Effects of Melatonin on Dream Bizarreness Among Male and Female College Students

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Anecdotal reports suggest dreams become more vivid and bizarre while taking melatonin. However, the connection between melatonin and dream characteristics has not been empirically established. The present study investigated the effects of 6 mg of melatonin (versus a placebo) on dream bizarreness in twenty two college students (8 male, 14 female), ages 18-25. The experiment ran for two weeks in which participants received either melatonin or a placebo for six nights. Each morning, participants provided a narrative of their dreams and also used a 7-point scale to respond to 17 questions measuring aspects of dream bizarreness. Bizarreness ratings following melatonin nights were compared with those following placebo nights. It was hypothesized that ratings of dream bizarreness would be reliably higher following melatonin treatments and that women would show greater increases than men. The hypotheses were partially supported by significant results on several specific aspects of dream bizarreness, including "transformations of objects" and "overall transformations." Patterns differed for males and females, indicating that melatonin may, indeed, impact dreaming characteristics and participants' sex must be considered when investigating such effects. (Sleep and Hypnosis 2000;2:74-83)

Key words: *melatonin, dreaming, dream characteristics, dream bizarreness, human sex differences*

INTRODUCTION

Melatonin, a hormone produced and secreted by the pineal gland, is involved in promoting sleep onset and in the synchronization of the circadian sleep/wake rhythm (1-4). A recent estimate puts the US retail market for melatonin at $200 million annually, according to Genzyme, a major manufacturer of synthetic melatonin (5).

The pineal gland secretes more melatonin at night, in part because light suppresses melatonin production. For this reason, melatonin has been termed "the hormone of darkness" (6). Recent research has shown that a supplemental dose of synthetic melatonin can be useful in reducing sleep latency in chronic insomniacs (7) and in alleviating the symptoms of jet-lag (8). The potential benefits of exogenous melatonin in non-clinical populations are less well-established (9-11).

In the popular literature, outrageous claims of the benefits of taking melatonin have ranged from its purported impact on numerous ailments such as cancer, heart disease and AIDS to its beneficial effects on aging, sex, and mood regulation (12-14). Additional anecdotal claims are that dreams become more vivid and bizarre while taking melatonin (14-16). However, systematic studies of melatonin's impact on dreaming variables have not yet been conducted.

Melatonin and Dreaming

Previous research has found that the effects of melatonin on normal, healthy individuals are very subtle. Dawson and Encel state that the effects of melatonin in large doses and on populations with sleep ab-

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normalities are significant. However, melatonin's effects on populations without sleep disorders or in low doses are much less consistent (17). Dawson and Encel also suggest that melatonin should have no effects on dreaming or dream content such as bizarreness (17). Yet, other researchers have informally observed an increase in dreaming or in dream vividness associated with melatonin. Although no mention was made of sex-differences in these purported effects (14-16), the present study sought to examine the impact of gender.

A potential bridge between melatonin and dreaming is through examination of data from electroencephalograph (EEG) measures. Research conducted by Anton-Tay et al. offers evidence for the possible connection between dream bizarreness and increased levels of melatonin in normal, healthy individuals (15). Participants were six male and five female college students. During a 90-min session participants were injected with 1.25 mg (per kg of body weight) of melatonin dissolved in a 1% ethanol solution. Participants in the control group were injected with the ethanol solution alone. EEG, EKG, respiration and GSR were monitored after the dose administration. Fifteen to twenty minutes after melatonin injection, participants fell asleep. Participants were awakened forty-five minutes later and questioned about their sleeping experience. Participants reported "abundant and vivid oneiric (dream-like) episodes" (p. 843). These reported episodes corresponded with increased amplitude and percentage of alpha rhythms observed in participants' EEG readings of the 45 minute sleep period. These results, while provocative, have not been replicated.

The finding that melatonin may influence EEG activity is significant since other research found that altered EEG activity is correlated with dream bizarreness. Tyson, Olgivie and Hunt (18) analyzed spectral and temporal characteristics of EEG alpha within REM periods in relation to dream lucidity and a variety of content dimensions, including bizarreness. Ten participants were aroused from sleep in a laboratory during relatively high or low amplitude REM alpha and asked to give a narrative of their dream experience. The narratives were analyzed using the scoring methods for dream content and bizarreness developed by Harry Hunt and his colleagues (19). One significant finding of the Tyson et al study was that pre-lucid dreams and bizarre content occurred most frequently during high amplitude REM alpha periods, a finding that is consistent with other research (20,21). Since these results suggest a possible link between REM features and dream bizarreness, it is possible that if melatonin impacts REM density, for example, that dream characteristics will be impacted as well.

