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Bizarreness in Dreams and Fantasies: Implications for the Activation-Synthesis Hypothesis

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Dreaming is a statistically robust cognitive correlate of REM sleep, but all of its formal features may occur in other states of sleep and even in waking, especially during fantasy. In order to test the hypothesis that the brain basis of such cognitive features as dream bizarreness is to be found in REM sleep neurophysiology, it is critical to quantify bizarreness in dreams and other mental states and to analyze the data with respect to both the magnitude and the kind of bizarreness so measured. Any differences in the cognitive dimensions are candidate correlates of REM sleep neurophysiology. Sixty pairs of home-based dream and fantasy reports were collected from 12 subjects and scored for bizarreness using a two-stage scoring system adapted from Hobson, Hoffman, Helfand, and Kostner (1987). Our results show that bizarreness was twice as prevalent in dream reports as in wake-state fantasy reports of the same subjects. Further analysis of the reports also showed differences in other features including the number of persona and remoteness of time and place.

INTRODUCTION

That dreams are strange is a firm tenet of folk psychology. Recent quantitative psychological studies, inspired by discoveries in sleep neurophysiology (Hobson, 1988), have characterized and quantified this strange quality (which we call dream bizarreness) as discontinuities and incongruities of dream perception and cognition (McCarley & Hoffman, 1981; Hobson et al., 1987).

Based on the assumption that dream bizarreness is the experiential correlate of REM sleep neurophysiology, Mamelak and Hobson (1989) developed a specific quantitative model using a neural net approach to elaborate the original activation-synthesis hypothesis (Hobson & McCarley, 1977). They concluded that in REM sleep the activated and disconnected brain generates internal signals in an erroneous and unpredictable manner because of chemical demodulation. Dream bizarreness may therefore be the experiential correlate of REM sleep neurophysiology.

However, it is by no means universally accepted either (1) that all or even most dreams are bizarre and even if bizarre, (b) that they are uniquely so. Thus Foulkes (1985) has reported that many children's REM sleep dreams lack bizarreness altogether, and Rechtschaffen (1978) has emphasized that in REM sleep dreams of adult subjects, coherence is the rule and incoherence (or bizarreness) relatively exceptional to it. Reinsel, Antrobus, and Wollman (in press) have further claimed

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that while REM sleep dreams are bizarre, they are no more so than reports of either NREM sleep mentation or waking fantasy.

These controversies fly in the face of both common sense and introspection. While dreams are considered strange by almost all adults, few experience the same kinds of discontinuity and incongruity in fantasy that are typical of their dreams. Finally, it seems intuitively unlikely to us that two brain states as physiologically different as waking and REM sleep could possibly be associated with cognitively identical states of mind. In our view, studies failing to show cognitive differences should thus be regarded with suspicion; for us, the ambiguity of the cited results is more likely attributable to limitations in psychological methodology and/or neurophysiological knowledge than to a true cognitive identity between dreaming and fantasy.

We have conducted a quantitative pilot study of bizarre cognition in the home-based dreams and incidental daytime fantasies of 12 adult subjects. Our results indicate that although no absolute distinction can be made between the two states using bizarreness alone as a measure, dreams are quantitatively different from waking fantasies. In the course of our work we have also identified two new factors that may serve to better differentiate the two states: we find a greater number of characters and more remoteness of time and place in dreams than in fantasies. We discuss the fact that these two new factors, like bizarreness, relate to the orientation domain of cognition and interpret the findings in terms of the modified activation-synthesis hypothesis.

METHODS

Subjects

The subjects were 12 students enrolled in a biopsychology course at the Harvard University Extension School (Cambridge, MA). Two subjects were male and 10 were female; the age range was 23 to 45 years of age.

Materials

During the semester students were asked to record, upon awakening during the night and in the morning, any and all dreams remembered. Mental activity occurring during waking was also to be recorded if it met this definition of fantasy: apparently spontaneous mentation of a narrative and/or perceptual nature without clear links to external stimuli or conscious intention. All of these reports were kept in the form of a written journal.

