A test of the Threat Simulation Theory - Replication of Results in an Independent Sample

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The Threat Simulation Theory (TST) postulates that dreaming evolved as a mental simulation for the rehearsal of the neurocognitive mechanisms essential for threat recognition and avoidance behaviors. In the present study, we tested the predictions of the TST that dreams are specialized in the frequent simulation of realistic and severe threatening events targeted against the dream self, and that the dream self is likely to take appropriate defensive actions against the threat.

The subjects were 50 Swedish university students who kept home-based dream diaries for a period of two or four weeks. The dreams were analyzed with a content analysis method specifically designed for identifying and classifying threatening events in dreams, the Dream Threat Scale. Our results show that in the dreams of ordinary young adults threatening events are frequent, severe, realistic and targeted against the self and significant others. Appropriate defensive actions are frequently undertaken when the situation allows active participation.

The present study replicates earlier findings but in an independent sample, collected in a different country and language area, and analyzed by judges different from the original study. Our findings thus offer further support for the predictions of the TST. **(Sleep and Hypnosis 2007;9(1):30-46)**

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INTRODUCTION

In the field of dream research there is an ongoing debate whether dreaming serves any function. Some currently influential views promote the idea that dreaming has no

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psychological or biological function. The Continuity Hypothesis (CH) (1-3) states that waking experiences are generally reflected in dream content because dreaming and waking consciousness are situated along the same continuum, but CH does not assign any function to this continuity. The contemporary view in cognitive neuroscience is that dreaming has no function what-so-ever, but is rather a mere side-effect of the neurophysiological processes going on in the brain during REM sleep (4-6).

In contrast to the above views, there are also many theories that claim that dreaming

does have a function, but disagree as to what this function is. The currently popular view in traditional dream psychology, traceable back to the works of Freud (7), Adler (8) and Jung (9), assumes that dreaming serves a psychotherapeutic function and maintains our psychological well-being (10-15). At the same time, evolutionary psychological theories propose that the process of dreaming or dreaming about particular contents may have been functional in the evolutionary biological sense: that during the evolutionary history, dreaming provided our ancestors with some kind of selective behavioral advantage.

A unifying theme in most of the evolutionary psychological theories is that dreaming is regarded as an off-line simulation of the sensory-perceptual, motor, and social space that we experience during wakefulness. Dreams have been suggested to be, for example, similar to play behavior (16-19) as both can simulate reality and rehearse real situations and interactions in a safe context. Another popular view is that dreaming simulates human social interactions and rehearses social perception and social skills. E.g. Brereton (20), Franklin and Zyphur (21), Humphrey (18), McNamara (22), and Nielsen and Germain (23) have proposed that because many of the selection pressures faced by ancestral humans were posed by complex human social life, modelling human relationships and interpersonal bonds might have had adaptive value. Also Mackey and Immerman (24) recently hypothesized that dreaming could provide aid in developing tactics for mastering the social chess of the dreamer's community. Additionally, Kahn and Hobson (25) imply that awareness of the minds of others ('Theory of Mind') during dreaming might have contributed to the ability to anticipate the intentions of others while awake. (For a theoretical review on evolutionary psychological theories of dreams, see Valli & Revonsuo (26)).

The third line of evolutionary psychological reasoning is presented in the Threat Simulation Theory (TST) (27). To put it briefly, the TST suggests that dream consciousness evolved as an off-line model of the world that is specialized in the simulation of various threatening events encountered in the human ancestral environment. In human EEA (Environment of Evolutionary Adaptedness; (28)), a threat simulation system that selected memory traces representing life-threatening experiences from episodic long term memory and constructed frequent threat simulations based on them could have provided our ancestors with a selective advantage in practicing threat recognition and avoidance skills. By simulating in various combinations the most severe threats encountered during wakefulness, threat coping skills could have been maintained and rehearsed without the risks of hazardous consequences that accompany threats in real situations. Because of the beneficial effects in enhancing survival and reproductive success, the threat simulation mechanism was selected for, thus propagating its own existence in the ancestral environment.

The Threat Simulation Theory is based on the currently available evidence of the systematically recurring dream content characteristics (e.g., 1,29,30). It takes into account the selection pressures most likely present in the human ancestral environment and proposes a plausible explanation for how dreaming of negative and threatening events might have provided a slight advantage to our ancestors in maintaining and enhancing their threat recognition and avoidance skills. Nevertheless, as the TST was rather recently proposed, it has been empirically tested in only a few studies (31-38).

In the very first study undertaken to test the TST, Revonsuo and Valli (31) explored the frequency and quality of threatening events in the dreams of Finnish university

students. They found that 66% of dreams of nontraumatized young adults included at least one threatening event, and on average there were 1.2 threatening events per dream report. Second, the prediction of the TST that only real, ecologically valid threat cues in the environment fully activate the threat simulation system, was investigated in a sample of dreams collected from severely and less traumatized Kurdish children and nontraumatized Finnish children (32), and in a sample collected from traumatized and nontraumatized Palestinian children (33). In both studies it was found that the more severe the degree of trauma, the more threat simulation dreams the children have, and the more intense and severe the content of the threat simulations are.

