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SESSION IV

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Study of EEG sleep characteristics in patients with anorexia nervosa before and after restoration of matched population mean weight consequent on ingestion of a 'normal' diet

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Summary

This experimental study confirms that insomnia and especially early morning waking is associated with low body weight in anorexia nervosa. It extends the view that there is a relationship between reduced nutritional intake and consequent change in weight and sleep disturbance. This relationship was studied by comparison of certain sleep EEG parameters in a group of hospitalized anorexia nervosa patients before and after a regime of re-feeding to matched population mean weight on a 'normal' diet. At low body weights, the patients had less sleep and more restlessness, especially in the last 4 hr of the night. After weight gain, there was a significant increase in length of sleep and REM sleep. The implications of these results are discussed with particular reference to an association between various anabolic profiles and differing need for REM sleep.

Introduction

This study uses patients with anorexia nervosa under treatment and gaining weight to examine the relationship between sleep characteristics and nutritional states. This relationship is presumably a complex one. It has been observed in conditions as diverse as the Pickwickian syndrome (Burwell *et al.*, 1956), narcolepsy (Daniels, 1934) and even in normal subjects after varying their bed-time milk cereal drinks (Editorial, 1972), In psychiatric practice the relationship between insomnia and weight loss is often elicited particularly from patients with depressive disorders.

Similarly, it has been noted for some time that patients with anorexia nervosa have a state of sleep different from the majority of young people. It was reported by Crisp (1965a, b) that anorectic patients tended to have disturbed sleep in the middle third of the night or in the early morning. Later (Crisp, 1967b) he showed, in a series of sixty anorectics, that their total amount of sleep was much less than usual and that this change, mainly early morning wakening, was not related to any particular feature of their disorder and certainly not related to any mood change. Further, Crisp and Stonehill (1971), using anorexia nervosa patients, obese patients (Crisp and Stonehill, 1970), and psychiatric out-patients (Stonehill and Crisp, 1973) showed, by using predominantly questionnaires and one-to-one interrogation procedures, that disturbances in sleep, especially in the second half of the night, are highly correlated with weight loss and may be reversed by restoration of weight.

One way of examining sleep is by all night EEG recordings which allow examination of parameters related to the quality and quantity of sleep. Crisp, Stonehill and Fenton (1971) used this method although only four of their sample (one a male) gained some weight but not to target weight (see Results and Discussion). Using a larger sample, this study examines alterations in sleep engendered by weight

gain using the patient's admission and re-fed weights as variables. In this way, each patient acts as his own control.

Method

There were ten patients in the study and all demonstrated unequivocal signs of anorexia nervosa. The sample (nine female, one male) were consecutive admissions to the Atkinson Morley's Hospital and fulfilled the following conditions: (1) Each had a history of weight loss such that the weight was at least 20% less than his matched population mean weight. The loss of weight was, in all cases, a deliberate and selective reduction of food intake (Russell, 1968, 1970); (2) all females in the study had amenorrhea of at least six months' duration or had never menstruated, despite being of post-pubertal age (Dally, 1969); (3) all showed the characteristic psychopathology of anorexia nervosa, including a fear of normal adolescent weight (Crisp, 1967a) and an excessive concern of being fat (Bruch, 1966).

No patient had haematological or electrolytic abnormalities. Routine chest X-rays were 'clear', and none of the patients had a history of epilepsy or fits. Once admitted, it was intended that the patients would not receive medication. However, one case (No. 208) had been placed on a major tranquillizer (chlorpromazine) before admission and another (No. 256) became so disturbed on admission that chlorpromazine was deemed necessary. Both, however, remained on this medication throughout the duration of the study. Each patient was prescribed a diet of 3000 calories/day from admission. Apart from normal helpings of the usual hospital meals, they only received supplements in the form of cheese sandwiches and biscuits with morning and afternoon tea. The diet was aimed to generate a weight increase of 2–3·5 lb/week (Crisp, 1967a). A weight gain or loss outside these limits led to a review of diet and an appraisal of the patient's eating behaviour. The target weight was calculated from standard tables, based on the population mean weight for the patient's height at the age when his or her anorexia began. The patients were restricted to bed rest, in individual cubicles, until they reached their target weight. This restriction extended to eating and washing activities although they were allowed to use a commode. Any occupational therapy was of a sort that did not lead to undue expenditure of energy.

After the patients had had time to become accustomed to their new environment, the first recording period began. It was never later than 12 days after admission. The second period was started when the patient had reached target weight. Each recording period lasted for 3 days. The first and second nights of each recording period allowed adaptation to the experimental situation and the third night's recording was set aside for examination. Nine electrodes were used in the classical manner, described by Rechtschaffen and Kales (1968), to produce two electro-oculogram recordings, one scalp EEG and one EMG recording. The two occipital placements used corresponded to positions C_3 and C_4 in the 10-20 system of electrode placement. Every effort was made to start the recording at 11.00 p.m. and the recording lasted for at least 7 hr or until the patient spontaneously awoke. The recordings were examined by an investigator who was unaware of the order in which the recordings were performed. Depth of sleep was rated for each 20-sec period throughout the night. The recordings were scored according to the internationally agreed criteria into stages 1, 2, 3, 4, REM (5) and awake (0).