As a way of encouraging self-observation, 10 dreams and 10 fantasies were to be submitted early in the course before any discussion of specific differences between waking and dream cognition had taken place. Twelve of the 40 students reported at least 10 dreams and fantasies and these 12 journals comprise our data set. A total of 60 dream reports and 60 fantasy reports were selected from the sample on the basis of length (>5 lines) and on the presence of descriptions of formed visual percepts. Reports that did not describe any visual experience or

that were not longer than five lines were excluded. The 120 reports selected for quantitative analysis varied in length from 30 to 600 words.

Quantification of Bizarreness in Dreams and Fantasies

Reports were divided into one-sentence units and were scored separately for bizarreness using a scale adapted from the two-stage system developed by Hobson et al. (1987) (see Table 1). The first stage of the scoring system describes the *locus* of the bizarre item: the plot (characters, objects, actions, place, or time) (A), the thoughts of the dreamer or dream character (B), or the feeling or emotion of the dreamer or dream character (C). The second stage describes the *type* of bizarreness as a discontinuity (1), an incongruity (2), or an uncertainty (3). Sentence units containing items considered to be bizarre were categorized as to locus and bizarreness type.

In the example below is an item that is scored as A2 (plot incongruity), since it is improbable that travelers would stuff sheep into their suitcases. The unit scored as A1 describes a sudden, unexpected change to a scene that has no relation whatsoever to the previous one:

> *The driver always returns with a sheep which we put in our suitcase.* (A2) I remain silent throughout the trip and just watch the indian man smile and joke. I worry about the sheep in my suitcase. I keep thinking that the sheep's blood is going to drip from the suitcase as soon as I pick it up and everyone is going to find out about me.
> *I am at a swimming pool watching my sister compete in a swimming match.* (A1)

Bizarre items in the locus of thought or feeling would include sentence units describing, for example, improbable thoughts (B2) or improbable emotions (C2—i.e., emotions or feelings experienced by the dreamer that would be improbable in a particular dreamed or imagined context):

> I'm sitting on the hood of the car which is parked perilously close to the edge of a sand pit, in fact, the front wheels are partly over the edge, *yet I feel very relaxed.* (C2)

The above statement is scored as C2 since it is unlikely that one would be relaxed if such a situation occurred in real life.

TABLE 1
Bizarreness Scale

A1	=	Discontinuity of place, action, characters, objects, and time.
A2	=	Incongruity of place, action, characters, objects, or time.
A3/B3	=	Cognitive uncertainty of dreamer or uncertain qualities of dreamed objects, characters, place, etc.
B1	=	Discontinuity of thoughts of the dreamer or dream character.
B2	=	Incongruous thoughts of dreamer or dream characters.
C1	=	Discontinuity of emotion/feeling.
C2	=	Incongruous emotions/feelings with context of dream.
C3	=	Uncertainty in emotions/feelings.
D	=	Ad hoc explanations.
0	=	Not bizarre.

> I was being taught how to destroy the ship in front of me with a torpedo. I had three choices. *I could blow it up with a torpedo, open it up like a can or just pierce the shell.* (B2)

This statement is scored as B2 since it describes an idea or a thought that does not make sense in terms of wake-state reality. While metaphorically understandable, a ship cannot literally be opened like a can.

The original scale was modified slightly in order to increase reliability of scoring and to investigate new dimensions of bizarreness. For example, the A3 (plot uncertainty) and B3 (cognitive uncertainty) categories were combined into one (A3/B3) because judges could not determine from the written reports whether the uncertainty arose as the subject reported his or her experience or was an inherent property of an imagined or dreamed object, character, or setting.

We also decided to add another category that could not be identified or included in the two-stage system. This category (which we called "D") was used to score ad hoc explanations, those statements that attempted to account for bizarre events in the dream plot (particularly A1's and A2's). For example:

> Everything and everybody is being pulled toward the outside (A2). Like all the other people around me, I am in a panic and try to hold on to anything that is still anchored to the ground . . . A man in a bowler and underwear with little hearts painted on it flies past me and I ask him what's going on (A2). *He says the giant magnet has come.* (D)

Although the explanation itself is both unlikely and inadequate, it seems designed to make sense out of the old situation. Hence, it is both ad hoc and bizarre.

Sentence units could receive more than one score if they contained more than one bizarre element while a unit that had no bizarre qualities received a score of 0. Such sentences were found to describe only straightforward actions, thoughts, or emotions that were continuous, clear, and plausible in terms of wake-state reality.

