Bizarreness Across the First Four Cycles of Sleep

Vincenzo Natale, M.D., Ph.D. and Maria Josè Esposito, B.S.

The principal aim of the present work was to compare the presence of bizarreness in sleep mentation during the first four cycles of sleep. 645 dream reports (342 REM reports and 303 St.2 reports) were obtained from the Dream Data Bank of the sleep laboratory of the Bologna University Department of Psychology. The distribution of the dream reports within the nights was: 203 St.2 (sleep onset) and 103 REM reports in the first cycle, 63 St.2 (descending) and 157 REM in the second, 15 St.2 and 49 REM in the third and 22 St.2 and 33 REM reports in the fourth one. The dream reports were analysed for length (number of temporal units) and bizarreness (implausibility, dimensional distortion, and space-time distortion). On the whole the results showed that the presence of bizarreness is only slightly influenced by the increase of the temporal distance from wakefulness in both REM and NREM reports. Only Sleep Onset dreams were significantly different (a lower degree of bizarreness) in comparison with the others reports, as if bizarre elements could be present in a constant way only when the Sleep Onset process is concluded. (Sleep and Hypnosis 2001;3(1):18-24)

Key words: bizarreness, dreaming, sleep mentation, sleep cycle, REM, Stage 2, cognitive system

INTRODUCTION

An agreement among researchers about dream definition is far from being reached. Nevertheless, everyone probably agrees to consider bizarreness as a frequent characteristic of dream-like activity. Several terms referring to bizarreness have been used in the literature, but it seems possible to summarise the concept of bizarreness by using two terms: impossibility and improbability. The first term includes those situations that are impossible from a physical and/or logical point of view. The second term implies an improbability from a statistical point of view, comparing the content of the dream with common daily experiences.

Sleep and dream psychophysiology has been dominated for several years and, under certain aspects it is so still today, by a strong bias which considers the dream-like activity (bizarreness included) as a peculiar aspect of REM sleep. For example, the activation-synthesis model (1) or A.I.M. Model (Activation level, Input source, information processing Mode model) (2,3) states that bizarreness is a result of randomly generated inputs from the brainstem (PGO spikes). From this point of view bizarreness should be not only a typical feature of REM dream, but it could be present during REM sleep only. Besides the models proposed by Hobson and co-workers, other interpretative models have been developed. Some of them have basically proposed again, in a more or less strong way, the role played by PGO waves in the production of bizarre events and, more generally, in the oneiric production (4-6). Other authors have instead supplied cognitive or connessionist type interpretations and models, like, for example, Antrobus (7,8) and Foulkes (9).

From the Department of Psychology, University of Bologna, Italy

Address reprint requests to: Dr. Vincenzo Natale, Università degli Studi di Bologna Dipartimento di Psicologia, Viale Berti Pichat 5 40127 Bologna, ITALY
Phone: +39-51-2091824
Fax: +39-51-243086

e-mail: natale@psibo.unibo.it

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Therefore, in the different models proposed during the years (for a review see Colace, 10), even though with some exceptions, a major role in the production of oneiric bizarreness has been ascribed to REM sleep. Nevertheless, experimental research clearly showed that the dream bizarreness experience has a very wide place in sleep (11): percentages of dream bizarreness equal to or higher than 50% have been found also in Slow Wave Sleep (12-14), which is greatly different, from a physiological point of view, from REM sleep.

According with these experimental evidences is the cognitive model by Foulkes (9). This model suggests that dream mental activity is probably distributed along all sleep stages and considers three phases in dream production: the input (the activation of memory units), the planner (which processes the activated memories), and the output (the final organisation). The mechanism of dream production may be perturbed by the presence of some peculiar memory units with an high and impinging level of activation: as a consequence the planning system cannot exclude them from dream processing; this could produce the presence of bizarre elements in the dream experience.