Results and discussion

All ten patients gained weight to their target weights. General statistics are shown in Table 1.

TABLE 1. Showing statistics of patients' first and target weights and time lapse between recordings

	Mean	s.d.	Range
Weight at first recording (kg)	37·55	5·13	28·2– 45·0
Weight at target recording (kg)	52·01	4·64	44·6– 57·5
Weight gain between recordings (kg)	14·46	3·31	10·3– 22·0
Elapsed time between recordings (days)	100·8	30·10	68·0–174·0

Total sleep time

The results (Table 2) appear to confirm Crisp's original observation (Crisp, 1965b) and support the motility-bed findings (Crisp and Stonehill, 1971) that patients with primary anorexia nervosa have less sleep at low body weights. Further, after weight gain there is a significant increase in total sleep time

TABLE 2. The total sleep time expressed in minutes. One-night recording before and after treatment in each of ten anorexia nervosa patients

Patient case no.	Total sleep time (min) Admission	Target
212	380·3	352·7
211	370·0	392·7
256	445·3	478·3
210	381·3	437·7
208	364·3	397·7
204	399·7	469·3
213	351·7	416·0
190	383·7	395·0
215	410·3	496·7
299	383·3	436·3

($P < 0{\cdot}005$) defined as time spent asleep including any periods of waking after onset of sleep. Only one patient (No. 212) goes against this trend and this could have been related to the fact that she was on chlorpromazine.

Pattern of wakefulness

The histogram (Fig. 1) demonstrates the decrease of wakefulness with re-feeding ($P < 0{\cdot}005$) and further, suggests that wakefulness, at low body

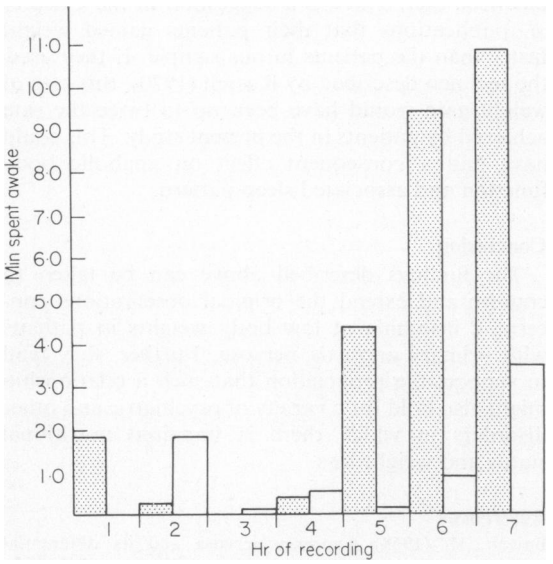

FIG. 1. Pattern of wakefulness throughout the night: the mean time in minutes spent awake during each hour of recording. One all-night recording before, ▨, and after treatment, □, in ten patients with anorexia nervosa.

weight, is concentrated towards the end of the sleeping period. This is examined in Table 3, which deals with the last four complete hours of recording in each patient before and after weight gain. The decrease in wakefulness and restlessness (stages $0 + 1$) are both significantly ($P < 0{\cdot}05$) reduced with re-feeding, confirming previous work (Crisp, 1967b) done on anorectics using self-rated and staff-rated questionnaires.

Stages of sleep

The histogram (Fig. 2) shows the mean amount of time spent in each stage of sleep before and after re-feeding. REM sleep increases significantly ($P < 0{\cdot}05$) from 86·16 min to 101·33 min (Table 4). This is an increase of 17·0% As it is known that REM sleep tends to accumulate in the second half of the night, it is necessary to see if this increase in stage REM sleep is because of the increase in length spent asleep

TABLE 3. Shows the time (in minutes) spent awake (Stage 0) and in a state of restlessness (0+1) in the last four complete hours of recording both before and after weight gain in each of ten anorectics

Patient case no.	Time (min) Stage 0 On admission	Stage 0 At target	Stage 0+1 On admission	Stage 0+1 At target
212	43·3	9·7	55·3	20·4
299	0·3	0·0	3·3	0·3
211	0·0	0·3	0·0	3·0
256	0·0	1·7	0·0	2·4
204	0·0	0·0	20·7	8·3
213	83·0	0·9	83·3	1·6
180	10·0	0·3	25·0	0·3
215	0·3	0·7	9·0	9·4
210	0·7	4·3	10·7	25·6
208	100·0	10·7	105·0	11·4