A bizarreness density for each report was calculated by dividing the number of bizarre items scored by the total number of units. Total densities for each type of bizarreness (A1, A2, etc.) were determined for both categories, dreams and fantasies.

Using this scale, three judges scored all 120 reports for bizarreness after the reports had been transcribed and coded randomly to ensure unbiased scoring. Judges worked individually so that reliability between raters could be determined for the adapted scale.

Blind Assessment of Reports as Either Dream or Fantasy

In addition to testing the differences between dreams and fantasies using the bizarreness scale, we also determined the ability of observers to identify a student's report as either a dream or a fantasy.

The 120-report sample was screened for dreams and fantasies that were 10–15 sentence units in length. Twelve dreams and 12 fantasies were selected, assigned random identifying numbers, and assembled in random order. Judges were then asked to discriminate reports as either dreams or fantasies and to say why and

with what degree of confidence they assigned a given report to one or the other category.

RESULTS

Reliability

The reliability of our bizarreness scoring procedure was determined by measuring the item-by-item agreement between each of the judges. Judges agreed about 80% of the time on both bizarre and nonbizarre items. Agreement on bizarre items alone (i.e., bizarre sentence units scored within the same bizarreness category by each judge) ranged from 50 to 60%. There was also a strong agreement between judges on bizarreness density scores for individual reports (r (judge 1 vs judge 2) = .68; r (2 vs 3) = .75; r (1 vs 3) = .72). Although reports were reliably judged to be more or less bizarre, the precise definition of bizarreness was ambiguous. In order to eliminate ambiguity arising from the indefinite nature of our definition of bizarreness, we decided to focus our analyses upon those items on which two or more judges agreed.

Dream and Fantasy Differences

The scores obtained for individual reports (n = 120) showed that dreams contained an average bizarreness density of 0.223, while the mean bizarreness density for fantasies was less than half of that at 0.089 and this difference is highly significant (t = 4.77, df = 118, $p < .001$). We wondered if the greater bizarreness in dreams was confounded by the length of the report since dreams are significantly longer than fantasies (t = 8.90, df = 118, $p < .001$). We found, however, that bizarreness density was very weakly and insignificantly related to report length (r = .16, $p < .05$).

Having established that dreams do contain more bizarreness than fantasies, we next investigated occurrences of the different categories of bizarreness to see which bizarreness subtypes distinguished dreams from fantasies. An analysis of the density scores for each bizarreness type (per individual report) showed significantly greater scores in dreams for plot discontinuity (A1), plot incongruity (A2), uncertainty (A3/B3), and thought incongruity (B2) categories (Table 2). Of these, plot discontinuity (A1) showed the greatest and most significant difference. No items in either dreams or fantasies were scored as thought discontinuity (B1), emotion discontinuity (C1), or emotion uncertainty (C3).

We investigated the report scores for individual subjects to see if the quantitative difference in bizarreness density between dreams and fantasies was consistent for each subject (see Fig. 1). Seven of the 12 subjects showed significance in bizarreness between their dreams and fantasies. One of the subjects had fantasy bizarreness scores that were actually higher than her own dream scores (as well as everyone else's scores in both categories), but the difference in bizarreness was not significant. That this subject is idiosyncratic is suggested by explicit references to her own magical powers in the fantasy reports.

TABLE 2
Independent *t*-tests of the Difference between the Mean Bizarreness Densities per Category in Dreams and Fantasies

	Dreams (n = 60)		Fantasies (n = 60)				
Type	Mean	SD	Mean	SD	*t*	*p*	Significance
A1	.019	.034	.003	.017	3.29	.001	***
A2	.132	.112	.071	.175	2.25	.025	*
A3/B3	.056	.095	.015	.043	2.96	.0025	**
B2	.010	.028	0	0	2.76	.005	**
C2	.001	.008	0	0	1.40	.10	NS
D	.003	.014	.001	.007	1.07	.25	NS
Total	.223	.120	.089	.182	4.77	.001	***

Note. df = 118.

Subject scores were also analyzed for each type of bizarreness. The profiles of each of the bizarreness categories (see Figs. 2A–2D) indicate that for every category, bizarreness in fantasies came from only a few subjects, whereas bizarreness in dreams usually came from nearly all subjects. Due to high variability among individual reports, few subjects showed significant differences between their dreams and fantasies for each type of bizarreness.