Sex Differences in Dream Content

The existence of sex differences in dream content has been clearly demonstrated in previous research, as Shafton's review points out (22). Research conducted by Kramer, Kinney and Scharf (23), in particular, bears on the question of gender differences in the vividness of dreams. Kramer et al. compared dreams of eleven male and eleven female participants to the data on gender differences reported by Hall and Van de Castle in 1966 (24). Participants were monitored in a sleep laboratory and awakened after the four REM periods during the night and asked to record a dream narrative. Kramer et al. reported that, overall, women recalled more dreams than men. Of the reported dreams, women reported more cognitive activity and stronger intensity of dreams, while males reported more auditory activity, less intense colors, and the presence of more male characters. The Kramer et al. study, while not addressing the issue of gender differences in dream bizarreness, is consistent with the suggestion that there are qualitative differences in the dreams of men and women. Since women typically have higher dream recall than men (24,25) gender differences may well extend to dream bizarreness given the possibility that higher recall in general may be correlated with the recall of bizarre dream elements. For example, morning recall of dreams reported during earlier REM periods included twice as many bizarre as non-bizarre elements (26).

Measuring Dream Bizarreness

Our measure of dream bizarreness is based on the work of Harry Hunt and his colleagues, who developed a detailed measure of what they call "formal anomalies" in dreams, or various types of dream bizarreness (19,27). Dream bizarreness was measured using either written dream narratives or recorded interviews about participants' dreams obtained in a laboratory which were later analyzed by a team of judges. For most aspects of bizarreness, raters used a three-stage scoring system, with one being the lowest and three being the highest level of bizarreness. The measure was shown to be reliable by testing it on over a thousand dream narratives obtained from various sources. In the present study, we used a self-rated measure of dream bizarreness. The main advantage of this measure is that bizarreness is rated in terms of the subject's own experience instead of on an absolute scale or using a complex narrative analysis.

The following summary identifies the major aspects of Hunt et al's bizarreness measure (19) and how each aspect relates to the present study:

1.Plot Discontinuity: This widely-used indicator of dream bizarreness was included in the present study (also see 14).

2.Hallucinations of Content: According to Hunt et al., three stages of hallucination exist. Stage one involves elements which "while physically and socially possible are unlikely or improbable in the (somewhat idealized) setting of everyday life..." (p.594). Stage two "included all those things which, while perfectly plausible from an abstract 'everyday' perspective, were known to be 'unreal' from special information offered by the subject or available to the rater..." (p.594). Stage three "consisted in the perception of something intrinsically impossible and/or bizarre in an everyday context- either something physically impossible or extremely unlikely or strange..." (p.594). Hunt et al. found that visual hallucinations of content (such as seeing a flying pig) are among the most common types of bizarre dream elements. For this reason, the present study included questions about highly improbable or impossible objects. Both somatic and auditory hallucinations of content were found to be rare by Hunt et al. and were therefore excluded from the present study.

3. Hallucinations of Exotic Settings: Exotic settings are defined by Hunt et al. as "a setting or perspective impossible to the waking reality of the person..." (p.582). The exotic aspects of dream settings were measured in the present study by asking the participants to evaluate how familiar or unfamiliar and how bizarre or ordinary dream settings seemed to them.

4. Anomalies of Affect and Thought: Since we chose to focus specifically on aspects of dream content, this category was not included in the present study.

5. General States or Levels of Consciousness: Some of the most bizarre states described by Hunt et al. were those of trance and coma. Again, this category was not included in the present study because of its narrow focus.

6. Bizarre Personification: Bizarre personification includes characters that are somehow mysterious, divine, or demonic or "monsters" with bizarre combinations of features or inanimate objects that appear to be "alive." We attempted to measure this aspect of participants' dreams with questions about the physical characteristics and the familiarity of objects or characters in the dream.

7. Transformations of Form, Body, or Identity: this dimension was also assessed in the present study via specific questions concerning transformations of the self, objects, characters, and/or settings in the dream.