In a third line of investigation, dream threats were compared to the most recent threats (collected with a daily log written during the same time period as the dream reports), and to the most salient and memorable threats ever experienced and encoded into episodic memory (collected in an interview) (34). It was found that threat simulations in dreams are much more frequent than real threat experiences in waking life. Furthermore, the threats in dreams seem to be constructed from the memory traces containing the highest negative emotional charge, i.e., the most threatening events ever encountered.

In a similar fashion, Malcolm-Smith and Solms (35) collected a single Most Recent Dream from 401 South-African university students, and discovered that approximately one fifth of MRD's included a threat to life or to physical well-being of the dreamer. They interpreted this finding as contradictory to the prediction of the TST that threatening events are frequent in dreams. Zadra et al (36), on the other hand, explored threatening events in recurrent dreams, and Desjardins and Zadra (37) in nightmares, as the TST proposes that recurrent dreams and nightmares might be paradigm cases of

intense threat simulation dreams. In both studies it was found that even though threatening events were not more frequent in nightmares or recurrent than normative dreams, they were significantly more often life-threatening. The dream self faced the threats with quite primitive defensive reactions, most often by fighting or fleeing the threat. Even though in the studies described above most of the TST's predictions have received empirical support, further testing of the theory is required before it can be regarded as a plausible explanation for the function of dreaming.

The aims of the present study

In the very first study that focused on testing the TST, Revonsuo and Valli (31) developed a content analysis method for identifying and classifying threatening events in dreams, the Dream Threat Scale, and published an analysis of the dreams of Finnish university students. The main aim of the study here undertaken was to replicate the aforementioned experiment in an independent dream report sample collected from Swedish university students. Furthermore, as most of the data that has been used in testing the TST has been scored by the same judge or judges that created the Dream Threat Scale and who are well familiar with the predictions of the TST, we wanted to explore whether judges who were not involved in the development of the scale could score the data reliably, and to test whether the previous results would be replicated or not. Similarly, we chose a participant population whose current life style, and probably also life experiences, closely resemble those of the original study population.

The hypotheses (H) and the research questions (Q) of the present study

The Threat Simulation Theory predicts that in order for efficient threat recognition

and avoidance rehearsal in dreams to be plausible:

(H1) The frequency of threatening events should be relatively high even in the dreams of ordinary nontraumatized young adults

(H2) The threat simulation mechanism should produce simulations of dangerous and severe threats that are critical for survival, not only trivial mishaps

(H3) The threats should be mainly targeted against the dream self and significant others

(H4) The dream self should be likely to actively participate in the course of the threatening events and take appropriate defensive actions against the impending threats

(H5) The dream threats should be realistic simulations of threats present in the real world, not based on fantasy, folk-lore or fiction

We further explored:

(Q1) Whether the previous results acquired with the Dream Threat Scale would be replicated in an independent dream sample collected in a different country and language area and analyzed by judges different from the original study.

METHODS

Participants and data collection procedure

The subjects were 50 (Female= 28; Male= 20; Sex not reported= 2) Swedish university students. The students recorded their dreams as part of a psychology course organized during the years 2000-2004. The subjects were given detailed instructions on how to write a systematic dream diary which consisted of writing down any remembered dreams each morning upon awakening, and were asked to keep a diary for a period of four weeks (years 2000, 2001, 2002) or two weeks (years 2003, 2004). The age of the subjects (who had given this information, N= 23), ranged from 20-40 years (M= 26.8, SD= 5.5). However, all the students who had participated on the course (not all of them returned the dream diary), were registered, and their age could be calculated from student records. As there was no statistically significant difference in the age of students who turned in the dream reports and all the registered students, the age information based on the 23 subjects should be close to accurate in the studied population. The subjects were not informed of the research hypotheses or questions, as the dreams were collected before the current study was initiated.

Data analysis and scoring procedure

The dream reports were analyzed in two stages: 1) Identification of threat descriptions in the dream reports, and 2) Classification of threats according to their content. Both stages were executed by two independent judges (second and third author) who first rehearsed the use of the rating scale in a pilot study, composed of ten dream reports (in the order compiled). No major difficulties were encountered in the pilot phase, and as the judges were close to unanimous over the rating scales from the beginning, the analysis of the rest of the data was initiated.

Threatening events in dreams were identified as those meeting at least one of the two following requirements (adapted directly from Revonsuo and Valli (31)):

Objective threat: An event in a dream 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). Such an event may be directly experienced or witnessed by the dreamer reporting the event, or only indirectly heard about in the dream.

Subjective threat: An event in a dream that

is interpreted or emotionally experienced by the dreamer (i.e., the dream self) to be somehow dangerous. Any event in which the subject reports the feeling of danger or threat, even if no objective threat (as defined above) is reported to accompany this feeling.