The frequency distribution of the different types of bizarre items in dreams was very similar to that in fantasies (r = .99). Most of the bizarre items were scored as A2 (plot incongruity) in both dreams and fantasies, and the remainder of the items was distributed among the A3/B3, A1, B2, C2, and D categories (see Fig. 3). Although scores for dreams and fantasies parallel each other, it is apparent that dreams have a considerably larger proportion of items scored as A1 (plot

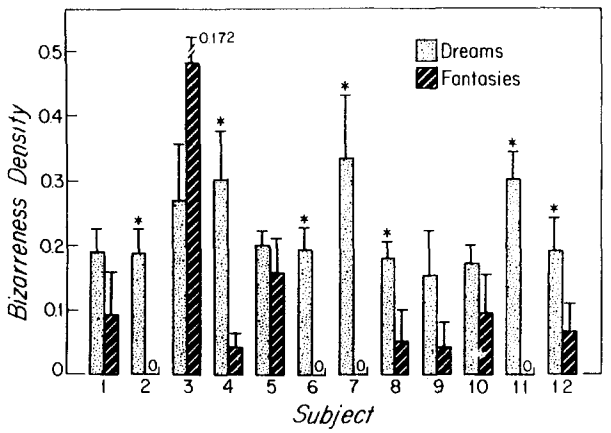

FIG. 1. Mean bizarreness densities for 12 subjects' dreams and fantasies. All but one subject had higher overall bizarreness scores in their dreams than in their fantasies and seven of the individual differences were significant at $p < .05$ by the t test.

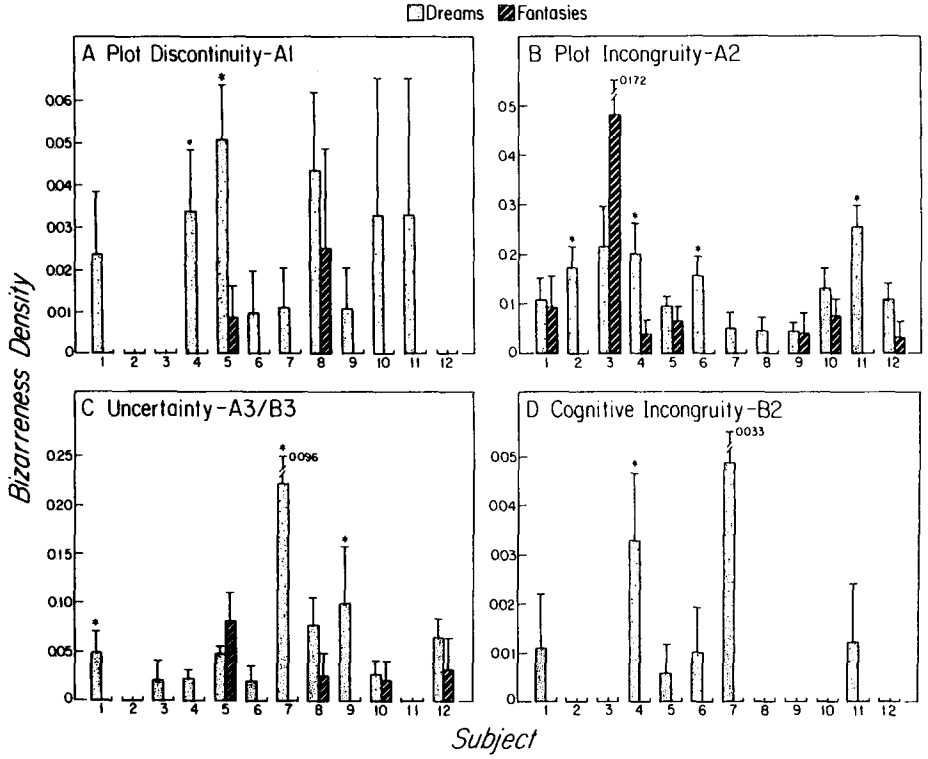

FIG. 2. Mean bizarreness density scores for each category of bizarreness. This figure illustrates the occurrence of the different bizarreness category types among subjects. In general, most subjects' dreams contained bizarreness from all categories, whereas just over half (seven) of the subjects had fantasies that contained plot incongruities and only a few subjects had fantasies that also contained plot discontinuity (two) or uncertainty (four). This suggests that usually only one type of bizarreness (plot incongruity) is common in fantasies and that only a few unique fantasies contain bizarre items of the type that is characteristic of dreams. (A) Two subjects show significantly higher discontinuity scores in dreams. (B) Four subjects show higher plot incongruity scores. (C) Three subjects show higher uncertainty scores. (D) No subjects had any thought incongruity in their fantasies, but only one subject showed significantly higher B2 scores for his/her dreams.