The Present Study

The purpose of the present study was to investigate the claim that a supplemental dose of melatonin (versus a placebo) may differentially influence the bizarreness of the dreams of healthy, young men and women. The independent variable was a 6-mg dose of melatonin or a comparable placebo in the form of rice flour and the dependent variables were participants' questionnaire-based ratings of aspects of dream bizarreness, including instances of discontinuity, transformations, and features which are out of the ordinary. A within-subjects design was used to obtain dream ratings from participants after taking melatonin and after taking a placebo. On six nights over a two week period, participants received either a 6-mg dose of melatonin or a placebo. Immediately upon awakening, the subject provided a narrative report of the dream he or she was having when awakened. The subject then completed the dream questionnaire, which asked the subject to rate the sensory qualities and bizarre features of the target dream, in relation to his or her typical waking experience.

We predicted that ratings of dream bizarreness would be higher for the dreams reported following melatonin treatment than for the dreams reported following placebo treatment. We also predicted that, in general, women would rate their dreams as more bizarre than men.

METHODS

Participants

Participants were eight male and 14 female college students (Mean age=25) recruited from courses at Santa Clara University, a private, liberal arts university in Northern California. Participants were unpaid volunteers who received research credit in a psychology class, if applicable. The study was reviewed and approved by the Santa Clara University Institutional Review Board (IRB) for research with human subjects. All participants were treated in accordance with APA ethical guidelines.

Potential participants were identified on the basis of their responses on a pre-screening questionnaire that assessed the person's sleep habits and general health history. Individuals who had a family history of any of a number of health conditions (e.g., hypoglycemia, leukemia, depression, steroid use, or were nursing or pregnant) were not invited to participate. We also excluded those persons taking melatonin or prescription medication.

Participants were selected if they slept six or more hours each night, went to bed and arose within an hour of the same times each day, did not drink more than three caffeinated beverages on an average day, and did not consume alcoholic beverages on more than one night per week (Sunday through Thursday). These selection criteria helped to control for major differences in sleeping habits and other factors such as alcohol and caffeine consumption which have been found to influence sleep architecture and natural melatonin levels (13).

Materials

The pre-screening questionnaire consisted of questions asking about the participant age, sex, average number of hours slept on Sunday through Thursday nights (on a numerical scale from 3 to 10), how often they went to bed and got up within an hour of the same time on Sunday through Thursdays (always, usually, sometimes, rarely). The questionnaire also asked how often participants recalled their dreams (every night, 3-5 per week, 3-5 per month, or 3-5 per year), how many caffeinated beverages were consumed on a typical day (0-8), and on how many nights alcohol was consumed between Sunday and Thursday (0-5). For those nights (Sunday through Thursday) on which participants consumed alcohol, they were asked how many alcoholic beverages were typically consumed each night (1-8). Finally, participants were asked if they were currently taking melatonin.

The melatonin used was in the form of a synthetically-manufactured powder in a gelatin capsule that was purchased at a vitamin retailer. Each gel cap contained 3-mg of melatonin. Sterilized preparation of the melatonin capsules was not necessary because they were prepared commercially.

The placebo consisted of a gel cap of similar size and appearance to the melatonin caplets, filled with heat-sterilized rice flour. Individual gel caps were filled under a Laminar flow hood using heat-sterilized metal instruments; each gel cap was opened, filled with the rice flour using a metal spatula and then closed. The placebo capsules were kept under the Laminar flow hood to maintain their sterility until they were ready to be placed into each subject's packet. Before placing each gel cap into the packets, the excess flour was wiped from the outside of the gel caps with sterile gauze. The capsules were then placed into 2" x 3" manila envelopes, each containing two capsules.

The qualities of participants' dreams, including aspects of dream bizarreness, were measured via the sleep and dreaming questionnaire we developed (based on the work of Harry Hunt and his colleagues). Participants self-rated several aspects of dream bizarreness using a Likert-type scale (1-7). For example, participants rated the physical characteristics and transformations (defined as the physical change of one thing into another) of objects, setting, and dream characters (1=ordinary; 7=bizarre). Actions and events in the dream were also rated on the same scale. Participants then rated the familiarity of dream characters, objects, and settings (1=familiar; 7=unfamiliar). Finally, participants rated the plot of their dreams (1=coherent; 7=fragmented). For each question, the subject could indicate that the question did not apply to that dream. Other questions assessed the sensory, affective and structural features of the dreams. Results related to the latter questions are not discussed in the present paper.