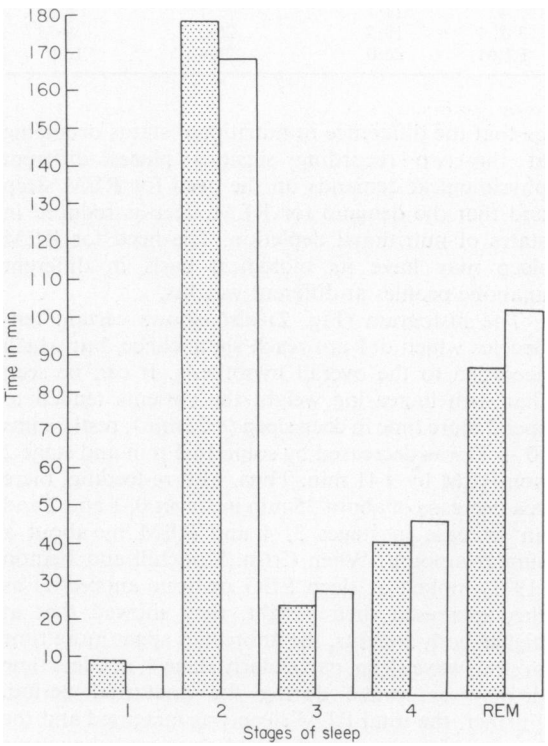

FIG. 2. Mean duration of each stage of sleep in anorexia nervosa patients (ten subjects). One night before treatment, ▨, and one night after treatment, □.

at higher body weights. Table 5 shows there is a 13·6% increase in REM sleep, even when correction is made for this increase in total sleep time. It thus appears that the increase in REM sleep, although taking place in the context of an increase in total sleep time, seems to transcend that increase. It may

TABLE 4. Time in each stage of sleep in minutes. Mean values during first 6 hr for ten subjects, each with one night recording before and after weight gain

Stage	Before treatment	After treatment	Significance
1	9·43	7·24	N.S.
2	178·39	168·78	N.S.
3	23·61	27·03	N.S.
4	40·47	45·30	N.S.
REM	86·16	101·33	<0·05

TABLE 5. The relative mean duration of each stage of sleep, as a percentage of total time spent asleep, together with the mean percentage change in the proportion of sleep time in each stage

Stage	Relative duration of stage (%) Before re-feeding	After re-feeding	% Change
1	2·74	2·03	−26·27
2	51·5	46·0	−10·68
3	6·8	7·6	11·76
4	11·7	12·7	8·54
3 & 4	18·5	20·3	9·73
REM	25·0	28·4	13·6

be that the difference in nutritional status occurring at the two recording sessions places different physiological demands on the need for REM sleep and that the demand for REM sleep is reduced in states of nutritional depletion. The need for REM sleep may have its biological basis in different anabolic profiles at different weights.

The histogram (Fig. 2) also shows certain tendencies which did not reach significance, but which accorded to the overall hypothesis. It can be seen that with increasing weight the patients tended to spend more time in deep sleep (8·22 min); restlessness (0 + 1) was decreased by some 14·5 min and stage 2 non-REM by 9·41 min. Thus, with re-feeding, there is a decrease of about 25 min in stages 0, 1 and 2 and an increase in stages 3, 4 and REM by about a similar amount. When Crisp, Stonehill and Fenton (1971) looked at sleep EEG on four anorectics as they increased their weight, they showed that at higher body weights, the anorectics spent more time in slow-wave sleep, particularly stage 4, and less time drowsy or awake during the nocturnal period. Further, the total REM sleep was increased and the latency of onset of both REM sleep and slow-wave sleep was delayed. The most striking difference between the two studies is that the present study fails to replicate the significant increase in slow-wave sleep after re-feeding.

There are, however, a number of differences in the two studies. Firstly, in the Crisp *et al.* (1971) study the patients 'did not necessarily meet their match population mean weight' and so they may well have been in a phase of active re-feeding with weight gain. Now, as it is thought that non-REM sleep is associated with restitutive anabolic functions of the body, increased amounts of slow-wave sleep would be expected if the patients were actively re-feeding. It may well have been that if the Crisp *et al.* patients had been re-fed to a stable target weight, the amount of slow-wave sleep would have diminished. Further, it appears that patients in the two samples had different diets. In the earlier study, the patients received a high protein, high carbohydrate diet including liquid supplements such as Complan (Russell, 1969), whilst in this study, the patients received the usual hospital balanced diet. There is a suggestion in the Crisp *et al.* publications that their patients gained weight faster than the patients in our sample. If they used the regimen described by Russell (1970), this rate of weight gain would have been up to twice the rate achieved by patients in the present study. This could have had a consequent effect on anabolic body function and associated sleep pattern.

Conclusion

The findings described above can be taken to confirm and extend the original observations concerning insomnia at low body weights in patients with primary anorexia nervosa. Further, they tend to support the proposition that such a relationship might also hold for a variety of psychiatric and other disorders in which there is impaired nutritional status and weight loss.

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