discontinuity) than fantasies (10.75% vs 5.13%). Also, more dreams contained some type of bizarreness than fantasies (see Table 3).

Of the three bizarreness categories that were most common in both dreams and fantasies (see Table 2), dreams were significantly more bizarre in all three (discontinuity, A1; incongruity, A2; and uncertainty, A3/B3). The highest level of significance was in the discontinuity category (A1). No units in fantasies were scored as either B2 (thought incongruity) or C2 (incongruous emotion).

Identification of Dreams and Fantasies

Judges were able to blindly assess a random sample of dream and fantasy reports with 88.7% accuracy. As this qualitative discrimination was generally more successful than one would predict solely on the basis of the observed 2:1

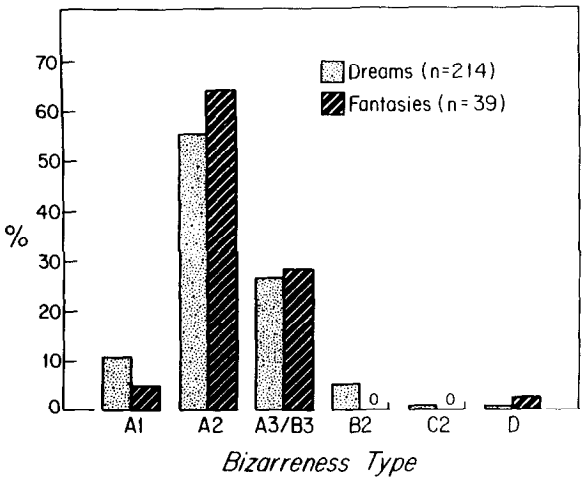

FIG. 3. The bizarre items in dreams (n = 214) and fantasies (n = 39) are subdivided into the different category types. This figure illustrates that the scores for dreams and fantasies tend to parallel one another except in the A1 (plot discontinuity) and B2 (thought incongruity) categories, both of which contain a much higher proportion of items in dreams than in fantasies.

ratio of bizarreness, we sought, in a preliminary way, to tease out other diagnostic features by counting their occurrence in the judge's explanations of their choices.

In our sample, dreams were always set in remote times or places (12/12) while fantasies were far more often current in both orientation domains (6/12). Fantasies involved the first person (self) only in one-third of the reports (4/12) while dreams always involved more than one character (12/12) and one involved more than eight characters (see Table 4).

To investigate the possibility that our cross-sectional design might have blurred other distinctions between the dream and the fantasy domains, we also ranked the reports as to our confidence that they were one or the other on a scale of 1 (unsure) to 3 (very sure). Judges were consistently more sure of their judgment that a report was a dream than it was a fantasy (see Table 4). This finding indicates: (1) that there is a quality easily and confidently detected in many reports

TABLE 3
Percentage of Dreams and Fantasies Containing Bizarreness Categories

	Dreams (n = 60)		Fantasies (n = 60)	
Type	*n*	%	*n*	%
A1	18	30.00	2	3.33
A2	51	85.00	16	26.67
A3/B3	29	48.33	8	13.33
B2	9	15.00	0	0
C2	2	3.33	0	0
D	3	5.00	1	1.67
Total	54	90.00	16	26.67

TABLE 4

Dreams					Fantasies				
Report No.	Bizarreness density	Remote	No. of characters	Mean LOC[a]	Report No.	Bizarreness density	Remote	No. of characters	Mean LOC
1	.091	+	2	2	1	.071	0	1	1.33
2	.143	+	2+	3	2	.300	0	1	1.67
3	.273	+	8+	3	3	0	0	1	2.67
4	.231	+	3+	1.67	4	0	0	2	2.33
5	.143	+	5+	2	5	.083	0	2	2
6	.250	+	5	(2)[b]	6	0	0	2	2.67
7	.273	+	2	3	7	.100	+	3+	(2.67)
8	.333	+	3	3	8	0	+	3	2.33
9	.286	+	3+	2.67	9	.357	+	1+	2
10	.167	+	2+	2.33	10	0	+	1+	2.33
11	.154	+	2	2	11	0	+	2+	2.67
12	.182	+	2+	2.67	12	0	+	1+	2
Means	.211	12/12	3.25*	2.50		.076	6/12	1.67*	2.17

[a] LOC, level of confidence.