Design and Procedure

The independent variable was a 6-mg dose[1] of melatonin or a comparable placebo in the form of rice flour; the dependent variables were subjects' questionnaire-based ratings of aspects of dream bizarreness, including instances of discontinuity, transformations, and features which are out of the ordinary. A within-subjects, repeated measures design was used to obtain dream ratings from participants after taking melatonin and after taking a placebo.

The instruction sheet detailed the experimental protocol, including when and how to take the capsules. Participants were instructed to ingest the gel caps with a full glass of water 30 mins before going to bed. If the subject was unable to take the capsules on a given night, he or she was to resume the study the following night and ingest the capsules intended for the skipped night. Participants were told that, although they could skip one day, they were not to skip any envelopes. The order of administration of melatonin or placebo was counterbalanced using block randomization. All possible combinations of three nights of melatonin and three nights of placebo were represented to control for any carry-over effects which may have occurred. This resulted in six different orders in which the capsules could be taken and to which subjects were assigned so that there were roughly equal numbers of subjects in each order.

Health variables controlled for were: diabetes, hypoglycemia, depression, leukemia, epilepsy, auto-immune diseases, pregnancy, nursing of infants, severe allergies to food or medication, and steroid use. Potential participants who reported having experienced any of the above conditions were not invited to participate in the study.

Additional procedural controls included the stability of the participant's sleep schedule, timing of dose ingestion, age of participant, and instructions given to participants. Stability of sleep schedule was defined as going to bed and waking up within an hour of the same time each day. Regularity of sleep schedule was also controlled by eliminating Friday and Saturday nights from the study, given that college students are more likely to have irregular sleep schedules and to consume alcohol on weekends. Timing of ingestion of melatonin and placebo was controlled by asking all participants to ingest their nightly capsules thirty minutes before going to bed. Ingestion timing was also controlled by instructing participants that if circumstances arose which would prevent them from ingesting the dosage at their established time, to skip the dosage on that night and take it the following night. The stated reasons for skipping an ex-

perimental night included excessive consumption of alcohol or caffeine or going to bed at a time significantly different from their established bedtime. Only one such "make-up" night was permitted. The age of participants was controlled by selecting only those participants who were between the ages of eighteen and twenty-five. This was done in order to decrease the effects of age on sleep and dream content[6].

Students interested in serving as participants first completed the pre-screening questionnaire. Eligible participants were then contacted to set up an orientation meeting. At this meeting, the participant was told that he or she would be involved in a study of the effects on melatonin on dream content that would require a two week commitment, excluding Friday and Saturday nights.

Each participant was given a 9 x 9 inch manila envelope containing an instruction sheet, nine legal-sized envelopes labeled "Day 1" through "Day 9" with questionnaires in each. Each legal-sized envelope was labeled with the night the participant was to ingest that packet's contents. Envelopes labeled "Day 4" through "Day 9" also contained smaller, 2 x 3 inch manila envelopes with either two 3 mg capsules of melatonin or placebo. Participants were instructed to store the packets in a cool, dark, and dry place to maintain the potency of the melatonin.

The experimenter explained the packet of materials, emphasizing the experimental protocol which was also detailed in the instruction sheet. The participants were told to open the envelope labeled "day 1" on the first night, the envelope labeled "day 2" on the second night, and so on. They were instructed to take the enclosed caplets (if any) thirty minutes before going to bed (with a full glass of water). Participants were told that if they were unable to ingest the dosage for a given night, to take the package intended for the skipped night on the following night and then resume the schedule as before. The researchers informed the participants that they would be contacted by phone in order to check their progress, answer any questions, and arrange a meeting time for returning the materials and debriefing. Participants were also instructed to complete the sleep and dreaming questionnaire immediately upon awakening the following morning and to return the questionnaire to the same envelope. Participants were given the name and phone number of a researcher to contact if they had any questions or concerns.