At this stage, the threatening events identified according to the above requirements were marked by highlighting the respective parts of the dream reports. The descriptions which were agreed upon by both judges passed on to the next stage of analysis directly, whereas the threats that the judges disagreed about were discussed, and after discussion either rejected from or accepted to final analyses. Then, the threatening events in dream reports were classified according to the following eight separate rating scales:

I The Nature of the Threatening Event

II The Target of the Threatening event

III The Severity of the Threatening Event for the Self

IV The Participation of the Self in the Threatening Event

V The Reaction of the Self to the Threatening Event

VI The Consequences of the Threatening Event to Self

VII The Resolution of the Threatening Event

VIII The Source of the Threatening Event

The final score of a threatening event on these scales was the one that both judges had assigned to the event. In the case of disagreement, the elements that were agreed upon after discussion were accepted to stage 2, while those unsettled were discarded from further analyses on that specific scale. The contents of the scales are described in further detail in the Results-section, and examples of identification and classification of threats are presented in the Appendix.

Statistical methods

Statistical analyses were performed with the SPSS for Windows 12.01 software. In estimating the reliability of inter-rater agreement, a simple percentage agreement was calculated for the identification of threatening events, and Cohen's Kappa Coefficient (_), an index that takes into account the amount of agreement that can be expected by chance, was used for dream content classifications. As the data were not normally distributed, a Mann-Whitney U Test was utilized in testing the differences between males and females in the number of dream reports and threatening events. The Mann-Whitney U Test is a rank-based test that evaluates whether the location of two independent groups is statistically different on the same test variable (39). In addition, Pearson's Correlation Coefficient (r) was used to determine whether the frequency of threats in dream reports was associated with the number or length of dream reports. To explore whether the frequency distributions in the quality of dream threats differed significantly between males and females in the Swedish sample, and whether the Swedish sample differed from the original Finnish sample, Pearson's Chi-Square Tests (c2) with Bonferroni corrections for multiple comparisons were performed. An alpha level of 0.05 was used for all statistical tests.

RESULTS

Reliability of identification and classification of threatening events

In estimating the reliability of inter-rater agreement, simple percent agreement was calculated for threat identification, and Cohen's Kappa Coefficient test was performed for content classifications. The threat identification agreement between raters was 92%, and the content classification agreement strong with respect to all categories (Table 1).

Table 1. Cohen's Kappa Coefficient (_) values for threat content classification •

Nature of threat	Target of threat ♦	Severi-ty of threat	Partici-pation of dream self	Reaction of dream self	Consequ-ences of threat	Resolu-tion of threat	Source of threat
0.94	0.88 - 0.94	0.89	0.99	0.95	0.97	0.96	0.92
***	***	***	***	***	***	***	***

• According to Fleiss [40], Kappa values < 0.4 indicate weak agreement, 0.4-0.75 fair to good agreement, and > 0.75 strong agreement.
♦ The target of the threat –variable could receive several scores as a single threatening event might have had multiple targets: self, significant others, significant resources, and insignificant people or resources.
*** p < .001

Dream reports

The analyzed material consisted of 248 dream reports (177 contributed by females, 68 by males, and 3 by the two persons who did not report their sex), averaging 4.96 dreams per subject (SD= 4.7, range= 1-24). Females reported a significantly higher number of dreams per person (M= 6.3, SD= 5.6, range= 1-24) than did males (M= 3.4, SD= 2.2, range= 1-10) (U= 172, p< 0.05). The difference remained even when the two (highly anomalous) female subjects with the most dream reports – 13 and 24 respectively – were omitted from statistical analysis.

The length of the dream reports averaged 261.6 words (SD= 247.2, range= 28-1895) per subject. One male, however, reported two extremely long dreams – totalling 1895 and 1731 words respectively – and when these were omitted, the average dream report length was reduced to 230.0 words per dream (M= 106.0, SD= 64.0-516.6). Similarly, females and males did not, at first sight, differ statistically concerning the length of dream reports, but when the two lengthiest dream reports were omitted from analysis, the dream reports of males attained an average length of 184.6 words (SD= 71.4, range= 45-532) compared to females' 252.4 words (SD= 116.1, range= 28-903), i.e., significantly shorter than the female reports (U= 173, p < 0.05).

The frequency of threatening events

Altogether, 400 threatening events were identified by the judges, 368 (92.0%) of which the judges agreed upon. Of those that the judges initially disagreed upon, 21 (5.25%) threats were accepted to content classification after discussion, while 11 (2.75%) were discarded from further analyses. Thus, altogether 389 threats were accepted to more detailed content analysis. Forty-nine of the fifty (98%) subjects reported at least one dream with at least one threatening event – this is although a handful of subjects (N= 7) reported no more than one dream.

The number of threatening events averaged 1.7 per dream report (SD= 1.0, range= 0-5), but the threats were not evenly distributed in the reports. Of the 248 dream reports, 191 reports (77.0%) included at least one threatening event, whereas 57 (23.0%) did not contain any threats. No statistically significant differences were found in the frequency of threatening events per dream in the dreams of females (M= 1.8, SD= 0.9, range= 0-5) and males (M= 1.4, SD= 0.9, range= 0-4). The frequency of threatening events correlated positively with the number of reported dreams (r= 0.79, p < .001) and dream report length (r= 0.86, p < .001), i.e., the more dreams and the longer the dreams the more frequent were the threatening events.

The quality of threats

Females and males did not differ statistically significantly on any content classification category, thus results are reported for the whole sample. The exact content distributions in specific categories are presented in Table 2, and next to them the comparable figures from the original Revonsuo and Valli (31) study.

