

The threat simulation theory of the evolutionary function of dreaming: Evidence from dreams of traumatized children

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Abstract

The threat simulation theory of dreaming (TST) (Revonsuo, 2000) states that dream consciousness is essentially an ancient biological defence mechanism, evolutionarily selected for its capacity to repeatedly simulate threatening events. Threat simulation during dreaming rehearses the cognitive mechanisms required for efficient threat perception and threat avoidance, leading to increased probability of reproductive success during human evolution. One hypothesis drawn from TST is that real threatening events encountered by the individual during wakefulness should lead to an increased activation of the system, a threat simulation response, and therefore, to an increased frequency and severity of threatening events in dreams. Consequently, children who live in an environment in which their physical and psychological well-being is constantly threatened should have a highly activated dream production and threat simulation system, whereas children living in a safe environment that is relatively free of such threat cues should have a weakly activated system. We tested this hypothesis by analysing the content of dream reports from severely traumatized and less traumatized Kurdish children and ordinary, non-traumatized Finnish children. Our results give support for most of the predictions drawn from TST. The severely traumatized children reported a significantly greater number of dreams and their dreams included a higher number of threatening dream events. The dream threats of traumatized children were also more severe in nature than the threats of less traumatized or non-traumatized children.

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1. Introduction

The most basic notion of consciousness refers to the *presence* or the *having* of subjective experiences such as sensations, percepts, thoughts and emotions. During sleep, we regularly have hallucinatory subjective experiences that are internally generated in the brain. Experiences during sleep have traditionally been divided to two broad categories: sleep mentation and dreaming. “Sleep mentation” refers to simple, static, or unimodal experiences whereas “dreaming” refers to *complex, temporally progressing, multimodal sequences of experiences during sleep* (Farthing, 1992). Dreaming is like a virtual-reality simulation of the perceptual world, created internally without the contribution of external physical stimulation (Revonsuo, 1995). Furthermore, dreaming is the most frequently occurring altered state of consciousness. The description and explanation of dreaming should therefore have a central role in the study of consciousness.

The ability to produce complex sequences of hallucinatory experiences during sleep seems to be a part of the brain’s biological machinery, for individuals in all cultures and times express this nocturnal form of consciousness. One of the most puzzling questions about dreaming is the following: *Why* should complex sequences of hallucinatory subjective experiences occur during sleep? Why shouldn’t we spend the night in total subjective silence and darkness, in the absence of any phenomenal contents of consciousness whatsoever?

Neurophysiological sleep research has sought for the answer to this question in the physiology of REM sleep. Dreaming and REM sleep should not, however, be confused or identified with each other. Dreaming is a sequence of subjective experiences whereas REM sleep is a stage of sleep with particular physiological criteria. REM sleep seems to be the most optimal physiological condition in which dreams are brought about (Pivik, 1991). In adult humans the phenomenology of dreaming is correlated with the occurrence of REM sleep in such a way that a person woken from REM sleep will report a dream in about 60–90% of awakenings, but a person woken from NREM sleep will report a dream in only about 25–50% of awakenings (Nielsen, 2000). Thus, questions about the function of REM sleep should not be identified with questions about the function of dreaming. REM sleep is neither a necessary nor a sufficient condition for dreaming. Furthermore, REM stage may have several functions independent of the experience of dreaming, e.g. memory consolidation (Hobson, 1994), or memory cleaning (Crick & Mitchinson, 1983, 1995). Similarly, dreaming may have functions independent of REM sleep, e.g. protecting sleep (Freud, 1900/1950; Solms, 1997).

REM sleep, with all of its physiological characteristics, appears to have evolved 140 million years ago (Winson, 1993), and it appears to be present in all marsupial and terrestrial placental mammals. Whether the earliest forms of REM sleep were associated with dreaming, we do not know, but there is now indirect experimental evidence that other mammals such as cats dream. Cats manifest complex behaviors during REM sleep if muscular atonia is removed (Morrison, 1983; Jouvet, 1999). These oneiric behaviors seem to be caused by the acting out of simultaneous dream experiences, and a similar human parasomnia, called “REM sleep behavior disorder” (Schenck, Bundlie, Ettiger, & Mahowald, 1986) has recently been recognized. Thus, dreaming does not seem to be restricted to humans but is likely to occur in many other species of mammals as well.

1.1. The function of dreaming: An evolutionary hypothesis

The TST (Revonsuo, 2000) proposes that the biological function of human dreaming is the realistic simulation of threatening events during sleep and the repeated rehearsal of the neuro-cognitive mechanisms involved in threat perception and avoidance. TST places human dreaming in the context of the original ancestral environment, the Pleistocene era, where early humans and their predecessors lived for hundreds of thousands of years. If dreaming is a part of the biological machinery of the human brain, it must have been present in the human ancestral environment, and probably long before, at least in some form.

The threat simulation hypothesis primarily applies to the explanation of the function of *human* dreaming, and its evidential basis consists in the content of the dreams and nightmares reported by different human populations. Revonsuo (2000), however, also suggests that TST can be formulated in a more general form so that it applies to all mammalian species: dreaming rehearses species-specific survival skills. The exact nature of these skills varies from species to species depending on the ecological niches that the species occupy. Evidence from the oneiric behaviors in cats during REM sleep support the view that cats dream about situations in which they may rehearse their species-specific survival skills. Thus, like other instinctive behavioral programs, the precise form and content of dreaming is species-specific rather than identical across all mammals.

According to TST, the precise form and content of human dreaming has been shaped by the original ancestral environment in which humans and their ancestors lived. The life of an average ancestral human was constantly at risk, and the dream production mechanism had plenty of real-life threatening events to simulate in the ancestral environment. The dream production system was likely to simulate threats thousands of times during an individual's lifetime, which tended to result in improved threat avoidance skills. Individuals with improved threat avoidance skills were more likely to leave offspring. Thus, a dream production system that generated threat simulations involved a selective advantage and a higher probability of successful reproduction for the individual living in the ancestral environment. As the neural basis of the dream production mechanism is innate, the threat simulation system consequently spread throughout the ancestral human population and persisted in successive populations.