Participation in the study took place over Sunday through Thursday nights of two consecutive weeks. For the first three days, participants were not given any capsules but were asked to complete the questionnaire the following mornings. The purpose of the first three questionnaire administrations was to accustom the participants to filling out the forms and to raise the level of dream recall. On the fourth day, participants started the ingestion of placebo or melatonin, which continued for the remainder of the study. Immediately upon awakening each morning, participants completed the questionnaire and returned it to its original envelope. Completion of the dreaming portion included a written narrative description of any dream recalled upon awakening, and completing the bizarreness measure described above. The participants then noted the time of ingestion of capsules and the time he or she went to sleep and woke up. Participants were instructed that, if they were unable to recall a dream, they should indicate that on the first sheet of the questionnaire. The participants' final task was to return the large manila envelope with the nine completed questionnaires to the researchers.

Half-way through the study, researchers contacted each of the participants by telephone to check on their progress, answer any questions and set up an appointment time for the return of the experimental materials and a debriefing. At the end of the two week period, researchers and the participants met individually to collect materials and debrief. During debriefing, researchers informed participants that their individual responses were confidential and that all data would be compiled as a group rather than individually, explained that deception regarding treatment condition was necessary to minimize expectancy effects, and explained how participants could obtain more information on melatonin if desired. Researchers also answered any questions the participants had and gave research participation credit, if applicable.

After the packets were returned by participants, researchers coded each questionnaire with either an "M" or a "P," corresponding to whether the questionnaire had been completed following a melatonin night or a placebo night, respectively. As the materials were examined for coding, we discovered that participants had a lower level of dream recall than we had hoped for. As a result, it was necessary to consider only one night of dream recall and ratings for each condition. Participants who did not recall at least one dream under both the melatonin and placebo conditions were excluded from the analysis, reducing the sample size from forty three to twenty two (eight males, fourteen females). For participants who recalled more than one dream in either condition, the researchers randomly selected (by flipping a coin) one observation from each condition for data analysis.

RESULTS

Data Scoring

Several new variables were computed by averaging scores on particular questions for each participant. A measure of the "bizarreness of physical characteristics of dream elements" was created by combining the ratings of

the bizarreness of: physical characteristics of the dreamer's self; other characters in the dream; other objects in the dream and the setting of the dream (Qs 1-4). A second measure, "bizarreness of overall transformations," was obtained by averaging each subject's responses to questions regarding bizarreness of transformations of the dreamer's self; other dream characters, objects in the dream, and the setting of the dream (Qs 5-8). A third measure, "bizarreness of the dreamer's self in the dream," was computed by averaging each subject's responses to questions regarding the bizarreness of physical characteristics of the dreamer's self, transformations of the dreamer's self, and the bizarreness of the dreamer's own actions (Qs 1,5,9). A fourth measure, "bizarreness of other characters in the dream," was obtained by averaging each participant's ratings of the bizarreness of the physical characteristics of other characters in the dream, transformations of other characters, and bizarreness of other character's actions (Qs 2,6,10). A fifth measure, "familiarity of dream elements," was obtained by averaging each participant's ratings of the familiarity of: other characters, objects, and settings (Qs 14-16). A sixth measure, of overall bizarreness, was created by averaging each participant's ratings over all seventeen of the questions on the bizarreness scale. Table 1 presents the mean ratings given by male and female participants for each of the original questions. Table 2 present along with the six computed variables, as a function of the treatment (melatonin or placebo) and sex of subject.

Statistical Analyses

Separate MANOVAs (using SPSS) were performed to analyze the effects of melatonin and sex on each of the seventeen questions on the bizarreness scale and for the six, computed, variables. An alpha level of .05 was used for all statistical analyses.

Differences Across Melatonin and Placebo Conditions

Significant differences in the way that melatonin effected males and females were observed for two variables. Treatment (melatonin versus placebo) interacted with sex in participants' mean ratings of "transformations of objects in dreams," (Q 7) F (1,9)=7.26, MSe=16.89, p=.02 (see Figure 1).

When melatonin had been ingested the previous night, higher mean ratings of "transformations of objects" were reported by females (M=3.20) than by males (M=2.40). When the placebo had been ingested the previous night, higher mean ratings of "transformations of objects" were reported by males (M=4.00) than by females (M=2.33).

There was also a significant interaction effect for treatment and sex in the mean ratings of "transformations in general" (Qs 5-8); F (1, 11)=4.51, MSe=4.16, p=.05 (see Figure 2).

Under placebo conditions, higher mean ratings were observed for males (M=3.33) than for females (M=2.19). Under melatonin conditions, higher mean ratings were observed for females (M=2.83 than for males (M=2.45).