The nature of the threatening events

Failures were the most common type of threatening event, followed by Non-physical aggression (23.7%) and Accidents and Misfortunes (Table 2). Direct physical aggression (9.8%), and Escape and Pursuit situations were less frequent, while Disease and Illness, and Catastrophes were rare. When all the percentages of those categories scoring for aggression, i.e., non-physical aggression, direct physical aggression and being chased or pursued, are summed, threats involving aggressive content are the most frequent type of threat (40.1%). Only 0.5% of threats could not be assigned to any of the above categories. Escape and pursuit situations, and Disease and illness were significantly more frequent, and Failures significantly less frequent in the Finnish than in Swedish participant sample (c2 (8, N= 1061) = 41.4).

The target of the threat

The dream self was most often the target of the threat, followed by persons significant to the dream self (Table 2). Resources significant to the dream self were targeted less often, as were people and resources insignificant to the dream self. Thus, dream threats seem to be more people- than resource –centred. There were no significant differences between the Swedish and the Finnish sample in the targets of the threatening events.

The severity of the threatening event for the self

The dream reports included a high number of quite severe threats, considered from an equivalent standpoint in waking life. Life-threatening and physically extremely dangerous threats totaled 17.7% of threats, whereas the majority of threats were scored as non-physically, i.e., psychologically,

socially or financially severe (Table 2). The total amount of severe threats, including both these categories, was 62.6%. The remaining threats were considered to be minor everyday

Table 2. The quality of threatening events in the present study vs. Revonsuo & Valli (31)

The Dream Threat Scale	The present study	Revonsuo & Valli (31)
I Nature of threat		
1. Escapes ***	6.9%	11%
2. Accidents	17.0%	22%
3. Failures ***	35.7%	26%
4. Catastrophes	3.1%	3%
5. Disease ***	3.3%	8%
6. Aggression	33.5%	31%
II Target of threat		
1. Self	67.4%	73%
2. Significant others	27.0%	27%
3. Sig.resources	9.5%	12%
4. Insig. people and resources	20.3%	27%
III Severity of threat		
1. Life-threatening	17.7%	22%
2. Non-physically severe ***	49.6%	17%
4. Minor ***	32.6%	61%
IV Participation		
1. Active	59.9%	56%
2. Does not / cannot actively participate	40.1%	44%
V Reaction •		
1. Relevant action	92.7%	94%
2. Impossible action	1.3%	2%
3. Irrelevant action	3.4%	4%
4. No reaction, not possible, not reported	40.1%	46%
VI Resolution		
1. Threat dissolved	23.4%	32%
2. Threat realized	40.4%	37%
3. Discontinuity	18.5%	14%
4. Disrupted	17.7%	17%
VII Consequences		
1. No losses	29.8%	37%
2. Minor losses ***	48.6%	22%
3. Severe losses	3.1%	<2%
4. Not reported ***	18.5%	28%
VIII Source of threat		
1. Realistic threat	59.9%	63%
2. Unlikely threat	32.9%	33%
3. Fictitious threat	6.7%	4%
4. Not classifiable	0.5%	<1%

*** A significant difference between Swedish and Finnish participant sample, p < .001
• Type of reaction (relevant, impossible, irrelevant) calculated only from those cases (59.9% and 56%) where reaction was reported.

mishaps, trivial for the future success of the dream self. The non-physically severe threats were significantly more frequent in the dreams of Swedish than Finnish students, whereas minor threats were significantly less frequent (c2 (2, N= 1054) = 132.2).

Participation in and reaction of the dream self to the threatening event

The dream self could actively participate in more than half of the threatening events (Table 2). In the rest of the cases, self-participation was not reported or it did not occur, because the dream self was either not present when the threat took place or he was prevented to participate, i.e., participation was not possible. When the dream self could participate in the course of the threatening events (N= 233; 59.9% of threats), the most common type of reaction was one that would also be possible and appropriate in a comparable situation in the waking realm. Actions possible in the waking life but irrelevant in the dream situation were rare, as were actions impossible in the waking life but effective in the dream. In only few cases where active participation was possible to begin with, the dream self did not react to the threats (2.6%). The participation rates and types of reactions were statistically similar in the Swedish and the Finnish sample.

Resolution and consequences of the threatening event to self

The threatening situation had a happy ending, i.e., the threat was resolved, in approximately one quarter of all threats (Table 2). Unhappy endings where the threat was realized were more common (40.4%), while 36.2% of the threatening events were disrupted either because the dreamer woke up in the middle of the threat or because the dream was discontinuous. Minor losses to dream self were reported to result from threats in half of the cases, significantly more

often than in the Finnish sample (c2 (1, N= 1061)= 53.2), whereas severe losses were very rare. These severe losses consisted of cases where a significant person died or was badly injured, but there were no cases where the dream self suffered fatal consequences. The threat had no consequences or the consequences were not adequately reported (because the dream was discontinuous or disrupted) in almost half of the cases.

