Study Objectives: To describe emotional experience during sleep-onset rapid-eye-movement [REM] SOREM sleep and nighttime REM in narcoleptic patients and to relate any differences in REM emotion to the more general abnormalities of this disorder.

Design: Awakenings were performed from SOREM (REM at the onset of daytime naps and nighttime sleep) and nighttime emergent (ascending) REM in 15 patients with narcolepsy and from nighttime REM in 9 normal healthy participants. Subjects rated the occurrence and intensity of discrete emotion types for each line in their REM-mentation reports. Fragmentation of REM was measured and related to emotion.

Setting: Subjects were studied in their own homes over 2 consecutive days and nights (3 nights for normals) and were monitored by ambulatory polysomnography.

Participants: Fifteen patients with narcolepsy, aged 17 to 70 years (mean = 45.3) and 9 normal healthy subjects, aged 31 to 60 years (mean = 43.0).

Results: Emotions were found more often and were more intense in narcoleptic SOREM than in nighttime REM of either narcoleptic or normal subjects, with anxiety/fear exhibiting the strongest increase, followed by joy/elation. Comparing nighttime REM in narcoleptic and normal subjects, narcoleptics were found to have more intense feelings of anxiety/fear and of joy/elation but to have a less frequent experience of surprise and anger. Positive and negative emotions occurred in a balanced fashion in SOREM and nighttime REM in narcoleptic subjects. In the SOREM of narcoleptic patients, high levels of positive emotions, in particular of joy/elation, were associated with a less fragmented (more stable) REM sleep.

Conclusion: The REM sleep of patients with narcolepsy affords a unique opportunity to study emotion and to analyze its psychophysiology. Narcolepsy intensifies REM-dream emotion, especially anxiety/fear and joy/elation, and this is most clearly seen during SOREM sleep. The changes in REM emotion of narcoleptic patients could reflect the effect of the fundamental pathology of this disorder upon neurobiologic systems that support cognitive-emotional functions.
the required time. Eight of the remaining 15 patients held or had recently held leading positions in the Norwegian Narcolepsy Association. The group of narcoleptic patients did not exhibit an elevated level of depression on the Beck Depression Inventory when compared to the normal control group.

All 15 narcoleptic subjects were HLA-DR2 type positive, reported a history of cataplexy, and revealed both increased sleepiness and the occurrence of SOREM episodes on the Multiple Sleep Latency Test. Four patients used no medication, 11 used stimulants (amphetamine or methylphenidate), 1 used paroxetine, and 2 used fluoxetine. Medications used to treat narcolepsy or that were known or assumed to affect sleep were discontinued at least 1 week before the study onset.

Nine healthy adults, aged 31 to 60 years (mean, 43.0; SD = 8.7) constituted the normal control group. (Additional information about this control population has been previously published.) These participants were either acquaintances of patients with narcolepsy (n = 4) or were recruited through advertisements (n = 5). None of the controls used any medication known or suspected to affect sleep. No subject in either group suffered from sleep apnea, restless legs syndrome, or any other identified disorders known to alter sleep, and they had no history of psychiatric disorders.

Apparatus

Six channels on an Oxford Medilog ambulatory system (9000) were used, of which two recorded electroencephalogram (C4-A1 and C3-A2), two recorded electrooculogram (left and right outer canthus with referrals to A1), and two recorded submental electromyogram (EMG). Signals were stored on cassette tape and simultaneously displayed on a portable Toshiba 3200 SXC personal computer. The REM periods were identified using Rechtschaffen and Kales’ criteria, modified to allow for tonically enhanced EMG amplitude during sleep-onset REM (SOREM) in narcoleptic patients.

Participants slept in their own beds in their own homes. The experimenter was situated in a room separated from the bedroom by at least one closed door and performed awakenings through a portable, 2-way intercom system. In the narcolepsy group, windows were covered during daytime sessions.

Scoring of Emotions

For each line in a written mentation report form, eight columns were used to indicate any experience of the following emotions or groups of emotions: anger, anxiety/fear, sadness, shame, joy/elation, love/eroticism, surprise, and “other” emotions. For the “other” category, subjects described the type of emotion at the bottom of the form. The numbers 1 (low), 2 (medium), and 3 (high) were used to indicate the intensity of emotions. No attempt was made to distinguish between emotions and moods; the subjects were instructed to register any experience of emotion regardless of its duration or the degree of relatedness to formal dream elements.

Table 1—Emotion types and emotion categories. Emotions were classified as positive, negative, or neutral. The last two types, frustration/irritation and stress/despair, were defined post-hoc and were indicated by subjects under the category of "other."

<table>
<thead>
<tr>
<th>Emotion type</th>
<th>Positive emotions</th>
<th>Negative emotions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety/fear</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Anger</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Joy/elation</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Love/eroticism</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Sadness</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Shame</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Surprise</td>
<td></td>
<td>Neutral</td>
</tr>
<tr>
<td>Frustration/irritation</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Stress/despair</td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

The emotion types that were reported by the subjects using this instrument, and the categories into which these emotions were sorted, are shown in Table 1.