In a recent work (15), in which mental activities during Sleep Onset (SO) and spontaneous morning awakening were compared, bizarreness was found to be greater in the dreams of the morning awakening than in SO, in spite of a similar qualitative memory activation. This difference has been interpreted as a consequence of the more dreamlike features which take place during sleep offset. Morning awakening is preceded by a long period of sleep, in which there is an intense hallucinatory production of oneiric events. On the contrary, SO is preceded by a long period of wakefulness. Sleep mentation in these two different moments could be affected by a sort of carry-over effect from the preceding condition of consciousness, as if the control processes which are totally efficient in the condition of alert consciousness would disengage progressively during sleep. In other words, the authors suggest that the temporal distance from wakefulness could be another important variable influencing the presence of bizarreness in dream mentation. This aspect has been previously investigated only occasionally and marginally. Rechtschaffen (16) reported that dreams occurring in the second half of the night were judged by the subjects themselves less plausible than dreams from the first half of the night. Analysing the REM dream reports of the first three cycles of sleep Domhoff and Kamiya (17) did not find any significant difference in the frequency of bizarre elements. Foulkes (18) and Pivik and Foulkes (19) found that both REM and NREM dreamlike fantasy score (bizarre contents included) increased from the first to the fourth sleep cycle of the night. Analysing dream reports from Stage 2 and REM, Antrobus et al. (20) and Casagrande et al. (21) found higher scores of bizarreness in the second part of the night.

The aims of the present work are:

First: an attempt to establish whether the percentage of bizarre dream reports really increases with the increase of temporal distance from wakefulness.

Second: starting from the evidence that dream bizarreness scores are positively correlated with the report length (22-24), many authors implicitly assumed that bizarreness depends on the report length. As an alternative, Hunt and coll. (25,26) suggested that the length of the dream report may be at least in part directly consequent of the relative bizarreness of the dream. In order to investigate the relationship between dream report length and bizarreness we decided to consider the dream reports length too.

Third: In all sleep cycles that follow one another during the whole night only two stages of sleep are always present, i.e. Stage 2 (St.2) and REM sleep. For this reason we decided to consider these two sleep stages to supply normative data on the presence of dream bizarreness in NREM and REM, an old issue of psychophysiology of sleep and dream.

Consequently, we analysed Stage 2 and REM reports, collected during the first four cycles of sleep, taken from the Dream Data Bank (DDB) (27,28) of our Department of Psychology.

METHODS

Dream reports from experiments carried out at the Sleep and Dream Laboratory of the Bologna University have been collected over the past thirty years in the Dream Data Bank. The DDB consists of two sections. In the first section (Data Base) reports are codified according to three parameters: a) information about the experiment, b) electropolygraphic and physiologic information about the sleep stages during which dream reports were collected, c) information about the structure and content of the dream reports obtained by at least two independent judges. Interrater reliability was usually higher than .80 for each dimension considered. In the second section of DDB the original dream reports were collected and identified by a progressive number code.

All subjects were paid university students, aged between twenty and twenty-nine. The experimental awakenings, only one per night, were carried out under standard electropolygraphic control (three EEG channels, two EOG channels, and one EMG channel). As regards the Stage 2 dream reports of the first cycle (Sleep Onset), subjects were awakened three minutes after the first sleep spindles (according to the criteria by Rechtschaffen and Kales, 29). The Stage 2 dream reports of the other cycles of sleep, instead, were collected after ten minutes of continuous Stage 2 sleep, provided that at least 20 minutes had elapsed from the end of the preceding REM phase. As regards the REM reports, subjects were awakened ten minutes after the appearance of the first clear burst of rapid eye movements. We must point out a methodological problem concerning the time elapsed in each sleep stage before experimental awakening. In our sample Stage 2 awakenings in first cycle (SO) were preceded by 3 minutes of Stage 2, on the contrary the awakenings of other sleep conditions (Stage 2, 2^{nd}-3^{th}-4^{th} cycle, and all REM awakenings) were preceded by a period of 10 minutes of continuous Stage 2 or REM sleep. Even though it has been shown that the time spent in REM does not influence the report length (30) we should take this difference into account since it could affect the results. Above all, the time elapsed in SO is very short and this could affect the reports length and perhaps also the frequency of bizarre elements in this condition. The choice of a 10 minute period of St.2 in the first cycle of sleep is problematic. In fact there are two alternatives: either choose the St.2, which coincides with Sleep Onset and then the time cannot be greater than three minutes, otherwise it would loose the characteristic of Onset of Sleep, or awake the participants after 10 minutes, at the frequent risk that evident delta waves (St.3) be already present in EEG. We preferred the first alternative, also on account of the availability of reports in the DDB, however we will consider this problem in the interpretation of our results.