Several other differences between men and women were suggestive. The "bizarreness of other dream characters' actions" was given higher ratings by females (M=3.47) than by males (M=1.68), F(1, 17)=4.46, MSe=5.63, p=.05.

The mean rating for "bizarreness of transformations of self in the dream" tended to be higher for males (M=2.73) than for females (M=1.33). This sex difference approached, but did not reach, statistical significance, F(1, 8)=4.42, MSE=1.63, p=.06.

Participants tended to rate objects in their dreams as less familiar in the melatonin conditions (M=2.62) than in the placebo conditions (M=3.10). This treatment effect approached, but did not reach, statistical significance, F (1, 19)=3.93, MSE=2.38, p=.06.

No other variables, whether indexed by individual questions on the bizarreness questionnaire, or by the combined ratings across several questions, revealed significant differences across the melatonin and placebo conditions, or between males and females.

DISCUSSION

We originally predicted that participants, especially the women, would report higher levels of dream bizarreness in the melatonin condition than in the placebo condition. The data were partially consistent with this prediction in that sex differences did qualify melatonin's impact on participants' ratings of two aspects of dream bizarreness.

Women rated the transformations of objects and overall transformations as more bizarre under the melatonin condition than under the placebo condition; the opposite pattern was observed for males (see Figures 1 and 2).

Figure 1. Mean bizarreness rating of transformations of objects for males and females as a function of condition.

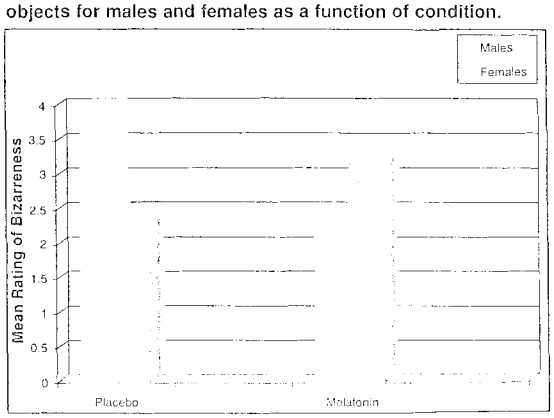
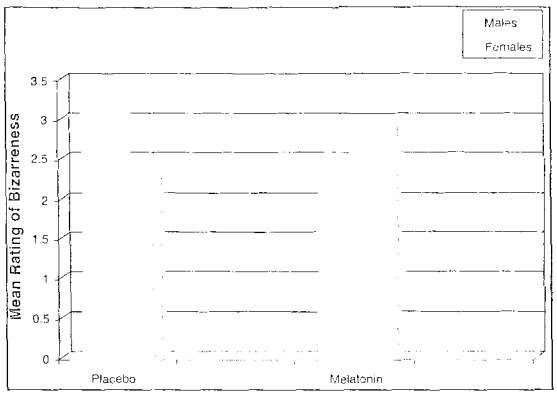


Figure 2. Mean bizarreness rating of overall transformations (questions 5-8) for males and females as a function of condition.



The results regarding sex differences between males and females support previous claims that there are significant sex differences in dream content (23,29), and suggest that the impact of melatonin on dream bizarreness may be different for men and women. In light of the present evidence that melatonin influences dream bizarreness differently in men and women, the question of how melatonin might impact dreaming deserves some discussion.

Melatonin, Sleep and Dreaming

Melatonin could impact dreaming via its effects on rapid-eye-movement (REM) sleep. Although vivid, narrative dreaming does occur outside REM sleep, particularly in late-night Stage 2 sleep (30), REM remains the sleep stage most strongly associated with vivid dreaming (31,32) Thus, an alteration in REM patterns may have an effect on the characteristics of dreams (28). On the other hand, it may be that the relationship between REM features and dream characteristics, especially dream bizarreness, has been overstated (26). David Foulkes, for example, has argued persuasively that dreams are typically neither bizarre nor fantastic (33,34). It is telling that the bizarreness ratings in the present study were, in general, not high and tended toward the "ordinary, familiar, and coherent" rather than the "bizarre, unfamiliar, and fragmented" anchor points (see Table 1 and 2).