TST proposes that human dream content shows too much organization to be produced by random cortical activation during REM sleep, thus challenging the views according to which dreams are mere incidental by-products of neurobiological processes operating during REM sleep (Crick & Mitchinson, 1983, 1995; Hobson, 1988, 1994; Hobson & McCarley, 1977). Dreams have a highly predictable form of "world-presenting" or "self in a world" (i.e., they are organized along the same general lines as our perceptual waking consciousness), and dreams are likely therefore to be a consequence of an active, organized process.

Furthermore, empirical evidence suggests that the dream production mechanism is selective: some types of experiences are underrepresented, others overrepresented. For example, reading, writing, typing, and calculating are grossly underrepresented in dreams, no matter how prominent in waking life (Hartmann, 2000). By contrast, various unpleasant and negative elements are overrepresented in dreams. Several studies have found that negative emotions are far more frequent in dreams than positive emotions, fear and anger being the most common emotional experiences (Hall & Van de Castle, 1966; Snyder, 1970; Strauch & Meier, 1996) (but for conflicting findings, see Schredl & Doll, 1998; Strauch & Meier, 1996; and Fosse, Stickgold, & Hobson, 2001). Misfortune is seven times

more frequent than good fortune (Hall & Van de Castle, 1966), and about 70% of the misfortunes happen to the dream self, threatening the well-being or the possessions of the dream self (Domhoff, 1996; Hall & Van de Castle, 1966). Aggression is the most frequent type of social interaction (45%), and dreamers are involved in 80% of the aggressions in their dreams, more often being the victim than the aggressor (Domhoff, 1996; Hall & Van de Castle, 1966). Our dream enemies are often either wild animals or male strangers (Domhoff, 1996; Hall & Van de Castle, 1966; Strauch, 1996), while encounters with females are more friendly in nature (Domhoff, 1996). In addition, the themes of recurrent dreams and nightmares are mostly simulations of primitive threats (Domhoff, 1996; Hartmann, 1984; Robbins & Houshi, 1983). On the basis of these findings, dream content seems to be more consistent with the original evolutionary environment than the present one, and seems to be specialized in the simulation of threatening events (Revonsuo, 2000).

1.2. Post-traumatic dreams as an evolved threat simulation response

The TST states that the dream production system becomes fully activated in the presence of ecologically valid threat cues. Such cues inform about potentially dangerous events and entities in the environment that may jeopardize the future reproductive success of the individual. Empirical evidence shows that dream content is powerfully modulated by real life-threatening events. Post-traumatic nightmares are commonly reported by both children (e.g. Nader, Pynoos, Fairbanks, & Frederick, 1990; Pynoos & Nader, 1988; Pynoos et al., 1987; Terr, 1979) and adults (e.g. Barrett, 1996; Hartmann, 1984, 1996; Wilmer, 1996) who have experienced threatening real-life situations. The higher the degree of personal threat involved, the more probable is the occurrence of post-traumatic nightmares or intense threat simulations.

TST predicts that children old enough to implement threat recognition and threat avoidance skills during wakefulness should also be capable of threat simulation during dreaming, especially if ecologically valid threat cues are present in the environment (Revonsuo, 2000). According to TST, early exposure to real threats should stimulate the threat simulation system leading to earlier, more frequent, and more intense threat simulations. By contrast, in the absence of ecologically valid threat cues, the threat simulation system should develop more slowly or stay in a resting state, and, consequently, the threat simulations will remain less frequent and milder. Although these predictions have not been directly tested before, they are indirectly supported by the available evidence: traumatizing events increase the number of nightmares (Nader, 1996) and seem to change the content of dreams. In the dreams of Palestinian children living in Gaza under violent conditions there was more aggression, more persecution, and more negative emotions than in the dreams of children living in a more peaceful area in Galilee (Punamäki, 1997, 1998).

1.3. Previous research on TST

In order to test the predictions of the threat simulation theory more directly, Revonsuo and Valli (2000) devised a content analysis scale for distinguishing threatening events from other events mentioned in dream reports. They studied 592 home-based dreams reported by 52 university students and discovered that 66.4% of dream reports included at least one threatening event. The average number of threatening events per dream report was 1.2, indicating that threatening events seem to be overrepresented in dreams compared to waking life.

When the threatening events were analysed in more detail, it was found that aggression was the most common type of threatening event (42%). Failures, accidents and misfortunes were also quite frequent, while catastrophes and diseases were rare. The most often threatened characters were the dream selves and significant others. Life-threatening or highly physically severe events accounted for 22% of the threats, and 17% of the threats were psychologically, socially, or financially severe, while sixty-one percent of the events were considered to be only mildly threatening. When the dream self was an active participant in the dream, the reaction to the threat was almost always relevant and appropriate action. Furthermore, if the situation was life-threatening, the dream self was significantly more likely to react to the threat. Overall, the results support the predictions derived from TST. The subjects were, however, ordinary Finnish students and probably unexposed to severe traumatic events, and therefore, the threat simulation system may not have been particularly activated in them.

1.4. The present study

In the present study, we focus on the dreams of severely traumatized children whose threat simulation system should, according to TST, be fully activated. We test directly the hypothesis according to which children exposed to threatening events should have more frequent and more intensive threat simulation dreams than children living in more peaceful conditions. We also investigate whether the threat simulation system is activated in a qualitatively distinctive manner after exposure to severe trauma.

Our hypotheses derived from TST are the following:

1. The severely traumatized children should report more dreams than less traumatized or non-traumatized children due to higher activation of the dream production system.
2. The severely traumatized children should have a higher frequency of threatening events in their dreams than less traumatized or non-traumatized children.
3. The threats of the severely traumatized children should be more severe in nature, e.g., include a higher frequency of life-threatening and psychologically, socially, or financially severe threats, than the threats of less traumatized or non-traumatized children.
4. The severely traumatized children should react to the threat more often than less traumatized or non-traumatized children.
5. The threat simulation system does not simulate the consequences of the threatening events as frequently as it does simulate the threatening events themselves, and thus the dream reports should often lack a description of the consequences of the threat. The subject groups should not show great variability in simulating the consequences of the threats.