342 REM dream reports and 303 St.2 dream reports were taken from the DDB for the present work. We considered both quantitative and qualitative features of dream reports. In particular we considered the following characteristics:

- Implausibility: a global evaluation of bizarreness, reports containing one or more impossible or improbable elements referring to the standard of the subject's life were scored as implausible (yes/no).
- Dimensional distortion: the presence of dimensional distortion of characters and/or objects (shape or size) (yes/no).
- Space-Time distortion: the presence of any spatio-temporal distortion (yes/no).
- Temporal Units: the report length was scored in Temporal Units, a temporal unit being defined as "whatever activities could have occurred synchronously and were not described as having occurred successively" (31).

Statistical analyses were performed using Chi square, t test, and ANOVA for independent samples, as suitable.

RESULTS

We first considered the cycle of sleep in which the dream was collected. As regards the REM, 103 dream reports from the first, 157 from the second, 49 from the third and 33 from the fourth cycle of sleep were taken from the bank. As for the St.2, 203 dream reports from the first (Sleep Onset), 63 from the second (descending Stage 2), 15 from the third and 22 from the fourth cycle of sleep were taken from the bank. The results are shown in Table 1.

Table 1. Results of all of the considered dimensions per cycle and stage of sleep

		sleep cycle			
		I	II	III	IV
Implausibility	St2	33.50%	60.32%	73.33%	86.36%
	REM	61.17%	66.88%	73.47%	81.82%
Dimensional distortion	St2	7.88%	14.29%	20.00%	13.64%
	REM	12.62%	5.73%	14.29%	6.06%
Spatio-temporal distortion	St2	10.34%	39.68%	33.33%	40.91%
	REM	32.04%	25.48%	32.65%	30.30%
Temporal Units of Implausible reports	St2	2.53±1.74	2.87±2.26	5.36±4.08	5.21±6.88
	REM	4.01±4.24	4.83±3.74	6.05±4.23	5.18±4.68
Temporal Units of Plausible reports	St2	1.52±1.05	1.48±.71	3.00±1.41	2.67±1.15
	REM	1.55±1.13	2.56±2.64	3.08±2.43	3.83±1.33

As far as implausibility is concerned, we did not find any significant difference in REM mentation among the sleep cycles. On the contrary, in Stage 2 reports, the distribution of implausible dreams was significantly different among the sleep cycles (x^2_3=36.91; p<.0001). This result was due to sleep onset reports (first sleep cycle). In fact, sleep onset reports (33.50%) were significantly less implausible than stage 2 reports of the others cycles (St.2 second cycle = 60.32%, x^2_1=14.42 p<.0001; St.2 third cycle = 73.33%, c21=9.59 p<.005; St.2 fourth cycle = 86.36%, c21=23.39% p<.0001). Sleep onset reports were also less implausible than REM reports of the first cycle (St.2 onset = 33.50%, REM first cycle = 61.17%; x^2_1=21.36; p<.00001).

The analysis of dimensional distortions showed a significant result only: a higher percentage of dreams with dimensional distortions in stage 2 reports of the second sleep cycle in comparison with the REM reports of the same sleep cycle (St.2 second cycle = 14.29%, REM second cycle = 5.73%; x^2_1=4.38; p<.05).