A single entry of emotion on a report form was defined as an emotion incident. The emotion (type) incidence rate for a report was defined as the total number of different emotions in that report.

The report prevalence of emotion for each subject was defined as the percentage of reports from that subject with at least one incident of emotion. The prevalence of a particular emotion or class of emotions for a subject was defined as the percentage of reports from that subject containing at least one incident of that emotion or class. The overall prevalence of a particular emotion or class of emotions was defined as the average subject report prevalence for that emotion or class.

When analyzing the intensity of emotion, only those reports (and subjects) were included that had at least one entry of the emotion or emotion class in question. When more than one incidence of a particular emotion type was present in a report, the highest intensity score for this type was used. The general intensity level of a REM report was defined as the highest intensity score for any emotion type in that report.

Some analyses were performed using a total score for emotion for each report. This total emotion score was defined as the sum of the highest intensity scores for the different emotion types noted in that report. For example, a report with the following emotion entries would be given a total emotion score of 5: anxiety/fear 1, joy/elation 2, surprise 2, joy/elation 1.

Fragmentation of REM

The relation between emotion and the stability or fragmentation of REM sleep was investigated by use of a fragmentation index. This index reflected the total number of brief arousals from sleep, as well as brief stage non-REM (NREM) intrusions within a REM period. Arousals and NREM intrusions were identified as the conjunct occurrence of increased EMG potential lasting at least 1.5 seconds, together with electroencephalographic changes indicative of waking or NREM. For each REM period, a fragmentation density score was calculated by dividing the sum of brief arousals and intermittent NREM intrusions by the number of minutes spent in REM.

Time Since Sleep Onset

For SOREM sleep, we investigated changes in emotion as a function of total time spent in sleep before awakening. The SOREM reports from each subject were divided into an early-report and late-report subset. The sleep time since sleep onset was defined as the time from sleep onset to the start of SOREM plus the time spent within SOREM. Reports with a sleep time since sleep onset less than the median were combined into the early subset, while those with times greater than the median made up the late subset. For subjects with an uneven number of reports, the median report was grouped with the subset having a mean sleep time from sleep onset closest to the median value. Emotion scores used for each report were the total scores.

Procedures

Due to the need to keep the narcoleptic patients off medication, all of the recording sessions for these subjects had to be performed intensively during the available time window. A pilot study showed that 2 consecutive days and nights were generally manageable for most subjects. The daytime sessions were scheduled 3 to 5 hours after habitual morning awakening. The order of the nighttime and daytime sessions was counterbalanced across subjects. The control group was studied for 3 consecutive nights, which gave both an additional nighttime session but one less experimental session than in the narcolepsy group. On each night, all subjects slept through at least one full REM period without being awakened. Awakenings were performed between 5 and 15 minutes into nighttime REM periods and between 3 and 15 minutes into SOREM.
In order to minimize the possible influence of fragmented sleep on mental activity, awakenings were performed immediately upon spontaneous arousal or transition to NREM if the awakening criteria were otherwise met. Awakenings were not performed if the last minutes of the REM record had dissociated features from NREM or waking, such as spindles, alpha activity, or a combination of tonically active EMG and a lack of REMs (for an example, see Broughton et al’s previously published work). Upon being awakened, participants wrote down their preawakening conscious experiences in as much detail as possible; they then indicated the type and intensity of emotion on all appropriate report lines. In addition, participants rated their level of self-reflective awareness and of experienced control over the course of the mental activity and chose a photograph from a photo board that best matched the vividness of their most vivid visual hallucination. (We have previously described these procedures in greater detail.)

### Table 2—General characteristics of REM mentation reports

<table>
<thead>
<tr>
<th>REM condition</th>
<th>Number of reports with content (% of all reports)</th>
<th>Mean time in REM (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOREM narcolepsy¹</td>
<td>62 (98)</td>
<td>6.7</td>
</tr>
<tr>
<td>Nighttime REM narcolepsy</td>
<td>71 (87)</td>
<td>8.9</td>
</tr>
<tr>
<td>Nighttime REM normals</td>
<td>88 (89)</td>
<td>8.8</td>
</tr>
<tr>
<td>Total</td>
<td>221 (91)</td>
<td>8.2</td>
</tr>
</tbody>
</table>

¹Only 13 of the 15 narcoleptic subjects had reports from daytime SOREM sleep; REM, rapid eye movement; SOREM, sleep-onset REM

The frequency and timing of mentation reports from the narcoleptic and normal subjects are shown in Table 2.