2. Methods

2.1. Participants

The participants consisted originally of 122 Kurdish children and adolescents, and 82 Finnish children. The Kurdish children live in the Kurdish autonomous area in Northern Iraq, where their nation has a long history of persecution (Amnesty International, 1990; McDowal, 1997). In the

1988 Anfal campaign, about 182,000 Kurdish people were captured by Iraqi military forces. The approximated number of missing people still varies today between 80,000–144,000. Almost all Kurdish villages (approximately 5000) were destroyed, and the forests were burned down in the hunt for the Kurdish freedom fighters (Ingatieff, 1994; McDowal, 1997). After the 2nd Gulf war in 1991, the Kurdish people rose against the Iraqi regime, and subsequently about 3–4 million Kurds fled in panic across the mountainous countryside towards the borders of Iran and Turkey. Moreover, a civil war between two main Kurdish political parties divided the Kurdish area until 1997.

Five Kurdish and twelve Finnish children were omitted from the study due to the lack of dream reports or missing data. The group of Kurdish children consisted of 48 boys and 69 girls, with age varying between 9–17 years ($M = 13.0$, $SD = 1.7$). The children were divided into the Trauma group and the Control group according to personally experienced traumatic events. Traumatic events were measured by 20 items, referring to military violence (seven items), family trauma (eight items), economic hardships (three items), and other (road traffic accident). The scale was developed for the Kurdish refugee children and updated by the events that children and adolescents typically experience in war zones and under military occupations (Abu Hein, Qouta, Thabet, & El Sarraj, 1993; Punamäki, 1998; Summerfield, 1993). Children responded on a dichotomous scale to indicate whether or not they had been exposed to the event.

The Trauma group consisted of children who had faced military violence and/or lost a caretaker or both caretakers or several relatives in war and military attacks. The Control group consisted of children who had had more ordinary lives and had been saved from military persecution, or who had lost a caretaker due to fatal illness or accident. The Trauma group consisted of 64 subjects ($M/F = 28/36$), and the Control group of 53 subjects ($M/F = 20/33$). The girls in the Trauma group were significantly older than the boys ($M = 13.5$ vs. 12.2 years; $U^1 = 372.5$, $p < .05$) as were the girls in the Control group ($M = 13.3$ vs. 12.2 years; $U = 211$, $p < .05$).

The Finnish children form a non-traumatized group. Even though some of the Finnish children might have suffered personal traumas, they have been brought up in the relatively safe North European environment and have never encountered political or military violence. The group of Finnish children consisted of 23 boys and 47 girls, their age ranged from 7 to 12 years ($M = 9.5$, $SD = 1.7$). The Finnish children were significantly younger than the children in the Trauma group ($U = 311.5$, $p < .001$) and in the Control group ($U = 335.5$, $p < .001$).

2.2. Procedure

The Kurdish children's dreams were collected by three of the authors (Ali, Ismahil, and Punamäki) in cooperation with local professionals in autonomous Iraqi Kurdistan during the year 2000. The researchers visited one school and one orphanage in one village and two schools and orphanages in two towns. Permission to enter the schools was obtained from the education authority. Written consent was also required from the children's parents or care assistants in the orphanages.

¹ U , Mann-Whitney U test, a non-parametric statistical test that is used to evaluate whether the medians on a test variable differ between two independent samples (Green, Salkind, & Akey, 1997).

The field work proceeded in two stages. First, the children and adolescents were asked to participate in the study. The idea of the study was then explained to the children in the following way: “All of us may have dreams during the night and some of us also remember them. We are interested in children’s dreams, and ask you to take part in reporting your dreams for one week.” We assessed dream content by a semistructured dream and sleep diary developed by R-L. Punamäki (1997, 1998). It has been formerly used among Arab and Finnish children. The diary was translated from Arabic into two Kurdish dialects (Sorani and Badinani), in order for the children to be able to report their dreams in their native language. The recording period was seven days, and for each night, a structured sheet was prepared. The participants were asked to record every morning the dream or the dreams that they had had the previous night. They were to complete a sheet consisting of 20 lines beginning: “Last night I dreamt that. . .” The dream diary was explained to the child or group of children carefully, page by page, and standardized examples of how to report the dreams were given. The children’s understanding of the explanation was checked by asking them to provide examples. Second, after seven days, the researchers returned to the schools and orphanages and collected the completed dream diaries. The diaries were given directly to them without teachers or orphanage personnel reading them. Afterwards, the dream diaries were translated into English, and these translations were used in the present study.

The dreams of the Finnish children were collected in 1997 by Punamäki and Joustie (1998). The researchers contacted two schools in Helsinki, and the volunteering children kept dream diaries for a period of seven days, in their native language. The same instructions were given to the Finnish children as to the Kurdish children. The dream diaries of the Finnish children were not translated into English, and thus, in the present study, they were analyzed in Finnish.

2.3. *The rating scale and scoring procedure*

The analysis of threatening events in dreams was carried out in two stages: (1) identification of descriptions of threatening events in the dream reports and (2) classification of the identified events with regard to content. Both stages were independently carried out by two raters, who were not blind to the hypotheses. The raters first practised the identification and the classification procedures until they reached a sufficient degree of agreement (Kappa value > 0.4). The detailed rating scale is available from the authors; only the basic principles of the scale are described below.

A threatening event in a dream is one which meets at least one of the following two criteria:

(1) *Objective threat*: An event in a dream where, if the event was real, the physical or psychological 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 waking life). Such an event may be directly witnessed by the dreamer reporting the event or only told about in the dream.

(2) *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. Also a purely fictional or fantastic threat, impossible in waking life, is identified as subjective.

At this stage, the raters identified all the words in the dream reports which described an event fulfilling at least one of the above criteria. The identified descriptions were marked by underlining

the respective parts of the dream reports. The descriptions identified by both raters were selected for the next stage of content analysis. The descriptions identified by only one rater were thoroughly discussed, and either selected for the next stage or rejected from further analysis.

The identified threatening dream events were analysed by using the following five 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 self
- IV. The reaction to the threatening event
- V. The consequences of the threatening event

For efficient coverage of the method and results, the more detailed content of these five scales is integrated with the results, and indicated in Figs. 1–5. The final scores received by a threatening event were designated on the basis that both of the raters had assigned the same score for the event. In the event that the raters disagreed, the scoring of the event was thoroughly discussed until agreed upon, and a final score was assigned to the event.