The source of the threatening event

Of the 389 threatening events, the source of more than half of the threats was traced back to the subjects' personal lives (Table 2), meaning that the subjects had probably heard about such events through their social contacts, possibly knew persons who had experienced such threats, or might even have personally been exposed to similar threats. In contrast, one third of the threatening events were categorized as realistic threats that are unlikely to take place in the subjects' normal waking lives, i.e., threats that the subject was most likely to come to contact with only through mass media (for instance, exotic animals or diseases, war, natural catastrophes). Less than ten percent of the threats were categorized as fantasy- of fiction-based and thus completely non-realistic. The results on the source of threat were statistically similar in the Swedish and Finnish sample.

The relationship between the severity of threats and the participation in and reaction to the threats

A cross-tabulation between the severity of the threats (life-threatening vs. other threats) and participation in the threats (active participation vs. no participation) and reaction to the threats (appropriate and relevant action vs. no reaction or inappropriate action) was conducted. There were no statistically significant differences in

the frequency distributions of participation in the threats or reactions to the threats between life-threatening and less severe situations. Thus, when facing a life-threatening event, participation in the threat is no more likely than in less severe threats and neither is the efficiency of the reaction.

DISCUSSION

The first aim of the present study was to test the hypotheses of the TST that 1) the frequency of threatening events is relatively high in the dreams of ordinary young adults; 2) that the threat simulation mechanism will produce realistic simulations of severe threats which are 3) targeted against the dream self and significant others; and 4) that the dream self is likely to actively participate in the course of the threatening events and defend oneself against the threats. We further investigated whether judges who did not participate in the development of the Dream Threat Scale are able to reliably identify and classify threatening events in dream reports, and whether the results acquired with the content analysis scale are similar, in an independent but comparable participant sample, to the previous findings of Revonsuo and Valli (31). Thus, the aims were to explore whether the Dream Threat Scale is a reliable method for content analysis of dream reports, and whether the predictions of the TST hold in an independent sample and study.

The results of the present study show that threatening events are frequently experienced in the dreams of Swedish university students, averaging more than one threat per dream. The threats are more often life-threatening, and physically or non-physically severe than minor or insignificant mishaps, and more often targeted against the dream self and significant others than insignificant people or resources. Even though participation in the course of the threatening events was not always possible,

in those cases where participation could occur, the dream self most often reacted to the threat in a manner that would also be possible and appropriate in a comparable waking situation. The majority of the threats were realistic, or realistic but unlikely, in the lives of our subjects, while only a few were based on fantasy, fiction or folk-lore.

As to the reliability of the Dream Threat Scale, the inter-rater agreement between the judges was high in both the identification of threats and in the classification of threats into specific content categories. The results are mainly in accordance with the previous findings by Revonsuo and Valli (31), although some significant differences in the frequency distributions within content categories can be observed. We therefore see that the present study adds to the reliability of the Dream Threat Scale developed for identifying and classifying threatening events in dreams. Below, the results of the present study are compared to the findings of the original study (Revonsuo and Valli (31)) and discussed in more detail.

The frequency of threatening events

In the sample of dreams of Swedish university students, three quarters of the dreams included at least one threatening event, and on average there were 1.7 threatening events per dream report. Only one subject out of fifty reported no threatening events. The findings are quite consistent with those of Revonsuo and Valli (31) who studied the dreams of Finnish university students. They found that two thirds of all dreams included at least one threatening event (N= 672), and that on average there were 1.2 threatening events per dream. Thus, we believe that it is justified to state that threatening events occur frequently in dreams, as more fifty percent of the dreams in the investigated university student samples (31, 34, the present study) include threatening events, and many dreams

include more than one threatening incident. The higher average number of threats in the dreams of Swedish than Finnish university students may be due to true underlying threat frequency differences in the samples in question, follow from longer dream reports in the Swedish sample, depend on biased sampling of dreams, or result from less strict use of threat identification criteria by the judges in the present study. There were 248 dream reports in the Swedish sample vs. 592 Finnish dream reports, but a comparable number of subjects (50 vs. 52), and, mostly, comparable length of dream diary period. Thus, the Swedish students reported fewer dreams per subject than Finnish students and they might have concentrated on writing down only the dreams they remembered best, i.e., the most salient and emotional, possibly threat-filled dreams. This might explain the fewer but longer dreams in the Swedish vs. in the Finnish sample (261.6 vs. 141.5 words). As in the present study, it has been also previously established that the frequency of threats positively correlates with dream report length as well as with the number of dream reports (34,41). Nevertheless, as the languages used in dream reporting in the present and in the original sample are not closely related (Finnish being Finno-Ugric and Swedish a Germanic language), and structural differences, such as the use of prepositions, are likely to yield the Swedish reports longer, we cannot directly compare the dream report length in these two data. Therefore, we cannot choose between the above listed alternative explanations for the slightly higher threat frequency in the present sample.