### Statistical Analysis

Analyses were performed on subject averages. Differences were tested using ANOVA when appropriate and possible. Other analyses were performed using paired and unpaired t tests or nonparametric equivalents. In some cases, narcoleptic subjects were excluded from comparisons due to their failure to enter SOREM. Additional analyses were performed using the mentation report as the unit of statistical analysis to control for type II errors. The analyses were performed using SPSS (SPSS, Inc, Chicago, IL) and StatView statistical software (SAS Institute Inc, Cary, NC).

### RESULTS

The current study investigates three questions. First, what are the differences, if any, in the REM emotion of narcoleptic and normal subjects? Second, how does the emotion profile differ between SOREM and nighttime REM within the narcolepsy group? Third, do REM emotions vary in conjunction with the fragmentation level of REM within and between the subject groups? As shown below, the analysis revealed significant findings for each of these questions.

### Prevalence of Emotions

Two-hundred and eleven instances of emotion were noted in 113 (85%) of the 133 REM reports from the 15 narcoleptic subjects. Of these, 137 were reported from SOREM (mean incidence rate = 2.2 dif-
positive emotion within narcoleptic SOREM. Fifty-three (39%) of the 137 discrete incidents of emotion in SOREM were classified as positive and 69 (50%) were classified as negative, with the remaining 15 (11%) being instances of surprise. This difference in incidence rates between negative and positive emotion was not significant (binomial test, n = 122, P = .17). In terms of report prevalence, positive emotion was found in 65% of the reports and negative emotion in 53% (Table 4), and mean report prevalence for positive and negative emotion did not differ significantly (paired t-test, t(12) = .8; P = .47).

Positive and negative emotion within nighttime narcoleptic REM. Of the 74 incidents of emotion in nighttime REM reports from narcoleptic subjects, 33 (45%) were classified as positive and 31 (42%) were classified as negative, rates that were not significantly different (binomial test, n = 74, P = .90). In terms of prevalence, positive emotion was found in 49% of reports and negative emotion in 51% (Table 3), which again did not differ significantly (paired t-test, t(14) = .96; P = .36).

Based on these general prevalence findings for positive and negative emotions, we next analyzed the prevalence of discrete emotions, focusing on the relative distribution of discrete emotions within each REM condition in narcoleptic subjects and on the differences in the prevalence of the most common emotions between narcoleptic and normal subjects.

Prevalence of Discrete Emotions

The discrete emotions that were most commonly seen in narcoleptic REM were the same as those seen in normal REM (Figure 1). In both REM conditions, joy/elation, anxiety/fear, anger, and surprise showed the highest prevalence rates in narcoleptics. We first analyzed the relative prevalence of these four discrete emotions between narcoleptic and normal subjects.

Distribution of discrete emotions in narcoleptic nighttime REM. In the nighttime REM of narcoleptic patients, joy/elation had close to three times the mean report prevalence rate per subject as did anxiety/fear, anger, and surprise (Figure 1). This primacy of joy/elation was significant compared to both anxiety/fear (Wilcoxon signed rank test, z(14) = 2.0; P = .047) and anger (z(14) = 2.1; P = .036), with a similar tendency compared to surprise (z(14) = 1.8; P = .077). No difference was found between anxiety/fear, anger, and surprise. Thus, joy/elation was the leading emotion in nighttime narcoleptic REM, paralleling findings previously reported for the control group.

Distribution of discrete emotions in narcoleptic SOREM. In contrast to nighttime REM, narcoleptic SOREM showed no significant difference between the report prevalence of joy/elation (45% of reports) and anxiety/fear (36%) with paired t-tests on subject means, P > .25). However, joy/elation was still significantly more common than surprise (Wilcoxon signed rank test, z(12) = 2.3; P = .021), and occurred twice as often as anger (45% vs 24% of reports). The latter difference was significant only when tested on a per-report basis (z(41) = 12.3; P = .024) and not when tested on a per-subject basis (P>.5). In addition, and again in contrast to nighttime REM, anxiety/fear tended to be more prevalent than surprise in SOREM (Wilcoxon signed rank test, z(11) = 1.7; P = .086).

These findings indicate, first, that joy/elation and anxiety/fear are the two most common emotions in narcoleptic SOREM and, second, that the prevalence of anxiety/fear in SOREM was enhanced compared to both control and narcoleptic nighttime REM.

Differences in emotion types between REM conditions and subject groups. The above findings indicate that at least anxiety/fear should be more prevalent in narcoleptic SOREM than in nighttime REM in either subject group, which is in line with the results shown below. In addition, surprise also differed between narcoleptic and normal subjects, although in a direction opposite to that seen for anxiety/fear.
The report prevalence of anxiety/fear was 170% higher in narcoleptic SOREM than in nighttime REM in these patients (paired t test on subject averages, t(12) = 2.1, P = .052), and 220% higher than in nighttime REM in the normal group (unpaired t test, t(20) = 1.9, P = .074; when tested on a per-report basis using the Mann-Whitney test, z = 3.1; n = 150; P = .002). No difference in the prevalence of anxiety/fear was found for nighttime REM in the two subject groups (P = .92).