3. Results

3.1. Reliability

In estimating the reliability of the interrater agreement, either the statistical Cohen's Kappa test was computed, or if Kappa could not be computed due to the nature of the data, a simple percentage agreement was used. A value of the Kappa statistic < 0.4 indicates weak agreement, 0.4 – 0.75 moderate agreement, and > 0.75 strong agreement (Fleiss, 1981). We used Kappa value > 0.4 as the minimum criterion of acceptable internal consistency between the raters.

3.1.1. Identification reliability

In this case, percentage agreement is reported, as Kappa could not be computed due to the nature of the data. The interrater agreement was calculated using two different strategies:

- (1) If the raters had underlined the same event, it was considered as a unanimous identification. The identification agreement percentage was 95.5%.
- (2) If the raters had underlined the same event, but one of the raters had identified the event as two separate threats and the other as one threat, the raters were calculated to agree on one threat and disagree on the other. After discussion the event was either considered to be one threatening event or two separately scorable events. The identification agreement percentage calculated this way was 86.3%.

Agreement between the raters in deciding what constitutes a threatening event was strong, independently of the way in which it was computed.

Altogether 652 threats were identified by the raters, and 592 of them were identified by both raters. After the raters had discussed the events over which they originally disagreed, 622 (95.4%) threatening events were admitted to the classification stage and 30 (4.6%) were rejected from further analysis.

3.1.2. Classification reliability

In this case, the interrater reliability was evaluated by using Cohen's Kappa test. The interrater agreement was strong with respect to all five categories, the Kappa value was below 0.75 only on the subcategory Territory (belonging to the main category The target of the threatening event) (Table 1).

3.2. The frequency of threatening events in dream reports

The number of reported dreams per subject, the frequency of threatening events in dream reports per subject, and the percentage of dreams including at least one threatening event per subject were calculated (Table 2). The length of the dream report was measured using total recall count (TRC) (Antrobus, 1983), and the relative proportion of words used to describe threatening events was also calculated (Table 3). The number of threatening events per dream report, the percentage of threat-dreams, and the number of words used to describe threatening events indicate the frequency of threatening situations in dream reports. For each subject, the ratio between the number of threatening events and the number of reported dreams was calculated by dividing the number of threats with the number of dreams. The results per group were calculated by using these ratios.

The Trauma group reported more dreams than the Control group ($U = 1142.5$, $p < .005$) or the Finnish children ($U = 829$, $p < .001$), and the Control group reported more dreams than the Finnish children ($U = 1367.5$, $p < .01$). The Trauma group had more threatening events per dream report than the Control group ($U = 619.5$, $p < .001$) or the Finnish children ($U = 454$, $p < .001$), and the Control group also had more threatening events than the Finnish children ($U = 1063.5$, $p < .001$). Thirty (42.9%) Finnish children and three (5.7%) children in the Control group had no threatening events in their dream reports; in the Trauma group there were no

Table 1
The reliability of classification

	The nature of the threatening event	The target of the threat					The severity of the threat	Reaction of the self to the threatening event	The consequences of the threatening event
		Dream self	Significant others	Territory	Significant resources	Insignificant others	Insignificant resources		
K	0.915	0.876	0.918	0.640	0.926	0.907	0.905	0.870	0.883
P	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001

Table 2
The number of dreams, threatening events, and dreams including threatening events per group

	The number of reported dreams			Threatening events per dream			The number of threatening events	The number of dreams including threats	
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	Range	<i>N</i>	%	<i>N</i>
Trauma group	5.2 ^a	1.7	331	1.2 ^a	0.4	0.3–2.3	388	79.5 ^a	263
Control group	4.1 ^c	2.1	216	0.7 ^b	0.4	0.0–2.0	144	55.6 ^b	120
Finnish children	3.1	1.5	216	0.4	0.4	0.0–1.3	81	31.0	67

^a Statistically significant difference to the Control group and to the Finnish children, $p < .001$.

^b Statistically significant difference to the Finnish children, $p < .001$.

^c Statistically significant difference to the Finnish children, $p < .05$.

Table 3

The total recall count per dream report, and the number of words used to describe threatening events

	Total recall count per dream report			Number of words used to describe threatening events	
	<i>M</i>	<i>SD</i>	Range	<i>M</i>	%
Trauma group	54.5 ^a	34.0	5–221	31.8 ^a	61.1
Control group	29.2	17.0	2–89	12.3 ^b	42.1
Finnish children	24.7	4.3	1–180	7.0	20.1

^a Statistically significant difference to the Control group and to the Finnish children, $p < .001$.^b Statistically significant difference to the Finnish children, $p < .001$.

subjects whose dreams did not include at least one threatening event. The Trauma group had a higher percentage of dreams including threats than the Control group ($U = 671$, $p < .001$) or the Finnish children ($U = 280.5$, $p < .005$), and the Control group had more threat-dreams than the Finnish children ($U = 836$, $p < .001$). The girls in the Trauma group reported significantly more dreams ($M = 5.8$, $SD = 1.6$) than the boys ($M = 4.4$, $SD = 1.5$) ($U = 237.5$, $p < .001$). A similar difference was found between the Finnish girls ($M = 3.3$, $SD = 1.5$) and boys ($M = 2.6$, $SD = 1.4$) ($U = 387.5$, $p < .05$).

3.3. Total recall count in dream reports

For each subject, a ratio was calculated between the total recall count and the number of words used to describe threatening events by dividing the number of words used to describe threatening events with the TRC. This was done in order to find out the relative proportion of words used for reporting threatening vs. other types of dream events. The results per group were calculated by using these ratios (Table 3). The results comparing the Kurdish and the Finnish children should be interpreted with caution, however, because the dreams of the Kurdish children were translated from two Kurdish dialects into English, and the Finnish children's dreams were analyzed in Finnish, which may systematically bias the results calculated using word count.

The dream reports of the Trauma group were significantly longer than the dream reports of the Control group ($U = 17301$, $p < .001$) or the reports of the Finnish children ($U = 13853$, $p < .001$). The children in the Trauma group used a higher percentage of words to describe threatening events than the children in the Control group ($U = 27306.5$, $p < .001$), and than the Finnish children ($U = 16689.5$, $p < .001$). The Control group also used more words to describe threatening events compared to the Finnish children ($U = 16975.5$, $p < .001$).

