Evolutionary function of dreams: A test of the threat simulation theory in recurrent dreams ☆

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Abstract

Revonsuo (2000a) proposed an intriguing and detailed evolutionary theory of dreams which stipulates that the biological function of dreaming is to simulate threatening events and to rehearse threat avoidance behaviors. The goal of the present study was to test this theory using a sample of 212 recurrent dreams that was scored using a slightly expanded version of the DreamThreat rating scale. Six of the eight hypotheses tested were supported. Among the positive findings, 66% of the recurrent dream reports contained one or more threats, the threats tended to be dangerous and aimed at the dreamer, and when facing a threat, the dreamer tended to take defensive or evasive actions that were possible and reasonable. However, less than 15% of the recurrent dreams depicted realistic and probable situations critical for one's physical survival or reproductive success and the dreamer rarely succeeded in fleeing the threat despite important and appropriate efforts. The findings thus provide mixed support for the threat simulation theory.
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Keywords: Dreaming; Dream function; Evolutionary theory; Recurrent dreams; Threat perception; Avoidance responses; Dream content

1. Introduction

People have always been interested in the how and why of dreams and theories of dream function have ranged from the esoteric to the mundane. Many contemporary dream theorists suggest that dreaming is functionally significant (e.g., see Moffitt, Kramer, & Hoffmann, 1993) but some argue that dreams are epiphenomenal and have no value in and of themselves (e.g., Crick & Mitchinson, 1983; Hobson, 1988; Flanagan, 1995). Revonsuo (2000a) recently added to the debate surrounding the function of dreams by proposing a well-articulated theory that, to its advantage, can be empirically tested. Revonsuo's theory puts forth the hypothesis that the biological and adaptive function of dreams is the simulation of threatening events with the intent of improving the subject's capability to perceive and avoid diverse threats in the waking state. Human evolution took place in a very threatening environment in which the capacity to repeatedly simulate confrontations with different kinds of dangers would have provided a certain adaptive advantage. By giving rise to a full-scale hallucinatory world of subjective experience during sleep, the dream production mechanism provides an ideal and safe environment for such sustained practice by selecting threatening waking events and simulating them repeatedly in various combinations.

To conceptualize his theory succinctly, Revonsuo (2000a) put forth six underlying propositions based on the integration of data from psychology, biology, and cognitive neuroscience: (1) Dream consciousness is an organized and selective simulation of the perceptual world; (2) dream consciousness is specialized in the simulation of threatening events; (3) nothing but exposure to real threatening events fully activates the threat simulation system; (4) the threat simulation produced by the fully activated system are perceptually and behaviorally realistic rehearsals of threatening events; (5) the realistic rehearsal of these skills can lead to enhanced performance regardless of whether or not the training episodes are explicitly remembered; and (6) the ancestral environment in which the human brain evolved included frequent dangerous events that constituted extreme threats to human reproductive success. They thus presented serious selection pressures to ancestral human populations and fully activated the treat simulation mechanisms (p. 878). This theory, taken as a whole, cannot be tested directly. Doing so would require an experimental paradigm in which the presence (or absence) of dream threats would be treated as an independent variable and the person's level of adaptation to waking circumstances as the dependent variable. Such a protocol is not feasible since the presence or absence of dream threats cannot be controlled and one's level of waking adaptation depends on an array of factors that go well beyond the context of dream content. That being said, the postulates that underlie the theory can nevertheless be used to test it indirectly.

The theory of threat simulation was so tested by Revonsuo and Valli (2000) who assessed the content of 592 everyday home dreams using the DreamThreat rating scale, a content analysis instrument designed to identify and classify a variety of threatening events. The results tended to support the researchers' predictions. Two thirds of the dream reports contained at least one threatening element and in most cases, the dreamer or someone close to the subject was the object of the threat. In general, the dreamer actively confronted the threatening event and presented a reaction appropriate to the situation. The majority of the threatening situations ended without major losses and over 60% of the threats were likely to be experienced in real life. While the proportion of threats belonging to the realm of fantasy was very low (4%), trivial threats were almost three times more frequent than those putting the subject's physical well-being in danger.