Joy/elation. In contrast to anxiety/fear, the prevalence of joy/elation was only 20% to 25% higher in SOREM in narcoleptic patients than in nighttime REM in either subject group, a difference which was not significant (P > .60).

Surprise. In nighttime REM, surprise occurred twice as often in controls (25% of the reports) as in narcoleptic REM (13%). This difference tended toward significance [non-parametric Mann-Whitney U-test, z(23) = 1.6, n = 24, P = .097; on a per-report basis, t(157) = 1.9, P = .061].

Other emotions. No significant differences between the REM conditions or subject groups were found for anger or for the less frequent emotions of love/eroticism, shame, and sadness. However, the prevalence of anger was twice as high in SOREM (mean subject prevalence of 24%) as in nighttime REM (12%) in narcolepsy, with intermediary values for the normal group (17%).

SUMMARY

Positive and negative emotions were found to occur in a balanced manner in both SOREM and nighttime REM in narcoleptics, which is in line with that seen for the control group. On the other hand, narcoleptic SOREM had higher prevalence rates for both positive and negative emotions compared to nighttime REM in each group. Among the discrete emotion types, joy/elation was the most common in both SOREM and nighttime REM in narcoleptic patients, paralleling that seen in the normal group. However, specific for SOREM in narcoleptic patients was a relatively strong increase in the prevalence of anxiety/fear. In contrast, surprise was indicated to be less common in the narcoleptic group when nighttime REM was compared to normal REM.

Intensity of Emotions

The difference in the prevalence of emotion in narcoleptic and normal REM was complemented by differences in the intensity level of emotion. We first compared the overall emotion intensity level in the reports from the different REM conditions and subject groups by use of the highest intensity score given to any emotion type in each report. Thus measured, reports from narcoleptic SOREM had higher maximum intensity levels than did reports from the nighttime REM of either narcoleptic (paired t test, t(12) = 2.5; P = .031) or control subjects (unpaired t test, t(16) = 2.7; P = .017) (Fig. 2A and 2B). No difference in overall emotion intensity level was seen for the nighttime REM of the two groups (P = .91).

Intensity of Discrete Emotion Types

As shown below, the higher intensity level of emotion in narcoleptic SOREM was found to be reflected in higher intensity ratings for each of anxiety/fear and joy/elation. Moreover, a similar although not equally strong difference in the intensity of these emotions was seen for nighttime REM in the two groups.

Compared to normal nighttime REM, joy/elation was more intense in both narcoleptic SOREM (unpaired t test, t(17) = 2.7; P = .015) and narcoleptic nighttime REM (t(19) = 1.7; P = .094) (Figure 3). A difference in the intensity of joy/elation between the nighttime REM of the two groups was evident also when tested on a per-report level (t(56) = 2.5; P = .014).

Anxiety/fear was found to be more intense in narcoleptic SOREM than in the nighttime REM of the control group (t(13) = 3.6; P = .003). When comparing anxiety/fear in nighttime REM in the two groups, a limiting factor for the statistical analysis was that only 7 narcoleptic and 6 normal subjects reported any incidence of this emotion. However, for...
These subjects, the mean intensity level of anxiety/fear was 92% above baseline (score of 1 = mild intensity) in narcoleptic subjects and only 31% above baseline in the normal group. This difference was not significant when tested on a per-subject level (unequal variances, t(8.5) = 1.5, p = .16) but approached significance when tested on a per-report basis (t(17) = 1.8, p = .096).

The data did not allow for tests of differences in the intensity of discrete emotion types between the SOREM and nighttime REM of narcoleptic subjects.

Overall, REM emotions were the most intense in narcoleptic SOREM, followed by nighttime REM in narcoleptic patients, with the lowest intensity levels—in particular of anxiety/fear and joy/elation—seen in the REM sleep of controls.

SOREM Emotions: The Effect of Time Spent in Sleep

Since the hypnagogic hallucinations of the wake/sleep transition period in narcoleptic patients have been reported to be highly emotional and often unpleasant, we asked whether the elevated emotions seen in narcoleptic SOREM could be a function of the proximity to the wake state. If this were indeed the case, a lower level of emotion within SOREM might be expected for reports derived after longer periods of sleep following sleep onset. As shown below, this hypothesis was not supported by the data.