The girls in the Trauma group reported significantly longer dreams ($M = 57.1$, $SD = 32.2$) than the boys in the Trauma group ($M = 50.1$, $SD = 36.5$) ($U = 10480.5$, $p < .005$). The same was true for the Finnish girls ($M = 27.4$, $SD = 19$) and boys ($M = 17.3$, $SD = 19.3$) ($U = 3220.5$, $p < .001$). However, there was no gender difference in any group in the number of words used to describe a threatening event. This result indicates that there might be a gender difference in reporting the non-threat related content of the dream; girls write longer descriptions of non-threat related contents than boys, but both write about threatening events with descriptions of similar length.

3.4. The quality of the threatening events

3.4.1. The nature of the threatening event

This category explored what kind of a threatening event was in question. The distribution of the nature of the threatening events in the dreams of the Trauma group, the Control group, and the Finnish children is depicted in Fig. 1.

The Trauma group had significantly fewer accidents and misfortunes than the Control group (χ^2 (1, $N = 532$) = 3.89, $p < .05$) or the Finnish children (χ^2 (1, $N = 469$) = 3.28, $p < .05$). The Control group's dreams also included significantly more failures than the Trauma group's dreams (χ^2 (1, $N = 532$) = 10.40, $p < .001$). The Trauma group's dreams incorporated non-physical aggression more frequently than the Control group's dreams (χ^2 (1, $N = 532$) = 5.60, $p < .01$). The Trauma group also had more unscorable events than the Control group (χ^2 (1, $N = 532$) = 6.79, $p < .01$) or the Finnish children (χ^2 (1, $N = 469$) = 4.77, $p < .05$). Statistical differences could not be calculated for catastrophes and diseases due to low frequencies.

The boys in the Control group had significantly more accidents and misfortunes than the girls in the Control group (χ^2 (1, $n = 144$) = 3.89, $p < .05$). In all the three groups the girls had a higher percentage of failures than the boys, but the difference was significant only for the Finnish children (χ^2 (1, $N = 81$) = 3.99, $p < .05$). The boys in the Trauma group had significantly more direct physical aggression than the girls (χ^2 (1, $N = 388$) = 5.70, $p < .01$) and the same was true for the Finnish children (χ^2 (1, $N = 81$) = 12.12, $p < .001$). The girls in the Trauma group produced significantly more threats with unclear nature than the boys (χ^2 (1, $N = 388$) = 11.11, $p < .001$).

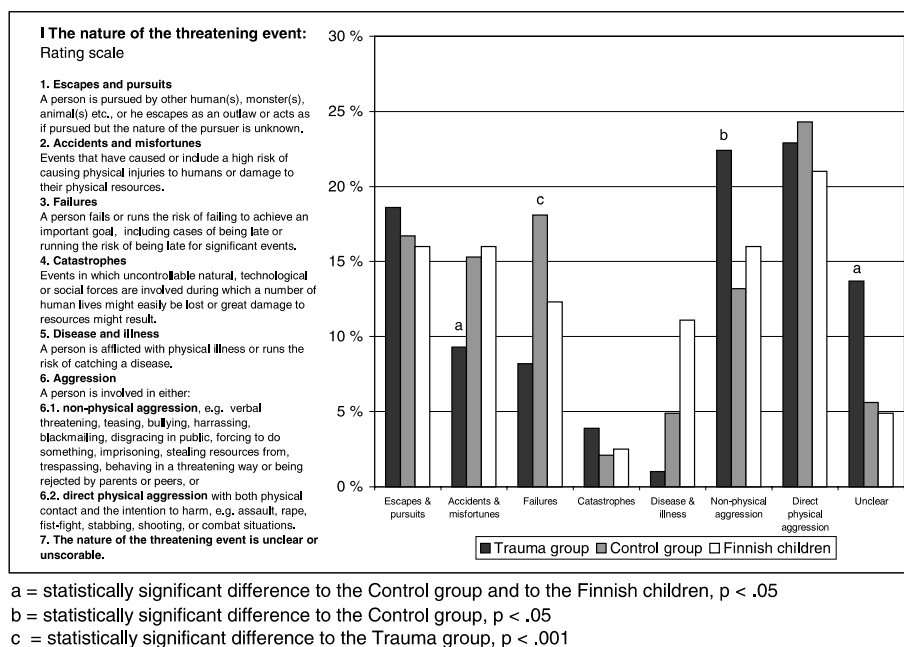


Fig. 1. The nature of the threatening events. The nature of the threatening events was quite similar in all groups, aggression being the most common type of threatening event.

3.4.2. Aggression in dreams

The threatening events were divided into aggressive and non-aggressive threats according to their overall nature (aggressive threats = escapes and pursuits, non-physical aggression and direct physical aggression; non-aggressive threats = accidents and misfortunes, failures, disease and illness). Catastrophes ($N = 14$) were left out of the analysis, hence they might have been either aggressive (e.g., war) or non-aggressive (e.g., natural disaster).

The Trauma group's dreams included aggressive vs. non-aggressive threats significantly more often (65.6% vs. 34.4%) than the Control group's dreams (55.3% vs. 44.7%) (χ^2 (1, $N = 519$) = 4.65, $p < .05$) or the dreams of the Finnish children (53.8% vs. 46.2%) (χ^2 (1, $N = 458$) = 4.00, $p < .05$). Worth noticing is that in every group the dreams included more aggressive than non-aggressive threats.

The Trauma group boys had aggressive threats more frequently than the Trauma group girls (73.2% vs. 60.7%) (χ^2 (1, $N = 378$) = 6.2, $p < .01$). The same was true for the Finnish boys and girls (71.4% vs. 47.5%) (χ^2 (1, $N = 80$) = 3.58, $p < .05$).

3.4.3. The target of the threatening event

This category investigated who or what was being threatened by the threatening event. The targets of the threat were closely similar in all three subject groups: Self was the most often threatened person, followed by significant others, and then by insignificant strangers. Territory and resources were less often threatened than people. The significant others of the Finnish children were less frequently threatened than the significant others of the Trauma group (χ^2 (1, $N = 469$) = 7.88, $p < .01$) or the significant others of the Control group (χ^2 (1, $N = 225$) = 3.95, $p < .05$) (Fig. 2).