The threat simulation theory views dreaming as both an organized and selective simulation of the world. A particularly well-organized form of dream content is the recurrent dream which is distinguished by its complete repetition as a remembered experience. In other words, recurrent dreams are defined as a class of dreams that reoccur over time while maintaining, not only the same *theme*, but the same *content* (Brown & Donderi, 1986; Heaton, Hill, Hess, Leotta, & Hoffman, 1998; Zadra, 1996). Revonsuo (2000a) agrees with Domhoff's (1993, 1996) position that to be taken seriously, a theory of dreaming must account for the "repetition dimension" in dreams and asserts that his evolutionary hypothesis of the function of dreaming explains this dimension as the paradigm case of threat simulation in dreams. Recurrent dreams should therefore reflect the mechanisms put forth by this evolutionary theory more strongly than a series of everyday dreams, and thus constitute choice material to test this theory.

Research results support the generic clinical dream theory that recurrent dreams are associated with the presence of unresolved conflicts or stressors. Studies have shown that in both late teenagers and older adults, recurrent dreams are accompanied by negative dream content in everyday dreams and that they are associated with a relative deficit in psychological well-being (e.g., Brown & Donderi, 1986; Robbins & Houshi, 1983; Zadra, O'Brien, & Donderi, 1998).

Approximately 85% of recurrent dreams contain negative emotions while themes in which the dreamer is in danger (e.g., threatened with injury, death, or chased) have been found to characterize approximately 40% of recurrent dreams (Cartwright, 1979; Cartwright & Romanek, 1978; Robbins & Houshi, 1983; Zadra, 1996). In most of these threatening dreams, the subject is fleeing, attempting to hide, or helplessly watching. The thematic content of the remaining 50–60% of recurrent dreams, however, does not show a direct relation to the threat simulation theory. Furthermore, a content analysis of recurrent dreams from adulthood and from childhood revealed that although chase and pursuit dreams were the most frequently reported theme in both samples, they represented less than 15% of the adult recurrent dreams and 42% of the childhood ones. Combined with clinical impressions, these data led Zadra and Donderi (2000) to suggest that many recurrent dreams do not contain realistic threats and that efficient avoidance responses are generally absent.

In response to these impressions and observations, Revonsuo (2000b) offered a different interpretation of the data that was consistent with the threat simulation theory. For example, it was proposed that ancient concerns in adult recurrent dreams (the default values in the system) were gradually replaced by current concerns, that when considered in a broader perspective, ancestral threats were in fact common in childhood recurrent dreams, and that modern artificial environments which are free of ancestral threats have reduced the importance of simulating ancestral threats. In addition, Revonsuo (2000b) correctly points out that a clearer evaluation of the threat simulation theory would require a quantitative analysis of the content of recurrent dreams. The main goal of this article was to conduct such an analysis.

2. Hypothesis

In accordance with the threat simulation theory, the following predictions were tested in a large sample of recurrent dreams:

1. A majority of dream reports will contain one or more threatening events.
2. Threats will normally target the dreamer or people on whom the reproductive success of the dreamer is most dependent: close relatives and friends rather than people or physical resources only remotely related to the future success of the dreamer.
3. The threatening situations encountered will be extremely dangerous and likely to be critical for survival.
4. When facing a threat, the dreamer will take defensive or evasive action.
5. When facing a threat, the dreamer's actions will be possible and reasonable.
6. The threat will not result in unpleasant consequences for the dreamer or people close to him or her.
7. In a majority of cases, the dreamer will succeed in overcoming or escaping the threat.
8. The threatening situations will be realistic rather than bizarre fantasies or science fiction stories.

3. Methods

3.1. Subjects

Our initial sample was comprised of all the recurrent dreams ($N = 266$) recorded in a questionnaire by subjects recruited between 1990 and 2000 for a series of studies on dreams and personality. The subjects' responses to key items on a Sleep/Dream Questionnaire were used to determine whether their recurrent dream met inclusion criteria for the present study. Specifically, subjects had to describe their recurrent dream as having occurred over a period of at least six months and the content of the recurrent dream as being "always" or "almost always" identical. Although some subjects reported more than one recurrent dream, only the first one reported was included to avoid any sampling bias.

