# Slow Wave Sleep Mentation: A Comparison Between the First and the Second Sleep Cycle

Vincenzo Natale, Ph.D.

The aim of the present work was to compare the features of Slow Wave Sleep (SWS) mentation during the first and the second sleep cycle. One hundred-two dream reports (66 SWS reports of the first cycle and 36 SWS reports of the second cycle) were obtained from the Dream Data Bank of the Sleep and Dream Laboratory of the Bologna University Department of Psychology. The dream reports were analysed for structure (number of temporal units, number of report multi-units, and narrative continuity), and content (self, double self, setting, laboratory references, number of non-self characters, dimensional distortion, space-time distortion, plausibility, body feelings, emotions, reality testing). On the whole the results showed no significant differences between Slow Wave Sleep dreams of the first and of the second sleep cycle. The SWS mentation in the second cycle is not influenced by the previous REM period. Data are discussed in relation to the present cognitive models on dream production. (Sleep and Hypnosis 2000;2:84-89)

Key words: dreaming, sleep mentation, slow wave sleep, sleep cycle, sleep psychophysiology, cognitive system

## INTRODUCTION

Sleep and dream psychophysiology has been dominated for many years and, under certain aspects still today, by strong bias which considered the dream-like mental activity as a peculiar aspect of REM sleep. The discovery of the REM phase (1), which determined a change in sleep research, raised great expectations. Going by the results of the first experiments on REM sleep, Dement and Kleitmann (2) were sure they had found "an objective method for the study of dreaming". The excessive emphasis put on the role ascribed to REM sleep almost led to consider the remaining sleep phases not very notable. It is not a case that sleep stages 1,2,3 e 4, although being different, have been classified all negative (Non-REM) in comparison with the REM phase. From the point of view of psychical contents, NREM sleep has been considered an almost silent period for a long time. The first REM/NREM dichotomy was based on these convictions, too.

Experimental research soon showed clearly that the dream phenomenon has a very wide place in sleep (3). However, the protocols collected after NREM awakenings were often short and fragmented and similar to reality-oriented thoughts. By using such observations, it seemed possible to blindly discriminate REM reports from NREM reports with sufficient accuracy (4). On the basis of these new data, an attempt was made in order to elaborate an alternative model, according to which it seemed legitimate to ascribe a dream-like character to REM mental activity, and a thought-like character to NREM mental activity (REM/NREM second dichotomy).

This point of view also was soon questioned, Foulkes (5,6) and other research groups (7-10) emphasised that, although NREM reports were more thought-like in comparison with REM reports, also in NREM reports dream-like experiences prevailed. Later on it

From the Department of Psychology, University of Bologna, Bologna, Italy

Address reprint requests to: Vincenzo Natale Universit degli Studi di Bologna Dipartimento di Psicologia Viale Berti Pichat 5 40127 Bologna ITALY
Phone: +39-051-2091824
Fax: +39-051-243086
E-mail: natale@psibo.unibo.it

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was realised that it was not possible to discriminate REM dreams from NREM ones for certain, and even real dreams from those simulated in waking condition (11,12).

Still today, anyway, it seems difficult to consider the actual and documented presence of dreaming in NREM sleep. For example, both Allan Hobson (13) and Tore Nielsen (14) hypothesise that the origin of mental activity during dreaming may be ascribed to specific neurophysiological mechanisms proper to the REM phase. In particular, as far as Nielsen s explanatory hypotheses are concerned, it is hypothesised that, episodes of covert REM sleep are traceable outside REM sleep. In this episodes one would find physiological aspects peculiar to REM sleep, which could, however, be identified only through exhaustive observations going beyond the standard reading of the EEG recording (e.g. spectral analysis of the EEG or neurovegetative modifications preceding or following the REM episode). According to Nielsen, covert REM would be responsible for the production of the oneiric activity outside REM sleep (phantom REM). These episodes are located in specific time intervals, during sleep onset and close to (immediately before and immediately after) REM episodes.

The spread of the cognitive-type orientation in the psychological sphere and, later on, the contributions of the neuroimaging techniques led to a modification of the theoretical approach in the study of oneiric activity. The study of the processes involved in the dream formation led several authors to formulate a hypothesis about possible analogies between the functioning of mind during the different sleep phases (15-17). The idea that there are structural differences between mental activity in REM sleep and in NREM sleep, maintained by many psychophysiological models, seems not to have, in fact, been confirmed. In this framework, the study of mental activity present in Slow Wave Sleep (SWS) is particularly interesting, being this sleep phase greatly different from the REM phase from a physiological point of view. The systematic study of mental activity in SWS is a relatively recent research field. The electroencephalographic characteristics of SWS made one suppose that in these conditions the presence of mental activity was not possible, or at least highly improbable, and the presence of dream-like mental activity even less probable. The research studies dealing with NREM sleep focused on St.2 and on Sleep Onset. Although there were studies reporting percentages of recalling in slow wave sleep, they were anyway not directly interested in the type of mental activity present in it (7,18-20).