Eleven narcoleptic patients were included who had at least two SOREM reports obtained from different times into sleep since sleep onset. Nine of the 11 narcoleptic patients had a higher total emotion score in the late-sleep-onset condition than in the early condition (binomial test assuming equal probability for increase and decrease, n = 11, P = .065). The increase from early to late sleep onset was significant for negative emotion (paired t test, t(1, 10) = 2.9; p = .017) but not for positive emotion (p = .57) As can be seen in Figure 4, when all 62 SOREM reports from the 13 subjects were included, positive and negative emotions, as well as each of the most frequent emotion types belonging to these categories, tended to increase with elapsed time in sleep before awakening. Similar results were seen separately for both sleep time prior to SOREM and REM time prior to awakening. Thus, the elevated level of emotion in narcoleptic SOREM was not specifically linked to the closeness of the reports to the preceding wake period.

Emotion and REM Sleep Fragmentation

Our next question was whether the difference in emotion that was seen between the subject groups reflected differences in the stability of the REM state. However, as previously reported,26 no difference in REM fragmentation (the inverse of REM stability) was seen between groups or between SOREM and nighttime REM in narcoleptic subjects, whether analyzed by subject (unpaired and paired t tests, P > .4) or by reports (1-way ANOVA across the three REM categories, P > .7). These findings are likely to reflect the particular awakening protocol of the current study, with subjects being awakened immediately when spontaneous arousal was detected and the awakening criteria were otherwise met, and are not likely to reflect a true lack of difference in the stability of REM between narcoleptic and normal subjects.

Although REM fragmentation did not appear to underlie the variation in emotion between subject groups and REM conditions, fragmentation could still be differentially associated with REM mentation in individual narcoleptic and normal subjects. We thus asked whether subjects with high emotion scores had particularly high (or low) degrees of REM fragmentation. The emotion measure used in these analyses was the total emotion score for each report, with analysis performed on the subject level using average report scores. For several analyses, this emotion measure did not exhibit a normal distribution across subjects. Since the fragmentation measure instead showed a normal distribution, in the analysis below, fragmentation was consistently used as the dependent variable and emotion was used as the independent variable. As shown below, a relation between REM fragmentation and emotion was evident in the narcoleptic but not the control group.

Relation between REM fragmentation and emotion within each subject group. In the control group, no emotion category (total, positive, negative) and no discrete emotion type showed any significant relationship to fragmentation (df = 7, P > .30).

In the narcolepsy group, subjects’ scores on the category of positive emotion was inversely related to their REM-fragmentation level (Pearson correlation coefficient, r(12) = - .51; P = .091). Moreover, the 6 narcoleptic subjects with the highest scores on positive emotion had a significantly lower fragmentation level than did the remaining 6 subjects (unpaired t test, t(11) = 2.9; P = .015). A similar difference was seen separately for SOREM (r(12) = 2.6; P = .027) and for nighttime REM (r(13) = 1.9, P = .087). Thus, the narcoleptic patients with the highest scores on positive emotion had the most stable (least fragmented) REM sleep. In contrast, no relation to fragmentation level was seen for the overall negative emotion category in the narcoleptic subjects (P > .3).

As with the general category of positive emotion, joy/elation was inversely related to REM fragmentation across the narcoleptic subjects (r(12) = - .55, P = .064). The 6 patients with the highest scores on joy/elation had a significantly lower fragmentation level than those with low scores on joy/elation (r(10) = 2.6, P = .027). This inverse relation was evident also for SOREM considered separately (r(12) = - .55, p = .062; t(10) = 2.9, P = .015) but not for nighttime REM (P > .70).

In contrast to the inverse relation to fragmentation that was seen for joy/elation, a positive relation to fragmentation was indicated for anxiety/fear. The 7 narcoleptic subjects with the highest scores on anxiety/fear had twice the fragmentation level as compared to the average of the remaining 5 subjects, although this difference failed to reach adequate statistical significance (t(11) = 2.0, P = .074). No other discrete emotion type was significantly related to the fragmentation of REM within the narcolepsy group.

Thus, a significant inverse relation was found for positive emotion and, in particular, joy/elation to the fragmentation of REM in narcolepsy being the most evident in SOREM. In contrast, subjects with more anxious and fearful dreams tended to have a higher level of REM fragmentation.
EMOTIONAL EXPERIENCE WAS FOUND TO BE MORE PREVALENT AND INTENSE DURING SOREM IN NARCOLEPTIC PATIENTS THAN DURING NIGHTTIME REM IN EITHER NARCOLEPTIC OR NORMAL SUBJECTS. A HIGHER PREVALENCE RATE AND INTENSITY OF POSITIVE AS WELL AS NEGATIVE EMOTIONS WERE FOUND IN SOREM, WITH THE MOST PRONOUNCED DIFFERENCE SEEN FOR ANXIETY/FEAR. FOR NIGHTTIME REM, NARCOLEPTIC SUBJECTS HAD A TREND TOWARD A LOWER PREVALENCE RATE FOR SUITABILITY BUT MORE INTENSE FEELINGS OF JOY/ELATION AND ANXIETY/FEAR. NARCOLEPTIC PATIENTS WITH HIGH LEVELS OF JOY/ELATION AND OF POSITIVE EMOTION IN GENERAL HAD A LESS FRAGMENTED SOREM SLEEP.