3.2. Methods

The analysis of threatening events in the recurrent dreams was carried out in two steps using the detailed DreamThreat rating scale developed by Revonsuo and Valli (2000). The first step consisted of identifying the presence of threats in the dream reports. To be judged as being threatening, an event was scored according to the same criteria used by Revonsuo and Valli (2000). Specifically, objective threats were comprised of any event in a dream report where, if the event was real, the physical or mental well-being of any person would be endangered or where any person's physical resources or territory would be jeopardized (i.e., any event that would be considered threatening if it should really occur in the waking life). Subjective threats included any event in a dream report that was interpreted or emotionally experienced by the dreamer to be somehow dangerous as well as those in which the subject reported the feeling of danger or threat even if no objective threat (as defined above) was reported to accompany this feeling. Dream reports in which the threat was perceived as fictitious by the dreamer (e.g., the dreamer reports that the threat takes place in a film) or in which the dreamer attempted to hurt himself (e.g., committing suicide) were excluded.

After an initial examination of their content, 50 dream reports were excluded either because they were not reported in sufficient detail for the requisite content analysis ($n = 48$) or because they were illegible ($n = 2$). Following a more in depth examination, four additional recurrent dreams were excluded from the final sample, either because the threat described was of a fictitious nature ($n = 3$), or because the dreamer acted in a self-destructive way ($n = 1$). The final sample was thus composed of 212 recurrent dreams (Female/Male: 187/25; age $M = 31.0 \pm 13.8$, range $= 18–81$).

The second step was to conduct the actual content analysis using Revonsuo and Valli's (2000) DreamThreat scale. After familiarizing themselves with the content scales by scoring an unrelated series of dream reports, two judges (S.D., E.M.) examined 5% of the recurrent dreams to discuss problematic cases and acquire a good level of inter-rater agreement. The remaining recurrent dreams were then divided equally between the two raters and were scored independently. Once the scoring was completed, 50 dream reports scored by the second judge were randomly selected and scored by the first judge to calculate the levels of inter-rater agreement for the various content scales. Disagreements between judges were resolved by discussion.

3.3. Materials

Each recurrent dream was analyzed with the help of a slightly extended version of the Dream-Threat rating scale (Revonsuo & Valli, 2000). This instrument is composed of the following eight scales: (I) Nature of the threatening event, (II) Target of the threat, (III) Severity of the threatening event for the self, (IV) Participation of the self to the threatening event, (V) Reaction of the self to the threatening event, (VI) Consequences of the threatening event to self, (VII) Resolution of the threatening event, and (VIII) Source of the threatening event. To further refine the level of the content analysis, a few categories and sub-categories were added to scales I and IV; these additional scales are identified by an asterisk.

4. Results

4.1. Reliability

The two judges had an inter-rater agreement of 88% for the identification of dream reports containing a threatening event. The results of statistical kappa tests obtained for each of the specific rating scales are presented in Table 1. The values indicate that inter-rater agreement ranged from good to excellent across the all of the content categories.

4.2. Percentage of recurrent dreams containing a threat

Of the 212 recurrent dreams included in the study, 139 (65.6%) contained a threatening event and eight of these dream reports contained two threats each. All but 4 of the 147 threats (97.3%) were objective in nature. The average length of the 212 recurrent dream reports was 78.8 words ($SD = 60.5$) while the average length of the 139 containing one or more threats was 81.5 ($SD = 49.8$). This difference was not significant.