As regards the spatio-temporal distortions of REM dreams, we did not find any significant difference among the sleep cycles. On the contrary, for Stage 2 reports the distribution of dreams with spatio-temporal distortions was significantly different among the sleep cycles (x^2_3=35.01; p<.00001). This result was due once again to the features of sleep onset reports (first sleep cycle). In fact the sleep onset reports showed significantly less spatio-temporal distortions than the Stage 2 reports of the second cycle (St.2 onset = 10.34%, St.2 second cycle = 36.68%; x^2_1=28.93; p<.00001), but did not show significant differences with respect to other cycles of Stages 2. Sleep onset reports showed also lower values than the REM reports of the first cycle (St.2 onset = 10.34%, REM first cycle = 32.04%; x^2_1=22.13; p<.00001). As in dimensional distortions in this case too, we found a higher percentage of dreams with spatio-temporal distortions in Stage 2 reports of the second sleep cycle in comparison with the REM reports of the same sleep cycle (St.2 second cycle = 39.68%, REM second cycle = 25.48%; x^2_1=4.36; p<.05).

As far as the dream report length is concerned, an analysis of variance was carried out with three factors: stage of sleep (two levels); cycle of sleep (four levels); and implausibility (two levels, i.e. yes/no). The first factor was significant (Stage 2 = 2.31±2.55, REM = 4.02±3.78; $F_{1,629}$=3.78; p<.05): REM reports were significantly longer than Stage 2 reports. If we consider the four sleep cycles separately, we find that REM reports were significantly longer than stage 2 reports only in the first (St. 2 first cycle = 1.86±1.40, REM first cycle = 3.06±3.59, t_{304}=4.18; p<.0001) and the second sleep cycle (St.2 second cycle = 2.32±1.92, REM second cycle = 4.08±3.57; t_{218}=3.69; p<.001). It is necessary to point out that in the sleep onset condition the subject was awakened 3 minutes after the appearance of first spindles, a very short time in comparison with the other awakening conditions. This precocious interruption could affect the length of sleep onset reports. Also the second factor (cycle of sleep) was significant ($F_{3,629}$=6.70; p<.0005). This means that reports are progressively longer from the first to the fourth sleep cycle. This is true for both sleep stages, therefore the interaction between the two factors was not significant. For stage 2 the reports of the second sleep cycle were longer than those of the first one (St 2 second cycle = 2.32±1.92, St.2 first cycle = 1.86±1.40; t_{264}=2.07; p<.05) and the reports of the third cycle were longer than those of the second one (St.2 third cycle = 4.73±3.67, St.2 second cycle = 2.32±1.92; t_{76}=3.58; p<.001). For REM the reports of the second sleep cycle were longer than those of the first one (REM second cycle = 4.08±3.57, REM first cycle = 3.06±3.59; t_{258}=2.24; p<.05) and the reports of the third cycle were longer than those of the second one (REM third cycle = 5.26±4.04, REM second cycle = 4.08±3.57; t_{204}=1.97; p<.05). Also the third factor (implausibility) was significant ($F_{1,629}$=24.22 p<.00001). The implausible reports were longer (4.24±3.93) than plausible ones (1.87±1.65). No significant interactions were recorded.

DISCUSSION

a) The obtained results have displayed a progressive increase of dreams evaluated as implausible during the first four cycles of sleep, regardless of the stage during which they were collected. It should, however, be underlined that, from the statistical point of view, only the comparison between the first cycle and the subsequent ones of the reports collected during St.2 were significant. Implausibility goes from 33.50% in the first cycle (SO) to 60.32% in the second cycle, and reaches 86.36% in the fourth cycle. In agreement with certain studies (32-35) it is confirmed that mental activity during SO differs from that occurring in other REM and NREM sleep conditions. It would seem that oneiric implausibili-

ty shows itself considerably only once the sleep onset process is ended. In fact, we know from the literature (12) that the percentages of implausibility in delta sleep in the first cycle are already higher than 50%. In order to better investigate when the modification in sleep mentation in favour of a higher presence of bizarre elements takes place one should collect dream reports at short time intervals, of about 5/10 minutes, during the first 60 minutes of sleep.