WE KNOW OF NO OTHER CONTROLLED STUDIES IN THE LITERATURE THAT MEASURED THE PREVALENCE OR INTENSITY OF DISCRETE EMOTIONS IN NARCOLEPTIC REM OR COMPARED THESE FEATURES WITH THOSE OF NORMAL SUBJECTS. IT IS NONETHLESS NOTEWORTHY THAT SINGLE-CASE AND CLINICAL-STUDY REPORTS HAVE ASSERTED THAT DREAMING DURING DAYTIME NAPS AND SHORTLY AFTER NIGHTTIME SLEEP ONSET IN NARCOLEPSY IS PARTICULARLY UNPLEASANT AND OFTEN FRIGHTENING.15-18 THESE REPORTS ARE IN LINE WITH OUR FINDING THAT DREAMING IS MORE EMOTIONAL AND ANXIOUS DURING NARCOLEPTIC SOREM THAN DURING NORMAL REM.

COMPARISON OF THE NEW RESULTS TO PREVIOUS FINDINGS

TWO INSTRUMENTAL AWAKENING STUDIES OF REM MENTATION IN NARCOLEPSY WERE FOUND IN THE LITERATURE, BUT THESE STUDIES REPORTED ONLY GENERAL CHARACTERISTICS OF THE EMOTIONAL EXPERIENCE. VOGEL20 FOUND THAT UNPLEASANT AND PLEASANT DREAMS OCCURRED IN A BALANCED FASHION DURING NARCOLEPTIC SOREM, AND HISHIKAWA ET AL19 MEASURED ONLY UNPLEASANT EMOTIONS AND FOUND THESE TO BE EXPERIENCED MORE OFTEN DURING SOREM THAN DURING EARLY NIGHTTIME (EMERGENT) REM. BOTH FINDINGS ARE CONSISTENT WITH THE PRESENT RESULTS.

HISHIKAWA ET AL19 FOUND SOREM DREAMS TO BE MORE OFTEN UNPLEASANT WHEN ACCOMPANIED BY AN ENHANCED LEVEL OF REFLECTIVE AWARENESS AND A SENSATION OF MOTOR PARALYSIS. THIS COMBINATION OF FEATURES WAS SEEN MOST OFTEN EARLY IN SOREM PERIODS THAT DEVELOPED IMMEDIATELY AFTER SLEEP ONSET. BASED ON THESE OBSERVATIONS, HISHIKAWA ET AL SUGGESTED THAT WHEN UNPLEASANT HALLUCINATORY MENTATION TAKES PLACE DURING THE HYPNOGOGIC SLEEP-ONSET PERIOD IN NARCOLEPSY, ALTERED BIOLOGIC ASPECTS OF THE REM STATE ITSELF ARE LIKELY TO BE INVOLVED.19 IN THE CURRENT STUDY, AWAKENINGS WERE PERFORMED LATER INTO SOREM SLEEP THAN IN HISHIKAWA ET AL’S STUDY AND WERE LESS LIKELY TO LEAD TO RECALL OF MENTAL ACTIVITY FROM THE TRANSITION PERIOD BETWEEN WAKING AND SLEEP. NONETHLESS, WE FOUND THAT EMOTION WAS REPORTED AT HIGH LEVELS THROUGHOUT SOREM, WITH AN INCREASE SEEN IN NEGATIVE EMOTION AS TIME SPENT IN SLEEP SINCE SLEEP ONSET INCREASED. ENHANCED EMOTION THUS APPEARS TO CHARACTERIZE NOT ONLY THE HYPNOGOGIC WAKE-UP (REM) TRANSITION PERIOD, BUT ALSO THE ENTIRE REM PERIOD WHEN OCCURRING SHORTLY AFTER SLEEP ONSET IN NARCOLEPTIC PATIENTS.

REM SLEEP IN NARCOLEPSY: A CONTEXT FOR ALTERED EMOTION

ACCORDING TO THE ACTIVATION-SYNTHESIS HYPOTHESIS,35-37 SLEEP MENTATION IS CONTROLLED AT THE LEVEL OF BASIC NEUROBIOLOGIC PROCESSES (ACTIVATION) AS WELL AS BY HIGHER COGNITIVE AND EMOTIONAL FUNCTION (SYNTHESIS), WHICH ARE PRESUMABLY MODIFIED BY THESE NEUROBIOLOGIC PROCESSES. IN NARCOLEPTIC REM, EACH OF THESE FUNDAMENTAL LEVELS HAS BEEN ALTERED, AND WE PROPOSE THAT THIS COULD EXPLAIN MUCH OF THE OVERALL DIFFERENCE IN EMOTION SEEN BETWEEN NARCOLEPTIC AND NORMAL SUBJECTS.