Table 1
Value of the Kappa statistic for all dream content scales

Category	Kappa
Nature of the threatening event	0.93
Target of the threat	0.95
Physical resources significant for the self	1.00
People or resources not significant for the self	0.79
Severity for the self	0.79
Severity for close relatives	0.93
Severity for not significant people	0.79
Participation of the self in the threatening event	0.89
Reaction of the self to the threatening event	0.79
Consequences of the threatening event	0.50
Resolution of the threatening event	0.94
Source of the threatening event	0.65

4.3. Content of threatening event

4.3.1. Nature of threatening events

Table 2 presents the results obtained on the 'Nature of the threatening event' scale. Results from Revonsuo and Valli (2000) are included for comparative purposes. Escapes and pursuits were the most frequent type of threat found in the current sample of recurrent dreams. The sub-categories of threats most often confronted by the dreamer included accidents, physical aggression, *environmental anomalies (i.e., the subject or another dream character notices that the physical environment does not behave as it should; e.g., walls become transparent or telephones turn into bombs), dangerous actions, *physical anomalies (i.e., the subject or another dream character notices that their body does not behave as it should; e.g., the subject feels that he no longer has control over body movements or one's teeth begin to fall out), being chased by a human being, by an animal, or by a supernatural being.

4.3.2. Target of the threat

The dreamer was the object of the threat in 94% of all cases. On some rare occasions, significant people for the dreamer (4%) or physical resources significant for the dreamer (3%) were also threatened. Eleven percent of recurrent dreams contained a threat which, from the dreamer's perspective, put insignificant strangers or resources in danger.

4.3.3. Severity of the threatening event for the dreamer

The degree of severity of the threatening event could be assessed in 88% of the dream reports. The dreamer was threatened with death or serious injury 65% of the time. Serious threats that targeted the psychological well-being of the subject accounted for 22% of the threats while futile threats were the least likely to be encountered (13%).

4.3.4. Dreamer's participation

The type of participation on the dreamer's part could be determined in 79% of the dream reports containing threats. The dream self generally participated in an active way, by fighting the

Table 2
Nature of the threatening events

Categories	N	% of the category	% of all threats (N = 147)	% obtained by Revonsuo and Valli (2000)
Escapes and pursuits	38		25.9	11
Human being	11	28.9	7.5	
Animal	12	31.5	8.2	
*Supernatural being	8	21.1	5.4	
As an outlaw	1	2.6	0.7	
Unknown	3	7.9	2.0	
*N/A	3	7.9	2.0	
Accidents and misfortunes	29		19.7	22
Dangerous actions	11	37.9	7.5	
Accident or misfortune	16	55.2	10.9	
*N/d	2	6.9	1.4	
Failures	10		6.8	26
Failure	5	50.0	3.4	
Being late	1	10.0	0.7	
*Mistake	0	—	—	
*Neglect	4	40.0	2.7	
*N/A	0	—	—	
Disasters	5		3.4	3
Caused by natural forces	4	80.0	2.7	
Caused by human beings	1	20.0	0.7	
*N/d	0	—		
Physical difficulties	25		17.0	8
Disease	0	—	—	
*Handicap	0	—	—	
*Physical anomaly	12	48.0	8.2	
*Environmental anomaly	13	52.0	8.8	
*N/A	0	—	—	
Emotional difficulties	11		7.5	n/a
*Loneliness	2	18.2	1.4	
*Jealousy	2	18.2	1.4	
*Being lost	6	54.5	4.1	
*N/A	1	9.1	0.7	
Aggressions and violence	28		19.0	31
Indirect aggression	6	21.4	4.1	
Trespassing	5	17.8	3.4	
Direct physical aggression	17	60.7	11.6	
*N/A	0	—	—	
N/A	1		0.7	

threat (34%), fleeing (39%), or doing both (5%). The rest of the time, the dreamer did not partic-ipate, either because someone prevented him from doing do (5%), because it was impossible to do so (15%), or because he or she chose to do nothing (2%).

4.3.5. Dreamer's reaction when confronting a threatening event

The subject's reaction to the threat was both possible and reasonable 54% of the time, while it was rarely impossible but efficient (3%) or possible but not pertinent (4%). No reaction was re-ported in 39% of the cases.