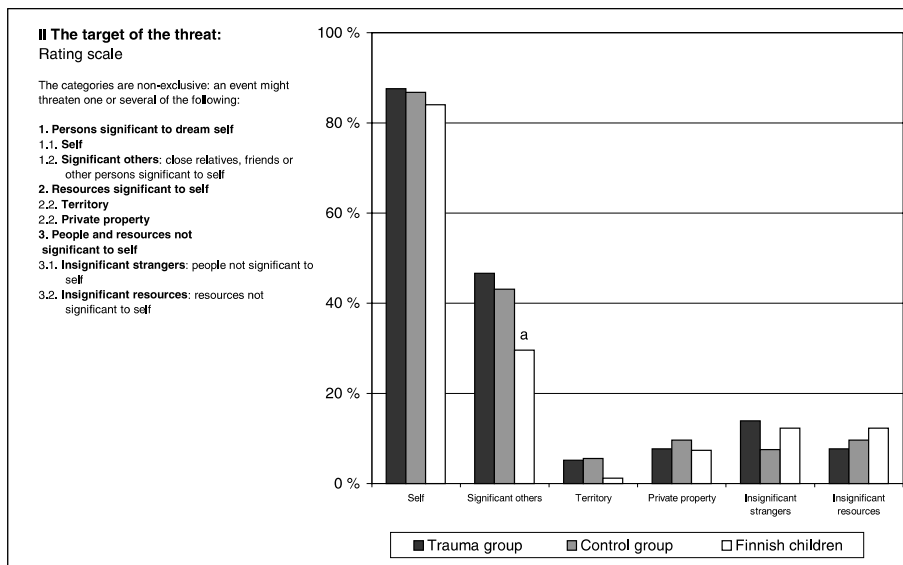


Fig. 2. The targets of threats. The threatening events were more self- and people-centered than concentrated upon resources.

Gender differences were also almost non-existent. Only the territory for the boys of the Trauma group was more often threatened than the territory for the girls ($\chi^2 (1, N = 388) = 5.64, p < .05$).

3.4.4. The severity of the threatening event for self

This category examined how risky for the self would the threatening event be considered if it happened in real life. The statistical comparison of the severity of the threat was conducted for the whole category, instead of single sub-categories. The threats of the Trauma group were significantly more severe than the threats reported by the Finnish children ($\chi^2 (3, N = 469) = 21.34, p < .001$) (Fig. 3). Similarly, the threats of the Control group were significantly more dangerous than the threats of the Finnish children ($\chi^2 (3, N = 225) = 6.90, p < .05$).

The threats of the boys of the Trauma group were significantly more dangerous than the threats of the girls ($\chi^2 (3, N = 613) = 9.53, p < .05$). In the Control group and in the group of the Finnish children the boys had a higher percentage of life-threatening events than the girls, but fewer psychologically, socially or financially severe threats.

3.4.5. The reaction to the threatening event

This category tested whether the Self reacts to the threatening event, whether someone else reacts, or whether participating in the course of events is impossible due to awakening or discontinuity within the dream. In all three groups, the reactions to the threatening event were similar (Fig. 4). The self reacted, someone else reacted or nobody reacted to the threat with

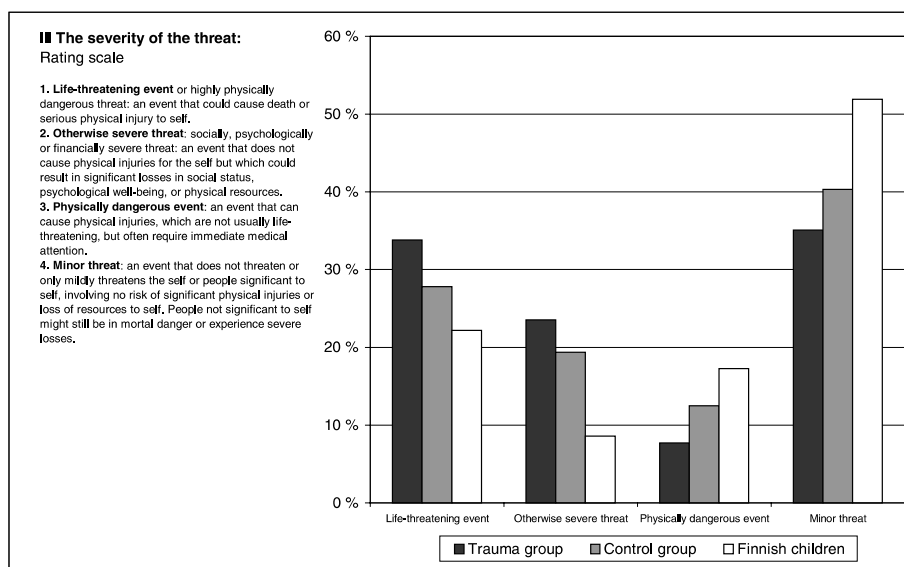


Fig. 3. The severity of the threatening events. The Trauma group children dreamt about more severe threats than the Control group children or the Finnish children.

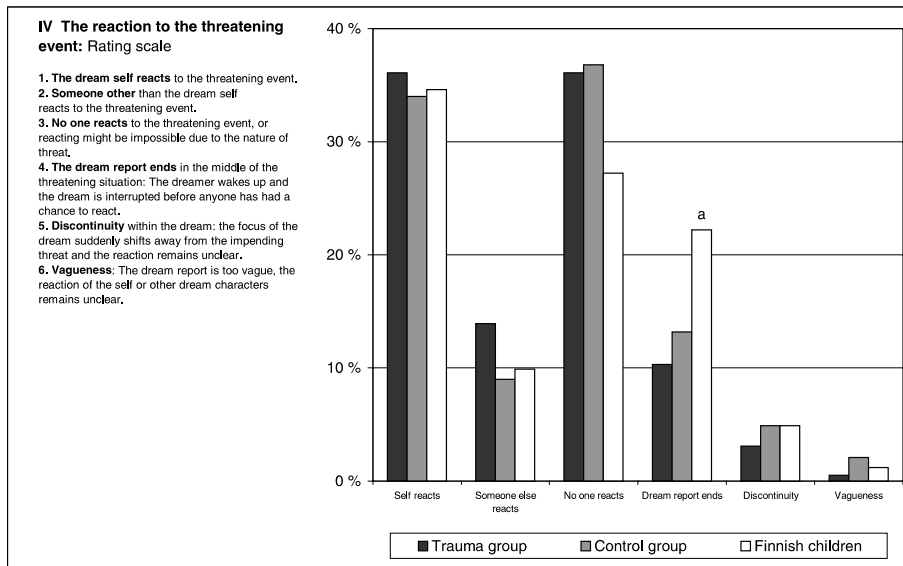


Fig. 4. The reaction to the threat. The reactions to the threatening events were similar in all groups, self reacting or no one reacting being the most common types of responses to the threat.

almost the same frequency in all groups. The dreams of the Finnish children, however, end in the middle of the threatening event more often than the dreams of the Trauma group ($\chi^2 (1, N = 469) = 8.78, p < .005$) or the dreams of the Control group ($\chi^2 (1, N = 225) = 2.08, p < .05$).