[b] Numbers in parantheses mean that all judges scored the report incorrectly with the LOC indicated. These numbers were not included in the calculation of the overall mean LOC.

* ($t = 2.71$, $p < .01$).

of dreams that distinguishes this form of mentation from fantasy and (2) that those reports most confidently judged to be fantasies may also possess a distinctive although less easily legible signature. To illustrate this point we provide two examples both of which concern the subjects' occupations.

Dream-like dream (all judges agreed):

> I am at a flea market, selling junk and clothing to a man who pays me in cash. My mom is there. I walk up to a booth which is Sotheby's in New York City. The antique watches on display for the auction are junk and few in number. The head of the watch department is hostile after an argument. The watch meeting rips apart the hotel, which is an immense glass structure with an orange glow to the interior. I am attending the meeting wearing a Harvard tee-shirt marked in Russian. George Kennan and his wife are on trial there, and we are plotting their escape. I fool the security guards by spraying nitrous oxide from a whipped cream can on the accused, and we elude the police by G.K. making a phone call to his wife to pretend to tell her to accept her fate. We walk out of the hotel casually.

This report is permeated by the sort of bizarre incongruity that is typical of dreaming: the presence of the dreamer's mother at his workplace, the ripping apart of the hotel, the orange glow, the Harvard T-shirt marked in Russian, and the whipped cream can of nitrous oxide are all more extravagant than is typical of fantasy. All judges diagnosed this report as a dream.

Fantasy-like fantasy (all judges agreed):

> I see myself standing on top of a huge sphere. There is nothing else. It is shiny, deep bluish-green, seemingly somewhat translucent. When classes start each term, the sphere starts to move, not spin by seems randomly (but isn't) in all directions, starting, stopping, fast and slow. As long as everything else "out there" is OK, I am fine and can handle it. It's almost, but not quite, fun. A challenge that feels good to handle. Then I see everything "out there" building up, and I can barely balance—there is nothing physical to hold on to; it's just a shiny sphere. Just use skill, plan, keep control to hold on. It always eventually stops, when the semester ends.

This report was consistently judged correctly as fantasy because, despite its vivid hallucinatory quality, it is *not* formally bizarre, involves only the subject, and has a local time reference.

The six most dream-like dreams were not only bizarre in possessing discontinuities, incongruities, and faulty reasoning but they also had a larger dramatis personnae; and the multiple characters acted in more remote time and space frames than was characteristic of the six most fantasy-like fantasies. The other six dreams and fantasies were, by definition, not so clearly different from each other; and it was in this intermediate class that all of our "errors" of judgment fell. Indeed, a few fantasies were very "dream-like" and some dreams were fantasy-like. When we examined specific errors of judgment we found that none of the three distinguishing features of dreams (multiple persons, space-time remoteness, and bizarreness) was absolutely specific to dreams. This means that all three distinctions between dreams and fantasies are quantitative rather than qualitative.

According to comments of judges, those reports that contained some degree of remoteness and absurdity in addition to bizarre elements were scored as dreams. The fantasy reports appeared to the judges to be more intentional, more pleasant, and more "narcissistic." And although scene changes were frequent, they were all connected by a single ongoing thought.

Of all twelve dream reports, only the following one was consistently scored incorrectly as a fantasy by the judges.

Fantasy-like dream:

> I am in a restaurant with a friend heading toward a table. I turn around and see my old roommate from Bard College, Betty Fisher, sitting at a table with another classmate. She has dark hair and looks familiar but I can't remember her name. I go over and hold her very affectionately and kiss her on either cheek. I do the same with the other woman. I say "Oh my God, I don't believe this" It has been thirty years since I've seen Betty and I was thinking about that while I was embracing her. Meanwhile my friend has gone on to the table and is sitting. "Let me give you my address and telephone, 832 Washington St., Brookline 02146 555-1990." There was a man at Betty's table, also, who tries to write down my address. He can't finish it because I go too fast so I end up writing it down. I regret that I can't stay and talk because I must join my friend who is waiting for me.