4.3.6. Consequence of the threatening event for the dreamer

In a majority of cases (73%), the dreamer did not suffer any loss due to the threatening event. In addition, when the subject did suffer a loss, it was twice as likely to be minor (e.g., illness or death of an unknown person, material loss) than major (e.g., death of the dreamer or of someone close, illness, and serious injury).

4.3.7. Solution to the threatening event

A minority (17%) of recurrent dreams involving a threat had a happy ending. Most of the time, the dream ended with the threat being fulfilled (40%) or by the subject waking up (37%). In the remaining 6% of the reports, the dream changed abruptly in terms of the imminent threat and the outcome was absent or remained vague.

4.3.8. Source of the threatening event

In a majority of the cases (81%), the threats encountered belonged to the realm of fantasy or fiction (47%) (e.g., fairy tales, comics, and science fiction) or were very unlikely to occur in the subject's waking life (34%) (e.g., falling in a deep ravine). Realistic and thus probable threats therefore accounted for less than 20% of all identified threats.

4.4. Gender differences

No significant gender differences were found in the length of the dream reports nor on any of the content rating scales.

4.5. Relation between the subject's participation and the threat's resolution

The participation of the dream self (active participation vs. non-participation) was cross-tabu-lated in a 2×2 table with the resolution of the threatening event (rejected threat vs. fulfilled threat). In all of the recurrent dreams where the threat was overcome or avoided, the subject ac-tively participated in the event, either by fleeing from the threatening element (67%) or by trying to combat it (33%). When the dream ended with the fulfillment of the threat, the subject remained inactive in 39% of the cases. Overall, this inactivity on the dreamer's part was not due to a decision to do nothing (0%) nor to the subject being prevented from taking action (11%), but rather be-cause an action was impossible under such circumstances (e.g., the dreamer heard of the event after it occurred; a plane passes overhead and crashes a few miles away, the dreamer is in an elevator that falls) (89%). This difference was significant ($n = 60$, $\chi^2 = 14.89$, $df = 1$, $p < .001$).

4.6. Relation between the subject's participation and the consequences of the threatening event

The participation of the self (active participation vs. non-participation) was also cross-tabulated in a 2×2 table with the consequences of the threatening event (presence vs. absence of consequences). This analysis allows us to conclude that the subject's active participation did not diminish the probability of the threat having a negative consequence ($n = 109$, $\chi^2 = 1.98$, $df = 1$, $p = .16$).

5. Discussion

Six of the eight predictions were supported. Consistent with our first hypothesis, a majority of recurrent dreams were found to contain at least one threatening event. This is in line with previous research showing that approximately 40% of recurrent dreams contain more narrowly defined themes in which the dreamer is in danger (Cartwright & Romanek, 1978; Robbins & Houshi, 1983; Zadra, 1996). However, we would have expected that in comparison to everyday dreams, a greater proportion of recurrent dreams would contain threatening events. This was not the case. The percentage of recurrent dreams in the current study and of everyday dream reports studied by Revonsuo and Valli (2000) containing threatening situations was virtually identical (65.6% versus 66.4%). This result may be partially attributable to the difference in the number of words per report for the recurrent dreams (79 ± 61) as opposed to the everyday dreams (141 ± 71). In addition, the current sample of recurrent dreams was obtained through retrospective reports provided on a questionnaire (thus, derived from long-term memory) while Revonsuo and Valli's (2000) everyday dream reports were written in a daily log upon awakening. This difference in the way the dream reports were collected may account for the differences in their length and raises the possibility of a memory bias (e.g., dreams recalled from long-term memory may contain the main theme but lack finer details).