REM EMOTION AND MONOAAMINERGIC/CHOLINERGIC IMBALANCE

WE PROPOSE THAT BOTTOM-UP BIOLOGIC PROCESSES CONTRIBUTE TO BOTH THE NORMATIVE PROFILE OF EMOTION THAT IS SEEN DURING REM37,35,36 AND TO THE ALTERED EMOTION PROFILE OF NARCOLEPSY. CENTRAL TO THE SYMPTOMS OF NARCOLEPSY IS A MONOAAMINERGIC-CHOLINERGIC IMBALANCE THAT REFLECTS ABNORMALITIES OF HYPOTHALAMIC HYPOCRETIN FUNCTION.2

ABNORMALITIES IN CHOLINERGIC AND DOPAMINERGIC NEURONAL PROCESSES IN THE EXTENDED AMYGDALA–BASEL-FOREBRAIN REGION, KNOWN TO CONTRIBUTE IMPORTANT COMPONENTS OF THE REWARD SYSTEM OF THE BRAIN, BECOME ALTERED IN NARCOLEPSY.7-12,38,39 ANIMAL STUDIES HAVE REVEALED A BASIC HYPERSENSITIVITY OF FOREBRAIN CHOLINERGIC ACTIVITY IN NARCOLEPSY, ACCOMPANIED BY ALTERATIONS IN DOPAMINERGIC FUNCTION IN THE VENTRAL SEGMENTAL AREA, THE AMYGDALA, THE BRAINSTEM, AND THE CAUDATE.2,12,14 THESE CHANGES APPEAR TO BE DIRECTLY INVOLVED IN THE TRIGGERING OF CATAPLEXY BY POSITIVE AND EXCITING EMOTION.2,13 SINCE DOPAMINE AS WELL AS INTERACTIONS BETWEEN DOPAMINE AND ACETYLCHOLINE ARE KNOWN TO SUPPORT POSITIVE EMOTION,7,12,38,39 ALTERATIONS IN THESE SYSTEMS MIGHT CONTRIBUTE TO THE INCREASE IN POSITIVE EMOTIONS SEEN DURING NARCOLEPTIC REM AND MIGHT EXPLAIN THE SPECIFIC RELATION BETWEEN REM-SEP-INSTABILITY AND POSITIVE EMOTIONS THAT WE REPORT HERE.

IN CONTRAST, ABNORMALITY IN NORADRENERGIC ACTIVITY IN NARCOLEPSY IS LIKELY TO MODULATE EMOTIONS SUCH AS ANXIETY AND FEAR. THE NORADRENERGIC LOCUS COERULEUS, IN ADDITION TO CONTRIBUTING TO AROUSAL AND FOCUSED ATTENTION, IS KNOWN TO BE A KEY STRUCTURE FOR ALARM REACTIONS, EXHIBITING HIGH LEVELS OF ENGAGEMENT IN THREATENING SITUATIONS ASSOCIATED WITH ANXIETY AND FEAR.40 THE CONSTRAINTS THAT APPEAR TO BE PLACED UPON ANXIETY AND FEAR DURING NORMAL REM37 ARE PLAUSIBLE CONSEQUENCES OF THE NORMALLY STRONG NORADRENERGIC BLOCKADE DURING THIS STAGE. THE HIGHER FRAGMENTATION OF REM IN NARCOLEPTIC PATIENTS IS PROPOSED TO REFLECT AN INEFFICIENT LOCUS COERULEUS BLOCKADE CAUSED BY THE MORE BASIC DEFICIENCIES IN HYPOTHALAMIC HYPOCRETIN ACTIVITY,31 PERHAPS IN COMBINATION WITH A LESS STABLE CHOLINERGIC NEUROMODULATION.32 AS A RESULT, ONE WOULD EXPECT THE OBSERVED INCREASE IN LOCUS COERULEUS-MEDIATED EMOTIONS OF FEAR AND ANXIETY, DRIVEN BY THE ACTION OF NORADELINE AT SEVERAL LEVELS OF THE NEURAXIS—RANGING FROM THE BRAINSTEM TO THE PREFRONTAL CORTEX.

REM SLEEP FRAGMENTATION AND EMOTION

THE PROPENSITY FOR POSITIVE EMOTIONS TO TRIGGER THE REM PARALYSIS OF CATAPLEXY IMPLIES A CONNECTION BETWEEN THE POSITIVE EMOTION SYSTEMS OF THE BRAIN AND THE UNDERLYING REM ABNORMALITIES OF NARCOLEPSY. IT WAS, THEREFORE, NOTEWORTHY THAT HIGH LEVELS OF POSITIVE EMOTIONS SUCH AS JOY AND ELATION WERE ASSOCIATED WITH LESS-FRAGMENTED REM SLEEP IN THESE PATIENTS, A RELATIONSHIP THAT WAS PARTICULARLY EVIDENT DURING SOREM. NO SUCH RELATION WAS SEEN IN THE CONTROL GROUP, AND NO SIMILAR INVERSE RELATION TO FRAGMENTATION WAS INDICATED FOR NEGATIVE EMOTION IN THE NARCOLEPTIC SUBJECTS.