The quality of threatening events

The distribution of different types of threats was almost identical between the present and the previous study (see Table 2 for details). Threats including aggression (either non-physical aggression, escape or pursuit situations, or direct physical aggression) were the most common types of threats, followed by failures and accidents and misfortunes. Disease and illness were infrequent in both samples, as were catastrophes. The most common types of threats in dreams thus seem to reflect threats predominant in the ancestral environment. In that environment, the safe nocturnal simulation of the most frequent types of threats present in the waking life could have contributed to the development and maintenance of threat perception and avoidance mechanisms, thus increasing the chances of survival and reproduction of our ancestors. Furthermore, in both samples the threats were mostly self- and people-centred, as if to make sure that the dreamer's full attention was devoted to dealing with the event. From an evolutionary perspective, simulating threats that involve persons or resources insignificant to the self would not be an efficient form of rehearsal.

Distinct from the findings of Revonsuo and Valli (31), the overall severity of threats was judged to be graver in the present study. Even though Revonsuo and Valli reported a slightly higher percentage of life-threatening events, in the present sample non-physically (i.e., socially, psychologically, or financially) severe threats were found to be much more common. In contrast, the amount of minor threats was reported to be higher in the dreams of Finnish university students. These differences support the notion that the Swedish students reported more salient, emotional and threatening dreams due to less strict sampling of dreams, but may also follow from problems in the scoring of the data consistently. In both samples, however, severe threats were frequent, in fact more frequent than during an equal period of wakefulness (34), indicating that dream consciousness is biased towards overrepresenting severe threatening events. These findings lend support for the prediction of the TST.

Concerning the participation of the self in the threats and the reaction of the self to the threats, the present and previous findings are uniform. In approximately 60% of threats the dreamer was able to participate in the course of the events, and when the dreamer reacted to the threat, the reaction was almost always appropriate and relevant to the situation. Physically impossible but efficient reactions, and possible but irrelevant reactions, were rare in both samples. The hypothesis of the TST that the dreamer is likely to act adequately in threatening situations thus gained further support.

The cross-tabulation between the severity of threats and the participation and reaction of self to the event produced, however, discrepant findings. While Revonsuo and Valli (31), and Valli et al. (34) reported that if the situation is fatally dangerous, the dream self is more likely to show an appropriate defensive response than if the situation is less dangerous, the present data did not lead to the same conclusion. Traumatized children, but not non-traumatized children, have also been found to react more likely to life-threatening than to less severe events (33). The relationship between the severity of threats and dreamer's activity in the situation should thus be further explored in future studies.

The findings concerning the resolution and consequences of the threats were similar in the present and the previous study. Even though the threat was realized in more than one third of the dreams, severe consequences were seldom reported. Remarkably, in neither studies the dream self suffered severe injuries or death. Minor losses were more frequently experienced, and almost twice as frequently in the dreams of the Swedish than the Finnish students. In approximately one third of the threats the situation had a happy ending, i.e., the threat was resolved, and did not result in any harmful consequences. Comparably, nearly in one third of the dream reports the resolution of the threatening

event remained unclear due to discontinuity or disruption of the dream. As such, the consequences of the threats were not reported in a similar number of dreams. Thus, it seems that the threat simulation mechanism is not particularly interested in simulating what happens after the threat has been encountered and the dream self has reacted to it. Practicing the recognition of the threat and appropriate reaction to it seems to be more important for efficient threat avoidance rehearsal than simulating the outcome of the threatening event.

The threatening events were found to be based mostly on realistic rather than fantastic sources in both studies. The majority of threats were either realistic portrayals of threats possible in the living environment of the subjects, or of threats possible but unlikely in the subjects' lives, indicating that threats in dreams are primarily constructed from real life sources. Unrealistic sources of threats, such as fantasy, fiction and fairytales, were rarely found. These results support the notion of the TST that, in order for threat rehearsal in dreams to be efficient, the simulated threats should bear close resemblance to threats present in reality.

The reliability of the Dream Threat Scale

In the present study the threat identification agreement between judges was very strong, stronger than in the original Revonsuo and Valli (31) publication (92% vs. 76%-84%) (in the original study, three judges scored the data and the range of pairwise agreement is reported here). Similarly, the threat content classification agreement was strong with respect to all content categories in the present study, whereas in the original study the agreement level varied between good and strong (_= 0.43 – 0.79). In addition, Zadra et al., (37) who used a similar version of the Dream Threat Scale in classifying the threat content of recurrent dreams, achieved an inter-rater

agreement of 88% in threat identification and good to strong inter-rater agreement in content classification (_= 0.50 – 1.00). It therefore seems that the Dream Threat Scale is a reliable tool for exploring the frequency and quality of threatening events in dreams, and we welcome both further use of the scale as well as any modifications that improve the method.

Limitations of the present study

In dream content research the data is composed of introspective reports. Thus, as any dream content study, the present study is subject to several limitations, such as reconstruction errors, verbal description difficulties, censorship and lack of independent verification. The current data was collected, however, using the same detailed dream diary instructions that were used in the original study by Revonsuo and Valli (31), and therefore these two data should be comparable.

Another problem posed by the present data set is that some participants kept dream diaries for a period of four weeks (those attending the course during years 2000, 2001, and 2002) while some for a period of two weeks (those attending the course during years 2003 and 2004). At the time of data collection, the dream diaries were included in the course plan to demonstrate to the students the limitations and difficulties in collecting and using introspective data, but the course instructor was not aware that the dreams would later be used for research purposes. Nevertheless, as the data collection methods and dream diary instructions were the same as in the original Revonsuo and Valli (31) study, and the data thus otherwise comparable, all dream reports were included in the study.