The analysis of the nature of the threatening events in recurrent dreams yielded a number of interesting findings. Escapes and pursuits represented the most frequently encountered threat, accounting for over 25% of all cases. By comparison, this content category characterized only 11% of threats in everyday dreams (see Table 2). While this difference is consistent with the threat simulation theory, others were not. For instance, aggressions and violence (including all forms of direct physical aggression) were twice as likely to occur in every day dream reports as in recurrent dreams. The data also reveal that environmental or physical anomalies (e.g., concrete walls shedding tears, losing one's teeth) occurred as frequently as physical aggressions or being chased by an animal. This finding is surprising and runs counter to the threat simulation theory since the former categories do not constitute situations originating from our ancestral environment nor the present one. Categories such as accidents/misfortunes and disasters has almost identical prevalence rates across recurrent and everyday dream reports. Finally, almost 8% of the threats in recurrent dreams involved emotional difficulties, a category not originally part of the DreamThreat coding system. Combined with the aforementioned findings on physical and environmental anomalies, these results indicate that the newly added scales were useful in classifying more precisely a non-negligible proportion of threatening events.

In agreement with our second prediction, and as was true for the sample of everyday dreams, the dreamed threats in the recurrent dreams tended to directly involve the subject or people important for the reproductive success of the dreamer.

Prediction 3 was that the threats encountered in recurrent dreams would be particularly dangerous. This was indeed the case. In fact, most of the time the threat was sufficiently severe to jeopardize the subject's life or physical well-being.

Predictions 4 and 5 were also confirmed. Specifically, in a majority of cases, the dreamer took defensive action or showed avoidant behaviors when confronted with a threat and the reactions tended to be both possible and reasonable. These data thus provide support for two important postulates of the threat simulation theory. However, as was also found by Revonsuo and Valli (2000), approximately 40% of threatening events were such that the dreamer did not or could not react to the situation (e.g., the dreamer only heard the threat after it had occurred, the dream was disrupted by awakening).

As predicted by hypothesis 6, the threat did not result in serious consequences for the dreamer or someone close to him or her. In addition, when a loss followed the threat, it was more likely to be of a minor nature rather than a major one. When compared to an absence of participation, however, the dreamer's active involvement was not associated with a lower number of losses. This suggests that the dreamer's actions are not necessarily positively reinforced, which in turn could lead the subject to believe that they are ineffective or that their impact is limited. Since the kappa value obtained for this category was lower than for most other categories, it is possible that that the number of threats having resulted in *major* negative consequences was underestimated. This possibility, however, does not change the fact the dreamer's participation was not associated to any form of reinforcement.

In addition, and contrary to prediction 7, the dreamer rarely succeeded in escaping the threat despite the actions taken to defend against it. As previously discussed, there were also many recurrent dreams where it was impossible for the dreamer to use an action designed to flee from or to confront the threatening element. These findings indicate that if dreaming serves to simulate threatening events on order to improve the dreamer's capability to perceive and avoid diverse threats in the waking state, then the perceptual component may be present but there is little evidence for successful avoidance behaviors. We do not believe that individuals must necessarily succeed in defending against *every* threat encountered in their dreams to adequately confront those arising during waking life. However, the experience of repeated failures in one's dreams could contribute to the person developing a belief that he or she does not have the requisite abilities to deal with threats arising in real life; a counter-adaptive and harmful possibility not unlike learned-helplessness (Peterson, Maier, & Seligman, 1993).

Finally, our eighth prediction was that the threats encountered in recurrent dreams would be realistic and capable of being experienced in real life. This was not the case. Approximately 80% of the threats were found to be unrealistic and often reflected domains of fiction (e.g., fairy tales, science fiction, and fantasy) or were very unlikely to occur in the dreamer's waking life (e.g., falling in a deep ravine). This is in stark contrast to the 4% of threats in everyday dreams that could be traced back to fantasy or other unrealistic sources. In fact, when taken over the entire sample, fewer than 15% of recurrent dreams contained realistic and probable threats. This marked difference highlights the particular and unusual character of recurrent dreams which has been noted by researchers and clinicians alike, and is more in line with the view of recurrent dreams

depicting the dreamer's current problems, concerns and well-being with strong metaphorical images than with the threat simulation theory. One might partially account for this negative result by pointing to the fact that the level of inter-rater agreement for this category (Kappa = 0.50) was only fair (Landis & Koch, 1977). However, the disagreements relative to this category were almost uniquely comprised of cases where the difficulty resided in determining what constituted a realistic and *probable* threat versus a realistic and *unlikely* threat and all problematic cases were resolved by discussion.

