previous EMG studies.
2. The dominance of the left hand is not to be explained by sleeping position.
3. The left dominance in a subgroup of PD patients is not as clear as in normal subjects, which might reflect a deviation in the cerebral organization or some special feature of the documented poor quality of their sleep—with increases in NREM I, awakenings, and complaints about the sleep quality.
4. Self-touching movements to the area of the head and neck are lateralized, but other movements are equally distributed, which strongly supports their different neuronal origin. The crucial elements in the generation of short, unorganized movements with symmetric distribution may be spinal cord or brainstem disinhibitory processes, whereas the large, organized movements with pyramidal components reflect cortical activation with possible impact of not only motor but also somatosensory and prefrontal cortex.

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