The most important limitation of the present study is that the judges, even though they were not previously familiar with the Dream Threat Scale, were aware of the TST.

This might have led to an unconscious demand characteristic. Although the judges were instructed to take precautions against any expectations, demand characteristics might, nevertheless, have had an impact on the results.

Furthermore, the present results are based on spontaneously recalled dreams, which are not a representative sample of all dreams. For instance, Conduit, Crewther and Coleman (42), Foulkes (43,44), Foulkes and Cavallero (45), Mealey (46), and Montangero (47) have argued that spontaneously recalled dreams form a biased sample due to selective memory, and it is suggested that more rigorous data collection methods, i.e., controlled laboratory awakenings, should be used in dream studies. As to date, the field offers contradictory results concerning whether there are differences between spontaneously remembered dreams vs. dreams recalled in controlled laboratory awakenings as well as the extent of these differences (1,43,44,48).

Moreover, spontaneously remembered dreams tend to be dreams that one wakes up from, mainly late night REM (Rapid Eye Movement) sleep dreams. Because that is when most REM sleep and dreaming occur, it might reflect an optimal activation level of the dream production mechanism, unlike early night awakenings. Thus, the threat simulation frequency and the quality of threat simulations might vary between NREM and REM dreams, as well as depend on the time of recall (early vs. late night sleep stages). However, qualitative differences in the content of REM and NREM dreams largely disappear when dream report length is controlled for (49,50,51). Even though monitoring sleep stages at home is also possible (52,53), the equipment is quite expensive and data collection more demanding for the subjects. Nevertheless, the frequency and quality of threat simulations throughout the night and across sleep stages should be investigated in future studies.

Regardless, as to the present study, same data collection methods was used as in the original Revonsuo and Valli (31) study, and therefore these two data are directly comparable. If a bias exists, it exists in both samples.

Finally, the Dream Threat Scale has been criticized for too broad a definition for threatening event, as it includes minor misfortunes. It is true that we have included all types of harmful events into our definition of threat, also failures and minor mishaps. However, including all kinds of threatening events in the definition, and separately coding their severity allows us to test hypotheses concerning the quantity and quality of threats in different populations. The TST predicts that the frequency and quality of threats in dreams is affected by waking-life experiences, especially exposure to real ecologically valid threat cues in the environment, and the activity level of the threat simulation system increases subsequently. Thus, including all types of threats into our coding system enables the comparison of the activity level of the threat simulation system in specific populations, even when the activity level is not maximal.

Conclusions

The present study has provided further evidence that dreams seem to be specialized in producing simulations of severe, highly self- and people-centred, realistic and personally relevant threatening events. The dream self reacts to threatening events in a manner appropriate and reasonable in a comparable waking situation, although the context of the dream does not always leave room for defensive reactions. Our findings may thus be interpreted as offering further support for the predictions of the TST. In the present study we have also demonstrated that the Dream Threat Scale is a reliable content analysis tool for identifying and classifying threatening events in dream reports.

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APPENDIX: Examples of the identification and classification of threatening events in dreams

The aim of the appendix is to illustrate the nature of the qualitative material analysed in the present study, and to demonstrate how threatening events were identified and classified. Exemplary cases of the most common types of dream threats are presented below. Threatening events are marked with italics, and numbered if there are several within one report. The content classifications are given at the end of each report. The most representative excerpts of specific types of threats have been selected from the reports of different subjects, and thus, are not a representative sample of any single subject's reports or threatening events. The example reports were translated from Swedish into English by the first author.

Subject 12, female, age unknown
Shark in a pool
I'm in a huge swimming hall, it's night and everything around me is shaded blue. 1) *I and another girl have been locked in and we have to try to get out.* The only way out is to swim in the pools. They are so deep that I can't see the bottom. We jump into the first pool, and 2) *suddenly we see a shark coming towards us from below. We swim as fast as we can and get out of the pool just before it gets to us.*1) (cont.) The worst thing is that we are not out of the swimming hall yet, we have at least two more pools to try. We jump into another pool and dive deep, and finally we come to the men's toilet. Then we see an old man, just sitting there. He says that he has been here a long time and has never gotten out.
   I Nature of threatening event: 1) Accident/misfortune; 2) Escape/pursuit
   II Target of threatening event: 1) Self, Insignificant others; 2) Self, Insignificant others
   III Severity of threat: 1) Psychologically severe; 2) Life-threatening
   IV Participation of the self in threatening event: 1) Active; 2) Active
   V Reaction to threatening event: 1) Possible and reasonable; 2) Possible and reasonable
   VI Consequences of threatening event: 1) Severe loss; 2) No losses
   VII Resolution of the threatening event: 1) Threat realized; 2) Threat resolved
   VIII Source of threatening event: 1) Personal life, realistic threat; 2) Mass media, realistic but unlikely threat

Subject 21, Female, age 30 years
Boat
I'm in a big boat. It's decorated with red, soft carpets. I and my class mates A-L, H and K sit at a round table. Suddenly I'm on the top deck, and the boat is sinking. I'm scared and start to

cry, I'm paralyzed. I know that I must jump into the water and save myself, but I cannot move. Suddenly somebody gives me a push and I fall head first into the cold water. I hold onto my purse. An orange life raft comes and somebody helps me and pulls me aboard from my arms. Then, I'm in a harbour. People are running around hysterically and speaking Finnish. An ambulance is parked farther off, back door open. I feel tired and apathetic, I have no strength to get up and ask for help. Then someone lays a hand on my shoulder. It's my teacher, A, he helps me up and leads me to his car. I feel relieved and happy.