3.4.6. The consequences of the threatening events

This category investigated what kind of losses does self or other dream characters suffer in consequence of the threatening event. The children in the Trauma group faced death or suffered severe losses more often than the Finnish children ($\chi^2 (1, N = 469) = 4.98, p < .05$) (Fig. 5). Similarly, the boys in the Trauma group died more often in their dreams than the girls in the Trauma group (5.2% vs. 1.7%). The boys also suffered severe losses more frequently (12.3% vs. 9.8%) ($\chi^2 (1, N = 388) = 2.79, p < .05$), but overall, the frequency of severe losses was low. In all groups, circa 40% of the threats did not include any description of the consequences of the threat.

3.5. The age effect and balanced sample

The Finnish children were significantly younger than the Kurdish children. To form a balanced sample, the results were therefore computed for those children between ages 9 and 12 (Trauma group $n = 21$, Control group $n = 22$, Finnish children $n = 42$). The effect of age difference between groups on results did not prove to be significant. The group sizes in the balanced sample were, however, quite small.

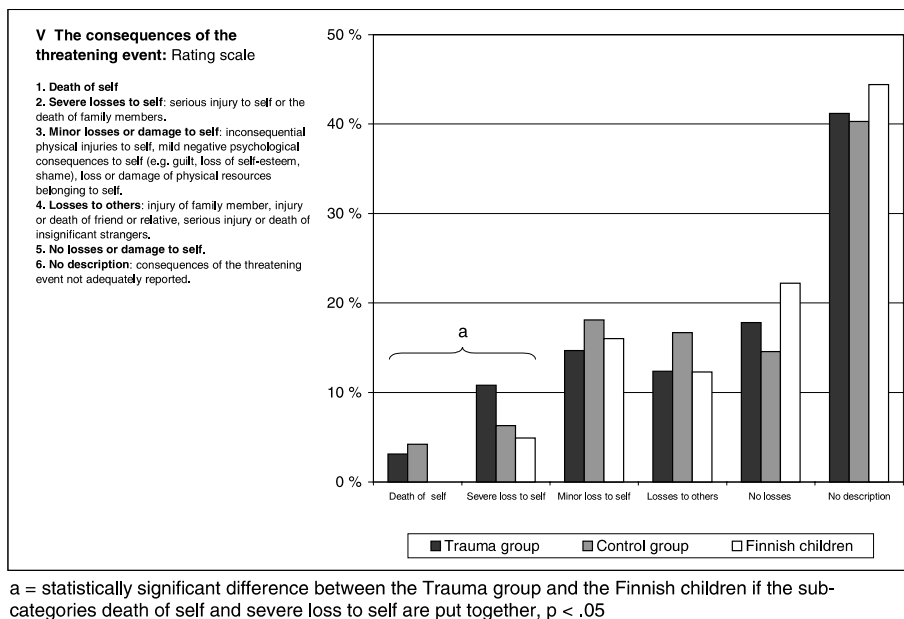


Fig. 5. The consequences of the threatening events. The consequences of the threatening events were described in approximately 60% of the cases, severe losses being very infrequent.

4. Discussion

The purpose of the present study was to test some of the hypotheses derived from the Threat Simulation Theory of dreaming (Revonsuo, 2000). We compared the frequency and quality of threatening events in the dreams of children exposed to severe traumatic experiences, children less exposed to traumatic events, and children not exposed to traumatic events. TST predicts that if the original evolutionary function of dreaming is threat simulation, then exposure to real-life threats early in life will fully activate the threat simulation system leading to more frequent and more intensive threat simulations.

If these hypotheses are correct, we should find that exposure to an environment containing ecologically valid threat cues will lead to more frequent and more intensive threat simulations while living in a relatively safe environment will cause the threat simulation system to develop more slowly or stay in a resting state. Therefore, the dreams of children exposed to severe traumatic events should contain a greater number of threatening situations than the dreams of children less exposed or not exposed to traumatic experiences. In addition, the threatening events in the dreams of traumatized children should be more severe than those of their less traumatized counterparts. The severely traumatized children should also react to the threat more often than less traumatized or non-traumatized children. The findings of the present study are quite consistent with these predictions, excluding the last hypothesis. The results indicate that there are differences both in the number and the content of dreams reported by severely traumatized, less traumatized and non-traumatized children.

4.1. The effect of trauma on dream recall

The more severely traumatized the children are, the more dreams they seem to report. Punamäki (1997) found a similar result in the dream recall frequency of traumatized and non-traumatized Palestinian children. Heightened dream recall has also been linked to stressful situations (Belicki, 1986; Duke & Davidson, 2002).

Three possible mechanisms might explain the effect of trauma on dream recall. First, severe trauma often disrupts sleep leading to repeated awakenings, which might have been preceded by a dream. Because we remember best the dreams we wake up from, trauma might in this way contribute to better dream recall. Second, it might be argued that a higher dream recall frequency is an indication of a stronger activation of the threat simulation system. We tend to recall emotionally charged events better than mundane ones, and this applies to both waking and dream events (Chapman & Underwood, 2000). If dreams including threatening events are better recalled than dreams with less negative emotional charge, then higher dream recall frequency might be explained by a more fully activated threat simulation system. The Trauma group could have had better dream recall simply because their dreams were more emotionally negatively charged and more threatening than the dreams of the Control group or the Finnish children. The third possible explanation for the findings is a combination of the previous two. The average dreams of the Trauma group children were probably more frightening than the dreams of the Control group or the Finnish children, and these nightmarish dreams might have woken up the Trauma group children more frequently, and thus led to better dream recall. Because in this study the Control group children also reported more dreams than the Finnish children, but less dreams than the Trauma group children, the result of better dream recall in the traumatized group, therefore, cannot be explained by cultural differences between the groups.