It has been suggested that some types of dreams reflect a breakdown in dream function. For instance, Kramer (1991, 1993) argues that nightmares represent a failure in the mood regulatory function of dreams since the psychological experience of dreaming is unable to contain the emotional surge which accompanies REM sleep. Similarly, it could be argued that the present results suggest that recurrent dreams constitute a partial failure in the threat simulation system. It is true that a majority of recurrent dreams contained one or more threats and in this sense, this may allow the dreamer to rehearse the perception of a wide array of threats and even efficient, although not necessarily successful, avoidance responses. That being said, when highly dangerous threats are present in recurrent dreams, they generally do not allow the dreamer to improve his or her ability to perceive *realistic* and *probable* threatening events nor to successfully avoid them. Several findings from the present study support this assertion: in recurrent dreams (a) the dream-self accumulates failures rather that successes in its attempts to fight or flee the threat, and this despite important and pertinent efforts, (b) expended efforts on the dreamer's part do not reduce the probability of threats having unpleasant consequences, (c) the dream production mechanism often places the dream-self in whimsical or surreal situations that are far removed from humans' ancestral or present-day environments and, (d) although dream threats rarely lead to severe consequences, more often than not it is impossible for the dreamer to come up with an action that would effectively thwart the threatening event.

Taken as a whole, the results are thus consistent with six of the eight predictions. However, the confirmation of some of these hypotheses (e.g., 1-that a majority of dreams would contain some sort of threat, and 2-that these threats would usually be aimed at the dreamer or close friends and relatives) are not surprising given previous content studies highlighting the preponderance of negative emotions, misfortunes and aggressive interactions in large dream samples (e.g., Hall & Van de Castle, 1966). When the more theory specific hypotheses are also taken into account, it bears noting that fewer than 2% of the recurrent dreams supported all of the predictions by containing a dangerous threat that was realistic, likely to occur in waking life, aimed directly at the dreamer, and which elicited a plausible and reasonable reaction that allowed the dreamer to avoid its potentially negative consequences.

The main question not solved by the threat simulation theory of dream function is why are both realistic and probable threat perceptions and successful avoidance responses absent from most recurrent dreams? As stated by Revonsuo (2000a), the threat simulation system would have originated in an environment dominated by the presence of important *physical* threats and preliterate humans thus dreamed realistic threat dreams that rehearsed their control of dangerous physical environments.

Throughout their evolution, humans learned to react to various dangers with behavioral actions and this might account for why most dreamers' reactions in such situations are generally centered around running and fighting. In our modern-day society, however, the threats people

are most likely to face on a daily basis are primarily emotional in nature. In addition, as previously stated, it appears that the occurrence of recurrent dreams is associated with lowered well-being. Faced with this very real but different type of threat from what it was it originally conceived, the threat simulation system is nonetheless activated but occasionally misses the mark. Specifically, it apparently falls short in its attempt to produce threats which are pertinent in preparing dreamers to face the actual threats that await them in real life. The threat simulation system may nevertheless attain its objective indirectly by encouraging individuals to develop a new repertoire of behaviors if the ones evinced in their dreams do not permit them to escape threats or their negative consequences.

Furthermore, it can be argued that the threat environment we now face tends to involve language and is more symbolic than physical. For instance, the threats which confront most people on a daily basis are often emotional in nature (e.g., work conflicts, peer pressure, familial discords, difficulties with relationships, and financial insecurity). Through metaphor and similes, language allows us to both manipulate our own mental images and to try and control those of others. We (Zadra & Donderi, 2000) therefore suggested that freed from goal-directing prefrontal control by the inhibitory processes associated with REM sleep, it may be that language mechanisms act on emotionally valenced memories to create the unpredictable metaphors and similes of dreams. It is therefore possible that many recurrent dreams are unrealistic because they are imaginally metaphoric and free-associative; not unlike our own language when freed from goal-directed constraint.