I Nature of threatening event: Accident/misfortune
II Target of threatening event: Self, Significant others
III Severity of threat: Life-threatening
IV Participation of the self in threatening event: Active
V Reaction to threatening event: Possible and reasonable
VI Consequences of threatening event: No losses
VII Resolution of the threatening event: Threat resolved
VIII Source of threatening event: Personal life, realistic threat

Subject 1, Male, age unknown
Train
I'm at home, but I have to leave for the railway station to catch a train. I realize that I'm running late, and will have difficulties making it in time. I'm starting to panic under the pressure. In the end, I manage to catch the train.

I Nature of threatening event: Failure
II Target of threatening event: Self
III Severity of threat: Minor
IV Participation of the self in threatening event: Active
V Reaction to threatening event: Possible and reasonable
VI Consequences of threatening event: No losses
VII Resolution of the threatening event: Threat resolved
VIII Source of threatening event: Personal life, realistic threat

Subject 6, Male, age 20 years
Resistance
1) Sweden, or at least the town where I live, is occupied by soldiers. I think they are Finnish. They have blue and white uniforms, and some kind of tall hats. They have set up a barbed wire fence around the town, so that the town looks like a concentration camp. I and a few friends, don't know who they are, decide to engage in resistance. But we don't have any weapons. I only have a key ring, with three keys in it. The keys can shoot projectiles if I press a particular buttont. We are outdoors and creep forwards by the fence. We see few soldiers on a nearby bridge, one of them has fallen a little behind the others. We decide to take him down and steal his rifle. I don't know how but we manage to subdue or kill him, maybe with the keys? We stay on the ground and sneak forward, but 2) the other soldiers detect us. There is a shoot-out. [Dream report ends]

I Nature of threatening event: 1) Catastrophe; 2) Direct physical aggression
II Target of threatening event: 1) Self, Significant others, Significant resources, Insignificant people and resources; 2) Self, Significant others
III Severity of threat: 1) Life-threatening; 2) Life-threatening
IV Participation of the self in threatening event: 1) Active; 2) Active
V Reaction to threatening event: 1) Possible and reasonable; 2) Possible and reasonable

VI Consequences of threatening event: 1) Losses to insignificant people; 2) Not reported

VII Resolution of the threatening event: 1) Threat realized; 2) Dream report ends: Cannot be classified

VIII Source of threatening event: 1) Mass media: realistic but unlikely threat; 2) Mass media: realistic but unlikely threat

Subject 29, Female, age unknown

My baby

I could somehow see into my womb. The doctor said that there is something wrong with my baby (I'm nine months pregnant). His head was crooked and his buttocks were in the middle of his back. The doctor said that they could operate him while he was still in my womb, so he would look like normal when he was born. I said they could do it, and they twisted his head and attached it to the throat with a safety pin.

I Nature of threatening event: Disease/illness

II Target of threatening event: Self, Significant others

III Severity of threat: Psychologically severe

IV Participation of the self in threatening event: Active

V Reaction to threatening event: Possible and reasonable

VI Consequences of threatening event: No losses

VII Resolution of the threatening event: Threat resolved

VIII Source of threatening event: Mass media: realistic but unlikely threat

Subject 42, Female, age 25 years

Monster man

1) I'm being held captive by a short man. We are somewhere on a lawn and he has a kind-looking dog on his left side. 2) He picks up a chain saw lying next to him, he smiles and tells me that I don't have a chance. His red lips are moist and he is sweating. I look like I've been beaten. He takes the chain off from the saw and I snatch it. I try to catch his hand with the chain, but he keeps on smiling and laughing and attacks me with a knife (the chain saw has turned into a knife). I manage to avoid being hit, but I'm getting tired. Somebody, I think it's a woman, comes to my rescue with a crossbow. The monster man hides behind his dog, but the woman keeps on shooting him. The arrows hit the dog, and the dog is dying, but the man still alive and smiling.

I Nature of threatening event: 1) Non-physical aggression; 2) Direct physical aggression

II Target of threatening event: 1) Self; 2) Self

III Severity of threat: 1) Psychologically severe; 2) Life-threatening

IV Participation of the self in threatening event: 1) Not reported: Cannot be classified; 2) Active

V Reaction to threatening event: 1) Not reported: Cannot be classified; 2) Possible and reasonable

VI Consequences of threatening event: 1) Not reported: Cannot be classified; 2) Losses to insignificant resources

VII Resolution of the threatening event: 1) Threat realized; 2) Threat resolved

VIII Source of threatening event: 1) Mass media: realistic but unlikely threat; 2) Mass media: realistic but unlikely threat