The first systematic studies on mental activity in SWS were carried out by the research team of the Sleep and Dream Laboratory of the Bologna University Department of Psychology (21-23). These studies aimed at investigating the quantitative and qualitative characteristics of delta sleep mentation of the first sleep cycle, comparing it with the one of the second REM phase. From the results it emerged that in SWS a percentage of recalling lower than in REM is actually noted, however over 60% on the average. REM reports were also significantly longer than SWS reports. From the point of view of quality, however, no significant differences were found. The only recorded differences (greater number of characters and greater presence of emotions in REM) were interpreted as a kind of by-product (or epiphenomenon) of the quantitative ones.

On the basis of these works and of the previous ones (7) it is possible to maintain that mental activity is present in SWS and that it can be defined as dream-like.

The purpose of the present work is double, on the one hand to supply data on the presence of dream-like sleep mentation in all of SWS phases which are recorded in the first part of the night, on the other hand, to evaluate possible differences between SWS mental activity of the first and of the second sleep cycle. The second SWS episode of the night might be influenced by the dream-on activation of the previous REM, a kind of carry-over effect of the first REM. In this case, the SWS mental activity of the second cycle might show quantitative, and as a consequence qualitative characteristics more similar to the REM one, that is longer dream reports, greater presence of bizarreness and emotions. It must be noted that in this case it is not possible to hypothesise the action of a covert REM (or phantom REM), in Nielsen s sense (14), since awakenings in SWS are not close to the REM phase (within a 10-15 minute interval), but at a distance of about 30 minutes.

SWS reports collected during the first and second sleep cycle, taken from the Dream Data Bank (DDB) (24,25) of the Sleep and Dream Laboratory of the Bologna University Department of Psychology were compared to this end. If the investigation showed quantitative and/or qualitative differences between the SWS reports of the two sleep cycles, one could infer an effect by the intervening REM phase. If, instead, the characteristics of SWS reports were not different, this result might be interpreted as a substantial independence of mental activity with respect to REM sleep influence during SWS.

## METHODS

Dream reports from experiments made at the Sleep Laboratory of the Bologna University Department of Psychology have been collected over the past thirty

years in the Dream Data Bank. The DDB consists of two sections. In the first one (Data Base) dream reports are codified according to three parameters: a) information about the experiment, b) electropolygraphic and physiologic information about the dream report, c) information about the structure and content of the dream report obtained by at least two independent judges. Interrater reliability has to be usually higher than. 80 for each considered dimension. One example of dream codified in the Data Base section of DDB is shown in Table 1.

Table 1. Example of dream codified in DDB in the data base section.

| | |
|---|---|
| Code | 476 |
| Original language | Italian |
| Laboratory | Bologna |
| Experimental Design | St 4 vs. REM, 44 Ss. 2 night, one awake per night |
| Year of execution | 1989 |
| Subject age | 20 |
| Gender | F |
| Subject features | University student, good sleeper and dreamer |
| Sleep cycle | I |
| Time of sleep before awakening | 70 minutes |
| Sleep stage | St 4 |
| Sleep phase | Delta sleep |
| Condition for awakening | 10 min. of continuous St4, at least 30 min. after sleep onset |
| Progressive subject number | 92 |
| Night number | II |
| Number of awakenings within the experimental night | I |
| Number of previous awakenings | 0 |
| Self | Yes |
| Double self | No |
| Setting | Yes |
| Laboratory references | No |
| Number of non-self characters | 1 |
| Reality testing | Lost |
| Dimensional distortion | Yes |
| Space-time distortion | Yes |
| Body feelings | No |
| Emotion | Yes |
| Plausibility | No |
| Narrative continuity | Yes |
| Temporal Units | 2 |

In the second section of DDB the original dream reports are collected, identified by a progressive number code.

All subjects are paid university students, aged between twenty and twenty-nine. The experimental awakenings were carried out under standard electropolygraphic control (three EEG channels, two EOG channels, and one EMG channel). As regards Slow Wave Sleep dream reports, object of this work, subjects were awakened after ten minutes of continuos delta sleep (according to the criteria by Rechtschaffen and Kales 26), provided that at least 30 minutes had elapsed since the initial sleep onset for the first cycle, or 20 minutes had elapsed from the end of the first REM for the second cycle.

For the present work 66 SWS dream reports collected during the first sleep cycle and 36 SWS dream reports collected during the second sleep cycle were taken from the DDB. We considered both quantitative and qualitative features of Slow Wave Sleep reports. In particular, we considered the following features of dream reports:

Self: the presence of the dreamer in the report (yes/no).

Double self: the presence of the double representation of the self (i.e. the dreamer is simultaneously character and observer in the report) (yes/no).

Setting: the presence of a definite setting (yes/no).

Laboratory references: the presence of specific references to the laboratory setting (e.g. researcher, electrodes, polygraph) (yes/no) in the report.

Numbers of non-self characters: the number of non-self character physically present in the dream.

Reality testing: the reality testing is codified at three levels: a) lost, when the subject is convinced that the oneiric scene has taken place in reality, b) maintained, when the subject can realise that this is a dream experience (lucid dream), c) uncertain, when it is not possible to identify a univocal dimension for it.

Dimensional distortion: the presence of dimensional distortion of characters and/or objects (shape or size) (yes/no).