If dreams are viewed as a meaningful psychological product of the mind in that they reflect important psychological differences, show responsiveness to psychological influences, and demonstrate a systematic relationship to waking thought (e.g., Domhoff, 1996, 2002; Kramer, 1982, 1994), then, by virtue of their repetition, recurrent dreams may be particularly meaningful. The clinical and empirical observation that recurrent dreams are related to subjects' current levels of well-being or to unresolved difficulties in the dreamer's life (e.g., Bonime, 1962; Brown & Donderi, 1986; Cartwright, 1979; Fosshage & Loew, 1987; Robbins & Houshi, 1983; Rossi, 1985; Zadra et al., 1998) is consistent with this view. These oneiric representations, like those of most dreams, are most likely structured through the use of conceptual metaphors (e.g., Lakoff, 1993).

In line with the continuity hypothesis, which postulates that the content of everyday dreams reflects the dreamer's waking states and concerns (e.g., Domhoff, 1996, 2003), it is possible that the mere act of reflecting upon the threats encountered in one's dreams may sometimes be more useful in waking life than actually overcoming such threats during our sleep. For instance, there is evidence to suggest that the dreams of relapse experienced by former alcohol or cigarette dependent individuals can have a positive impact in helping them maintain abstinence (e.g., Choi, 1973; Hajek & Belcher, 1991; Shafton, 1995). These dreams typically contain strong emotions of panic, regret or guilt and are accompanied by feelings of relief upon awakening. As suggested by Hajek and Belcher (1991), the association between the drug use and the unpleasant dream experience may represent a form of aversive conditioning and its effect enhanced by a reflected cognitive link between the undesirable behavior and its emotional impact. In a related vein, Dement (1974), the pioneer of REM research, wrote that he quite smoking following a dream of "an ominous shadow in my chest X-ray," then a physical exam confirming "wide spread metastases," and "the incredible anguish of knowing my life was soon to end…"

It is also important to note that dreaming may not necessarily have *a* function. As stated by Hunt (1989), "there may not be a fundamental *function* of dreaming, any more than we can find a function for human existence generally. A self-referential, self-transforming system like the human mind will evolve its uses creatively and open-endedly as it evolved its structures" (p. 76). Hence, in the course of our evolution, factors like language acquisition and the capacity for symbolic representation in combination with an increase in emotional as opposed to physical threats may have contributed to altering the how and why of our dream content.

Finally, we believe that different types of dreams could differentially reflect the predictions arising from the threat simulation theory. For instance, nightmares may very well be one type of dream which reveals the prime importance of threat simulation mechanisms whereas flying dreams or lucid dreams may be the least likely to. In accordance with this view, a quantitative study (Desjardins & Zadra, 2004) of 175 nightmare reports from 118 adults revealed greater support for the postulates underling the threat simulation theory than did the present analysis of recurrent dreams (e.g., a greater proportion of the threats encountered in nightmares were likely to occur in the dreamer's waking life). This observation is in line with Revonsuo's (2000a) idea that the threats encountered in waking contribute the activation of the threat simulation system. When such threats are severe, they are more likely to be followed by nightmares than by recurrent dreams or lucid dreams.

In sum, the data derived from the current sample of recurrent dreams provide mixed support for the threat simulation theory. The results indicate that simulation of threat recognition during dreaming (and presumably REM sleep) may very well fulfill the goal of priming an amygdalocortical network to perform rapid and appropriate emotional evaluation of the potential danger. In addition, we also find some support for the second stage of the threat simulation theory that stipulates the rapid selection of an appropriate behavioral response and its instantiation. On the other hand, most recurrent dreams did not depict probable situations critical for physical survival and reproductive success and fewer than 10% contained realistic and probable threats. Even in those cases where the recurrent dreams did contain threats critical for physical survival and reproductive success, and in spite of the dreamer's possible threat avoidance behaviors or coping strategies against the threats, the subject rarely succeeded in escaping the threat or overcoming it. More studies on other types of dreams (e.g., PTSD and non-PTSD nightmares) and varied populations (e.g., children) are required to further test the threat simulation theory and elucidate the relative merits of its different postulates.

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