Table 1. Mean ratings of dream qualities as a function of gender of participants and melatonin (Mel) versus placebo (Plc) conditions

Question Number	Males			Females		
and Dream Quality:	Mel	Plc	n	Mel	Plc	n
Physical characteristics of:						
1) Myself	2.29	1.88	(8)	1.46	1.50	(14)
S.E. Mean:	(.84)	(.74)		(.28)	(.34)	
2) Other characters	1.88	2.00	(8)	3.00	2.43	(14)
S.E. Mean:	(.48)	(.69)		(.75)	(.59)	
3) The objects	1.71	2.43	(7)	3.15	2.14	(14)
S.E. Mean:	(.71)	(.95)		(.52)	(.48)	
4) The setting(s)	2.75	3.57	(8)	4.08	3.29	(14)
S.E. Mean:	(.70)	(.92)		(.68)	(.62)	
The transformations (physical change of one thing into another) of:						
5) Myself	2.67	2.80	(5)	1.44	1.22	(9)
S.E. Mean:	(1.67)	(1.11)		(.24)	(.22)	
6) Other characters	2.40	3.00	(5)	2.78	2.11	(9)
S.E. Mean:	(1.17)	(.91)		(.76)	(.75)	
7) The objects*	2.40	4.00	(5)	3.20	2.33	(10)
S.E. Mean:	(.87)	(1.03)		(.71)	(.69)	
8) The setting(s)	2.40	3.50	(5)	3.91	3.10	(11)
S.E. Mean:	(.98)	(1.44)		(.71)	(.78)	
9) My actions were:	2.88	2.00	(8)	2.54	3.07	(14)
S.E. Mean:	(.88)	(.54)		(.48)	(.50)	
10) Others' actions were:**	1.38	2.00	(8)	3.39	3.57	(14)
S.E. Mean:	(.18)	(.37)		(.62)	(.54)	
11) The impersonal events (not actions of characters) that occured were:	3.12	4.50	(8)	3.92	3.54	(13)
S.E. Mean:	(.87)	(.89)		(.67)	(.72)	
12) The sequence of events was:	3.25	2.86	(8)	2.92	3.39	(13)
S.E. Mean:	(.96)	(.88)		(.64)	(.59)	
13) The situation (the arrangement or combination of objects or people in the dream) was:	4.57	3.25	(8)	4.14	2.14	(14)
S.E. Mean:	(.68)	(.75)		(.59)	(.63)	
Familiarity:						
14) To me, the other characters were:	2.88	2.33	(8)	3.57	3.29	(14)
S.E. Mean:	(.69)	(.67)		(.73)	(.71)	
15) To me, the objects were:	2.12	3.71	(8)	3.21	3.50	(14)
S.E. Mean:	(.48)	(.92)		(.49)	(.60)	
16) To me, the setting was:	3.87	4.43	(8)	4.14	4.64	(14)
S.E. Mean:	(.88)	(.95)		(.57)	(.73)	
Plot:						
17) The plot of the dream was:	3.75	3.43	(8)	4.27	3.00	(14)
S.E. Mean:	(.80)	(.87)		(.63)	(.50)	

Anchor points (1 and 7, respectively) were: "ordinary" and "bizarre" for questions 1-13; "familiar" and "unfamiliar" for questions 14-16; and "coherent" and "fragmented" for question 17. *Gender by treatment interaction significant $p<.05$ **Gender main effect significant $p<.05$

Table 2. Mean ratings and standard error of the mean (S.E. Mean) for the six computed variables as a function of gender of participants and melatonin (Mel) versus placebo (Plc) conditions

	Males			Females		
Aspect of Dream Bizarreness:	Mel	Plc	n	Mel	Plc	n
1) Physical characteristics of dream elements:						
Mean:	2.15	2.50	(8)	2.96	2.34	(14)
S.E. Mean:	(.30)	(.57)		(.42)	(.34)	
2) Overall transformations:						
Mean:	2.45	3.33*	(6)	2.83	2.19*	(12)
S.E. Mean:	(.67)	(.76)		(.54)	(.66)	
3) Bizarre elements involving self:						
Mean:	2.52	2.25	(8)	2.00	2.06	(14)
S.E. Mean:	(.73)	(.26)		(.36)	(.34)	
4) Bizarre elements involving others:						
Mean:	1.79	2.24	(8)	3.03	2.71	(14)
S.E. Mean:	(.26)	(.34)		(.54)	(.47)	
5) Familiarity of dream elements:						
Mean:	2.96	3.25	(8)	3.64	3.81	(14)
S.E. Mean:	(.38)	(.73)		(.42)	(.56)	
6) Overall bizarreness:						
Mean:	2.74	3.04	(8)	3.28	2.99	(14)
S.E. Mean:	(.35)	(.41)		(.38)	(.33)	