This report is deceptive because of the abundance of prosaic detail and the lack of bizarreness of the extreme type often seen in dreaming. In retrospect the only feature that is radically inconsistent with this report being a fantasy is the extremely remote time references (the dreamer has not seen Betty for 30 years—an unusually great time dislocation even for a dream).

Here is an illustration of the symmetrical error, a fantasy judged to be a dream.

Dream-like fantasy:

> I am in Cambridge visiting Sally. She's just won her race and everyone has gone wild. People are screaming, standing up in the boats, jumping overboard and swimming in the river. This is the first time that Cambridge has beaten Oxford in years. I get caught in the excitement and get helped over the boats so that I can join Sally and her friends in the celebration.
>
> Sally, Trish, and I are at a huge victory party. Sally is sloshed and standing on top of the bar. Suddenly she simply keels over and is caught by the crowd of people below. Trish and

I try to drag her back to her room but she is too heavy to carry. We see a pair of roller skates in the back, put them on her feet, and wheel her like a wheelbarrow through Cambridge.

Judges diagnosed this report incorrectly as a dream because of the intensity of the subject's involvement in an imagined scenario and the improbability of the human-wheelbarrow-on-rollerskates in the last line. While highly imaginative, the report is not as definitively bizarre as most dreams and is both local in space reference and current in time, as is typical of fantasy.

DISCUSSION

Methodological Problems

One problem with using home-based reports is the lack of controlled conditions for both the dreams and the fantasies. Different settings and reporting techniques of each subject could thus contribute to the high variablility among the report scores. More importantly, in home-based reporting of dreams and fantasies, we cannot be sure that subjects recorded their experiences immediately after they occurred. During a delay, the subjects have the opportunity to further organize and make sense out of their recall and produce a more coherent and edited narrative. As a result, much of the bizarreness in dreams (especially the discontinuity and uncertainty) could be lost by the time the subject described the experience. For this reason, dream and fantasy reports collected in a laboratory setting would be useful to verify the observed differences between dreams and fantasies.

Another disadvantage to using home-based reports is that there is a possibility that some of the dreams used for the data set came from a NREM sleep-state, while some fantasies may have occurred in hypnagogic states with NREM-like physiology. It is well known that sleep onset stage I is associated with dream-like mentation (Foulkes & Vogel, 1965). We made an attempt to reduce this source of error by omitting subjects who explicitly reported that their fantasies arose from a hypnagogic state. Also, as mentioned earlier, we limited our data set to those reports describing visual experience. It has been reported previously that visual episodes are characteristic of REM sleep and not of NREM sleep (Aserinsky & Kleitman, 1953). Therefore, we can reasonably assume that all or most of the "dream" reports we analyzed are from REM sleep arousals.

With respect to the issue of subject compliance, we recognize the possibility that both dream and fantasy reports might have been omitted or edited in order to prevent embarrassment. We do not regard this as likely to confound our analysis because we have no reason to suppose that such distortions would significantly affect the bizarreness score.

Previous Studies Comparing Dreams and Fantasies

Much of what has previously been concluded about fantasy (whether derived from introspective or laboratory observation) has not made direct quantitative comparisons of fantasies with dreams. Many investigators have characterized fantasies as hallucinatory visual experiences (Foulkes & Scott, 1973; Foulkes,

1975; Reinsel et al., in press; McKellar, 1957; Klinger, 1971). Although some fantasies may indeed have a hallucinatory quality, this by no means qualifies them as bizarre by our definition, we take the position that mental imagery in waking, like that in dreaming, may be either banal *or* bizarre.

Foulkes and Fleisher (1975) observed that fantasy reports scored as hallucinatory (by the subjects themselves) were rarely also scored as regressive, and vice versa. Reports with features such as distorted imagery, "bizarre sequencing," or dissociation of thoughts (from the imagined scene) were considered to be regressive. Although Foulkes and Fleisher's regressivity measure was strictly qualitative, it detected some of the same elements as our bizarreness scale. For example, our "B2" category (thought incongruity) would be expected to include the thought dissociation criterion for regressivity in reports.