Space-Time distortion: the presence of any spatial-temporal distortions (yes/no).

Body feelings: body feelings experienced during the dream and clearly expressed by the dreamer (yes/no).

Plausibility: a global evaluation of bizarreness, reports containing one or more than one impossible or improbable elements referring to subject s life were scored as implausible (yes/no).

Emotions: the presence of emotions clearly

expressed by the dreamer (yes/no).

Temporal Units: the length of report was scored in Temporal Units, a temporal unit is defined as "whatever activities could have occurred synchronously and were not described as having occurred successively" (27).

Narrative continuity: reports which contained more than one temporal unit (multi-unit reports) were scored continuous whenever they showed a consistent narrative plot (yes/no).

Moreover, we considered the time of awakening, and the number of minutes of sleep (e.g. the time elapsed between sleep onset and awakening).

Statistical analyses were performed by using Chi square and t-Test for independent samples, as suitable.

Table 2. Comparison between first and second SWS reports for structural dimensions.

| | 1¡ cycle SWS | 2¡ cycle SWS | p< |
|---|---|---|---|
| Mean number of Temporal Units | 1,98–1,91 | 2,05–1,43 | NS |
| Number of multi-units Reports | 50,00% | 55,55% | NS |
| Narrative Continuity | 72,72% | 50,00% | NS |

Table 3. Comparison between first and second SWS reports for content dimensions.

| | 1¡ cycle SWS | 2¡ Cycle SWS | p< |
|---|---|---|---|
| Self | 87,88% | 88,89% | NS |
| Double self | 7,58% | - | NS |
| Setting | 77,27% | 83,33% | NS |
| Laboratory References | 16,67% | 22,22% | NS |
| Mean number of non-self characters | .86–1.26 | 2.50–6.01 | .05 |
| Reality Testing: | | | |
| Lost | 90.91% | 94,44% | NS |
| Maintained | - | - | |
| Uncertain | 9,09% | 5,56% | NS |
| Dimensional distortion | 16,67% | 5,56% | NS |
| Space-time distortion | 15,15% | 5,56% | NS |
| Body feelings | 16,67% | 22,22% | NS |
| Emotions | 33,33% | 55,56% | NS |
| Plausibility | 53,03% | 50,00% | NS |

## RESULTS

The mean time of experimental awakening was 01:15 –45 for SWS1, and 02:35 –45 for SWS2. The mean number of sleep minutes was 61.47 –36.37 for SWS1, and 122.72 –40.69 for SWS2.

As far as the dream structure analysis is concerned (see Table 2), we did not found any significant results.

As far as the dream content analysis is concerned (see Table 3), we found only one significant result. The mean number of non self characters was lower in the first cycle (.86–1.26) in comparison with the second cycle (2.50–6.01) ($t_{100}$=2.07; p<.05).

## DISCUSSION

As for the first objective of the research study, results confirm the presence of dream mentation in SWS both during the first sleep cycle and during the second one. In particular, the evaluation of the length of reports, of narrative continuity, of the presence of the dreamer as a character, of the loss of reality testing, allowed to stress its dreamlike characteristic.

As for the comparison between the two sleep cycles, no notable differences emerge. The presence of non-self characters is just an aspect which differs in dream reports, in the sense that in the second cycle, characters are more numerous on the average than in the first one. However, one should consider that it is probably experimental artificial elements, such a difference may be in fact ascribed to the fact that in a protocol of the second delta sleep cycle 26 characters were present (rugby match). By carrying out the same analysis again, excluding this unique protocol, which deviates from the other protocols characteristic very much, the difference is not significant.

The lack of remarkable structural and qualitative differences between SWS mentation of the first and of the second cycle weakens the hypothesis that REM sleep influences the subsequent SWS. We think that the non-effect of the intervening REM on SWS reports of the second cycle is a datum to be considered in the creation/validation of models on dream generation. For example, Nielsen s present model of covert REM is unable to explain the origin of SWS mentation and, as it has been recently underlined by the author himself (28), as a consequence, the model is incomplete.

The fact that mental activity in SWS is analogous in the first and in the second cycle is compatible with the cognitive model (21-23,29) which envisages a single system of dream generation. Such a system would operate at different rhythms according to the different physiological levels of REM and NREM activation.

According to these models sleep would be a particular container of mental activity which binds its production in terms of quantity and, to a certain extent, of quality, according to the physiological characteristics of the different stages. The evident differences of mental activity in the different sleep phases are then basically explained in terms of greater or smaller mnestic activation and functionality of control processes, that is in quantitative terms rather than in qualitative terms.

Recently, also research studies in the neuropsychological field have demonstrated that the greatest differences between REM and NREM sleep in the SNC activation patterns mostly concern the cortical areas involved in the processing of mnestic traces and the cortical-subcortical circuits involved in emotions; surprisingly no remarkable differences were noted in the activation of cortical areas involved in the functionality of control processes (30,31). Then, also according to neuropsychological evidence, the differences in mentation of the various sleep phases are explained in terms of greater or smaller activation of the memory systems involved in dream generation, that is, in quantitative rather than in qualitative terms.

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