Anchor points (1 and 7, respectively) for variables 1-4 and 6 are "ordinary" and "bizarre"; for variable 5, "familiar" and "unfamiliar". *P<.05

Melatonin's Effects on Sleep Architecture

Several studies suggest that melatonin intake results in altered patterns of REM sleep during the night. James et al. (10) found that if participants took 5 mg of melatonin before bedtime, they experienced longer periods of REM latency during the night, defined as longer-than-normal times between REM periods. Participants were given either a 1 or 5-mg dose of melatonin fifteen minutes before going to bed and polysomnographic readings were taken throughout the night. Participants in the 1 mg condition showed no differences from the placebo group. Participants who received 5 mg experienced significant prolongation of REM latency; however, overall REM time and REM percent were not changed.

Melatonin's effect on sleep architecture was also explored in a study discussed by Anton-Tay (35). Participants were orally given 250 mg of melatonin dissolved in 400 mg of carbowax or 400 mg of carbowax, four times a day for six consecutive days. In the melatonin condition, polygraphic (EEG) readings showed significant enhancement of stage two sleep and shortening of stage four sleep. This suggests that increased levels of melatonin may promote the stages of sleep in which dreaming is more likely to occur (REM and stage 2) and decrease the stages of sleep when dreaming is least likely to occur (stages 3 and 4). Unfortunately, these findings are not conclusive, nor have they been replicated. Other research indicates that increased levels of melatonin may not have an effect on sleep architecture (17).

Melatonin, Dreaming, and Sex Differences

The study of EEG patterns may be useful when considering our observed gender differences in melatonin's effect on dreaming. Sex differences have been observed in sleep EEG readings of young men and women (36). The normal sleeping patterns of participants between the ages of nineteen and twenty eight were monitored by an EEG and EMG in a sleep lab. The researchers found no significant differences in the length of REM sleep of men and women, however, there was a significant difference in the power densities (clusters of high amplitude EEG waves) of men and women during REM sleep. Women experienced much higher power densities than men during REM sleep. These results suggest that there are sex differences in sleep patterns and EEG readings in young adults (37,38). Although we were not able to measure participants' EEGs in the present study, the results of the aforementioned studies are consistent with our observations that a connection between melatonin, dream bizarreness and gender does exist.

Conclusions and Suggestions for Future Research

The present study offers qualified support for here to fore anecdotal claims that melatonin impacts dreaming variables; in the present study, dream bizarreness. Although the effects of melatonin on dream bizarreness were observed for only three of our questions; the fact that any effects of melatonin on dream bizarreness were found is provocative. The present findings must be considered preliminary in light of our small and unequal samples of men and women and the fact that we were able to obtain dream ratings under only one melatonin condition and one placebo condition. Hence, an important suggestion for future research is to recruit a larger participant pool with equal numbers of males and females who evidence

stable dream recall.

Another suggestion for future research on melatonin and dream bizarreness is to conduct the study in a sleep laboratory, permitting polysomnographic recordings of major sleep variables, control of the administration of melatonin, and an index of the sleep stage associated with dream recall. However, dreams in the lab are qualitatively different from home dreams and are often less vivid and bizarre (39). On the other hand, some researchers argue that dreams collected in the sleep laboratory are actually more representative of dreams in general (31). Clearly, the method used to sample dreaming experience is an important issue since the "defining" features of dreams may look very different when dreams are sampled at home versus in the sleep lab. Such methodological issues are important for researchers investigating possible correspondences between sleep physiology and dreaming and point to the desirability of including even minimal psychophysiological recordings when dreaming is studied in a home setting.

Footnotes:

[a] This dosage is justified since melatonin has been found to be safe with little or no side effects at dosages of 250 mg (35).

[b] Zepelin (40) found an age-related decline in dream bizarreness and other content variations. Therefore, it was important to select a group of participants of relatively the same age.

[c] Because melatonin is a hormone, it may interact with other hormones and, therefore, with a woman's menstrual cycle. As such, the relationship between melatonin and dreaming may vary for men and women because of hormonal changes associated with women's menstrual cycles (22,41).

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