It can be hypothesised that mental activity in sleep onset be influenced by the preceding long period of wakefulness. The passage from waking to sleeping implies gradually loosing the voluntary control on thought as well as the contact with the surrounding reality, and a substantial modification of the conscious experience. It is plausible to suppose that, during this transition period, mental contents be still strongly connected with the preceding waking condition and this would limit the presence of bizarre contents in SO mentation. Another hypothesis, which does not exclude the previous one, is that sleep onset is a psychologically delicate phase and therefore many types of experiences might disturb or hinder it (9). Similarly to what has been proposed for emotional contents in the I.D.R. (Intact Ego, Destructuralized Ego, Restructuralized Ego) model (36), it may be hypothesised that the cognitive system tends to minimise also the appearance of bizarre elements.

The temporal distance from sleep onset affects the presence of implausibility during the night only in part. In fact, a tendency (not significant) toward an increase of implausibility during the night was observed. On the contrary, the bizarreness sub-categories analysed, i.e. dimensional and spatio-temporal distortions did not show a similar tendency to increase dependent upon the sleep cycles sequence. This datum suggests that there might be specific forms of bizarrenes, not considered here, which tend to appear more frequently as sleep hours pass on. Anyway, it should be underlined that the implausibility scoring used in the present study implied a global evaluation of the protocol. In the light of the different distributions observed in the considered bizarreness indexes, in order to better evaluate the effect produced by the passed hours of sleep, it would be desirable to study the protocols using more analytical instruments. A detailed analysis might show whether there are specific forms of bizarreness that significantly increase during the night. Furthermore, a study in this direction would help us to understand whether the oneiric bizarreness elements come from a defective functioning of the elaboration processes or, instead, are a function of the strong activation of specific memory contents included in the oneiric plot.

At any rate, there is another possibility of study to consider before discarding the hypothesis of an effect of the temporal distance from wakefulness on oneiric bizarreness. The analysis might be extended also to the 5th and to the 6th sleep cycle, possibly collecting protocols in subjects who sleep for a long time.

b) The length of the protocols significantly increased from the first to the third sleep cycle in both stages. The REM reports were significantly longer than St2 protocols in the first and in the second sleep cycle. The mean length of implausible reports was longer than plausible reports, nevertheless the results concerning the relationship between the dream length and implausibility do not appear to be univocal. The increase in length from the first to the second sleep cycle is accompanied by an increase in implausibility, however for stage 2 only. The increase in length from the second to the third cycle is not characterised by an equally significant increase in implausibility in both stages. Furthermore, a smaller length of the St2 protocols in the second cycle goes with a greater presence of both dimensional and spatio-temporal distortions in comparison with REM reports.

It is possible to guess that bizarreness and report length are two independent dimensions of sleep mentation.

c) As for the problem concerning the REM/NREM dream mentation, on the basis of the results obtained, we may conclude that, apart from SO reports, there are no significant differences between the two sleep phases. Once again differences are noted for the first sleep cycle, that is when sleep onset dreams are considered, which are less implausible than the REM ones. This result is also confirmed for spatio-temporal distortions. In the other sleep cycles there are not significant differences in favour of REM, on the contrary, a significantly greater presence of spatio-temporal and dimensional distortions was recorded in stage 2 in comparison with REM. It is surely difficult to interpreter this datum, even though it should be mentioned that, as far as spatio-temporal distortions are concerned, similar observations have already been reported in the literature (15). Lack of univocal differences between the two sleep stages considered weakens the classical correlation approach which inferred a parallelism between physiological activity and mental activity during sleep and led to consider

dream mentation as rigidly stage-dependent. A decidedly more psycological-cognitive approach seems to have a higher heuristic and explicative value. Through the cognitive models, it is perhaps possible to explain the quantitative and qualitative differences in the mental activity present in any sleep phase, by getting free, in part, of the physiological correlate.

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