INCREASED REM-SEP-SEGMENTATION IS A TYPICAL REFLECTION OF THE INSTABILITY OF REM IN NARCOLEPSY34 AND CAN BE CONCEIVED OF AS THE MIRROR IMAGE OF THE REM PARALYSIS OF CATAPLEXY. WHEREAS CATAPLEXY IS MARKED BY A DECREASED MUSCLE TONE, FRAGMENTATION OF REM SLEEP IS REFLECTED IN AN INCREASED MUSCLE TONE AND ACCOMPANYING ELECROENCEPHALOGRAPHIC CHANGES OF AROUSAL OR NREM. IF THE RELATION BETWEEN POSITIVE EMOTION AND MOTOR PARALYSIS THAT IS SEEN DURING CATAPLEXY WERE RETAINED DURING SOREM, MORE-STABLE MUSCLE PARALYSIS WOULD CORRELATE WITH INCREASED POSITIVE DREAM EMOTIONS IN NARCOLEPTIC PATIENTS, AS IN FACT WAS FOUND HERE.

THE NARCOLEPTIC PATIENTS WITH THE MOST-FRAGMENTED REM SLEEP HAD NOT ONLY LOWER LEVELS OF POSITIVE EMOTIONS BUT ALSO HIGHER LEVELS OF ANXIETY/FEAR. THIS INCREASE IN FRAGMENTATION FOR SUBJECTS WITH HIGH LEVELS OF ANXIETY/FEAR DID NOT REACH STATISTICAL SIGNIFICANCE IN OUR DATA SET (P = 0.74), BUT IF CONFIRMED BY SUBSEQUENT RESEARCH, IT WOULD INDICATE THE EXISTENCE OF A FUNCTIONAL RELATIONSHIP BETWEEN THE BASIC PROCESSES OF REM FRAGMENTATION AND THE APPEARANCE OF ANXIETY IN REM MENTATION.

THOUGHTS, HALLUCINATIONS, AND EMOTIONS

IN ADDITION TO THE CONTRIBUTIONS FROM BOTTOM-UP BIOLOGIC PROCESSES, TOP-DOWN SYNTHETIC ACTIVITY36 IS LIKELY TO INFLUENCE EMOTION IN REM. THE REM-DREAM EMOTIONS ARE EMBEDDED IN THE HALLUCINATIONS AND THOUGHTS OF THE ONGOING DREAM37 (TABLE 3), SIMILAR TO THE PERCEPTS AND THOUGHTS THAT CONTEXTUALIZE MUCH WAKING EMOTION.43 ALTERATIONS IN HALLUCINATION AND THOUGHT IN NARCOLEPTIC REM MIGHT THEREFORE CONTRIBUTE TO THE CHANGES OBSERVED IN EMOTION.

THE PERCEPTUAL SCENARIO OF REM DREAMS IS CHANGED IN DISTINCTIVE WAYS IN NARCOLEPTIC PATIENTS. IN THE CURRENT REPORTS FROM SOREM AND NIGHTTIME REM, NARCOLEPTIC PATIENTS LESS OFTEN REPORTED THE TYPE OF SLEEP, Vol. 25, No. 7, 2002 730 REM Emotions in Narcolepsy—Fosse et al
REM19,20,28 might permit the dreamer to better identify hallucinated REM. The enhanced level of reflective awareness in narcoleptic especially a lower prevalence rate of surprise, which was found in nighttime narcoleptic REM.

Changes in the nature of thoughts might likewise affect emotion in REM. The enhanced level of reflective awareness in narcoleptic REM might permit the dreamer to better identify hallucinated events as strange, bizarre, and even frightening, resulting in a higher propensity to initiate emotion based on reasoned expectations.

CONCLUSION

The sleep disorder narcolepsy intensifies emotion during REM, with the most pronounced change seen for anxiety/fear, followed by joy/elation. We propose, first, that the propensity to feel anxiety/fear is increased during narcoleptic REM due to inadequate blockade of noradrenergic activity in the locus coeruleus and, second, that the propensity to experience positive emotion is increased due to cholinergic hyper-sensitivity and dopaminergic dysregulation. At the end of this cascade of events, REM emotion in narcoleptic, as well as normal, subjects is likely determined by cortical regions that support thought, perception, and emotion.

Neither neurobiology nor psychology alone can provide an adequate explanation of the alterations seen in REM dream emotion in narcolepsy. Instead, an integrated cognitive neuroscience perspective needs to be adopted to test hypotheses of conjunct changes in cognitive-emotional function, regional brain activation, and neurochemical brain modulation in narcoleptic REM.

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