Based on their laboratory observations, Reinsel et al. (in press) concluded that fantasies contain as much bizarreness as do dreams. Their bizarreness scale employed included (1) discontinuities, (2) improbable combinations, and (3) improbable identities. Their results showed that dream reports from REM sleep awakenings contained *fewer* discontinuities than fantasies from waking with (WS) and without (WO) stimulation. However, the dreams did contain more improbable combinations than fantasies from the stimulated waking condition and three to five times more improbable identities than the fantasies from either condition, a finding in keeping with our results. The uniqueness of bizarreness to REM vs NREM sleep has also been questioned by Antrobus (1983), who found that mentation reports from NREM sleep arousals are much shorter and less detailed in imagery than wake or REM mentation, but contained an equal density of bizarre items as measured by their scale. Utilizing the same data set and the bizarreness scale described here, Porte and Hobson (1986) found that even taking lower word count into consideration, NREM sleep mentation is less bizarre than REM mentation.

For several reasons, we consider all of these results to be consistent with our results and with the predictions of our physiological model. First, we consider improbable identity to be the most bizarre of the three categories. Items included in this category could be scored by our criteria as A1 (for changing identities) or as B2 (when a character looks like a particular person but is perceived as someone else). Therefore, we would predict dreams to contain significantly more items from this category than fantasies, and they do. Second, as will be discussed in more detail below, there are two types of discontinuity that occur in both dreams and fantasies. One type (intentional and influenced by cognitive synthesis and external stimuli) is common in both, and another (involuntary and influenced by internal stimuli) we would expect to be characteristic only of dreams. If both types of discontinuity were lumped together by Reinsel et al., then we could explain their finding that fantasies contain as many or more discontinuities than do dreams.

Theoretical Predictions and Interpretation of Results

Our physiological model of dreaming, called the activation-synthesis hypothesis (Hobson & McCarley, 1977), predicts a difference between REM sleep dreams

and waking fantasies due to the difference in neuronal activity of the brain between the two states (Mamelak & Hobson, 1989). Specifically, during waking it is known that the frontal cortex is both aminergically and cholinergically modulated whereas during REM sleep the firing of the aminergic neurons is shut off thus leaving the forebrain cholinergically dominant (Hobson & Steriade, 1986). It is also known that aminergic neurotransmitters are associated with learning, memory, and selective attention processes (Flicker, McCarley, & Hobson, 1981). Therefore in the absence of aminergic modulation, the brain is unable to adequately organize or record the events in a dream. Second, there is evidence that phasic activity such as eye movements and PGO spikes that occur during REM sleep are triggered by cholinergic neurons (Datta, Calvo, Quattrochi, & Hobson, 1991). Mamelak and Hobson (1989) suggest that such cholinergically mediated activity contributes significantly to changes in thought or scene shifts during a dream.

Fully acknowledging the tentative and speculative nature of our hypothesis, we postulate that dream bizarreness is the direct cognitive correlate of aminergic demodulation of cortical networks in REM sleep. In support of this hypothesis our results indicate that dreams contain more bizarreness as well as other "dreamy" features such as remoteness of time and place than do fantasies. In addition, the fact that both trained and untrained observers could distinguish dreams from fantasies with about 90% accuracy suggests that dreaming and fantasizing are two quite different modes of information processing. The data nonetheless show a continuity of cognitive features across states with a significant area of overlap between inattentive waking and sleep. This finding of cognitive continuity—with only quantitative distinctions between extremes of the continuum—is isomorphic with what we know of brain physiology and has recently been modeled (Hobson, in press) as a three-dimensional state-space (AIM) whose axes are activation level (A), input source (I), and modulation (M). The tendency for the cortex to become sensorially disconnected and to fire autonomously is a function of declining aminergic input. This can occur in inattentive waking, with loss of external signal discrimination (Foote, Bloom, & Aston-Jones, 1983), and it is a regular feature of REM sleep when it is accompanied by an increase in internal stimulus generation. In both cases, the effect on cortical networks underlying internal narrative generation might be expected to be formally similar. Thus the overlap in cognitive features between dreaming and fantasy parallels the physiological continuity of the wake–sleep state boundaries.

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