4.2. The effect of trauma on the frequency of threatening events

Traumatic experiences increase the number of threatening events in dreams. Almost 80% of the dreams reported by the children in the Trauma group included at least one threatening event, while 56% of the dream reports by the Control group and 31% of the dream reports by the Finnish children contained a threat. All the Trauma group subjects reported at least one threatening event during the week, while 6% of the Control group children, and almost 43% of the Finnish children failed to report any threatening events at all. In addition to having more dreams including threatening events, the dreams of the Trauma group children frequently included more than one threatening event per dream. According to the study conducted by Schredl, Pallmer, and Montasser (1996), only 11% of ten to sixteen year olds report having one or more what the researchers call “a bad dream” per week. In a longitudinal study conducted in a sleep laboratory with subjects ten years of age and older, only one dream out of ten contained a feeling of fear (Foulkes, 1982). Even if not every dream including a threatening event is necessarily “a bad dream” or a dream containing the feeling of fear, still the number of dangerous events in the dreams of the Trauma group is high. In light of the results reported by Schredl et al. (1996) and the present findings, it can be concluded that trauma indeed increases the number of threatening events in dreams. Thus, threats encountered during waking seem to activate the threat simulation system in a manner that non-threatening real-life events encountered in a safe environment seldom do.

The Trauma group children reported longer dreams (54.5 words) than the Control group children (29.2 words) or the Finnish children (24.7), and they used a higher proportion of the dream reports' words (61%) to describe threatening events than the Control group (42%) or the Finnish children (20%). This finding again supports the claim that trauma leads to more frequent threat simulation. The comparison between the Kurdish children and the Finnish children should be made with caution, however, as the Kurdish children's dreams were reported in two Kurdish dialects, and then translated into English, while the Finnish children kept their dream diaries in Finnish.

4.3. The effect of trauma on the quality of threatening events

4.3.1. The nature of threatening events

Children from all subject groups did dream about similar kind of events, i.e., escapes and pursuits, accidents and misfortunes, failures, illnesses and aggression, indicating that the differences in the specific types of threatening events dreamt about were relatively small. The similar frequencies in the nature of the threats might be explained by arguing that all the children possessed knowledge of different types of threatening events in the world. The threatening events in the dreams of severely traumatized children are, however, qualitatively different in terms of the severity of the dream threats.

All three subject groups had more aggressive than non-aggressive threats. The dreams of the Trauma group contained a greater proportion of aggressive threats (65.6%) than the dreams of the Control group (55.3%) or the Finnish children (53.8%). This result is also in concordance with previous findings. After exposure to any kind of trauma, children typically dream of pursuits or of someone trying to harm them, i.e., aggression. The more severe the incident, and the more threatened the child has felt him- or herself to be in the situation, the more likely these dreams are to occur (Nader, 1996).

Children in the Trauma group typically had been exposed to experiences such as witnessing a killing, loss of a parent, and destruction of a home. Several of the Trauma group subjects had experienced severe harassment, had been chased, or had even been attacked. Thus, they had been exposed to aggressive real-life threats, which the amount of aggressive events in their dreams is probably reflecting. Punamäki and Joustie (1998) have also discovered that living in a violent environment increases the number of dreams including persecution and aggression.

Aggression is quite common, however, also in the dreams of non-traumatized children. According to previous findings, approximately 50% of dreams of 8–15 year olds include at least one aggressive event (Avila-White, Schneider, & Domhoff, 1999; Saline, 1999; Strauch & Lederbogen, 1999). Unfortunately, these results cannot be compared in a straightforward way with the present ones as these studies have used a different unit of analysis (dream reports) from our study (threatening event in the dream report).

4.3.2. The target of the threatening event

The dream self was the target of the threat in 80% of the threatening events, though significant others were also frequently threatened. In addition, people were more often threatened than resources. Previous findings show that in dreams, children are more often than adults in the role of the victim (Domhoff, 1996), and that children are more frequently the target of aggression rather

than the aggressor (Van de Castle, 1970; Foulkes, 1982; Strauch, 1996; Strauch & Lederbogen, 1999; Avila-White et al., 1999). The previous and the present findings lend support to the threat simulation theory. In order for threat simulation to be efficient, the well-being of the dream self and the people significant for the self should be more often jeopardized than trivial resources or the well-being of insignificant strangers. For most part of human evolution, people lived in small bands (Landers, 1992; Meindl, 1992). The other people in the same group were all significant others, important for the reproductive success of an individual. Threat simulation targeted mainly to insignificant resources or strangers would not be evolutionarily functional, as such simulation would not directly help preserve the inclusive fitness of the individual, and thus, it would not serve as efficient rehearsal of individual's threat avoidance skills.

The present study revealed that significant others were much more often the target of the threat in the dreams of the Kurdish children than in the dreams of the Finnish children. This result could be explained by referring to cultural variations in family cohesion. The Kurdish culture places greater value on family and close ties with relatives than the western culture which emphasizes individualism. Levine (1991) found similar culturally specific impact of family cohesion on children's dreaming. The Beduin children living in a collective culture, characterized by a highly supportive social system, had more familiar persons and relatives in their dreams than the Irish children living in small family farms in geographical isolation from other families.

4.3.3. The severity of the threatening event

Trauma increases the severity of threatening events in dreams. The threats reported by the Trauma group were more dangerous for the dream self than the threats reported by the Control group or the Finnish children. More than half of the threats reported by the Finnish children were everyday misfortunes, rather trivial for the dream self, while the Trauma group and the Control group reported life-threatening and socially, psychologically, or financially severe threats much more frequently. Similar findings have also appeared in previous studies. The Beduin children intimidated and harassed by Israeli soldiers in the Negev desert had more dreams concerning threats to physical survival than the Israeli children living in kibbutz or the Irish children living in the Irish countryside (Levine, 1991). The Palestinian children living in the West bank refugee camps exposed to military violence by occupation soldiers had dreams of brutal physical aggression that resulted in death to one or both sides of the conflict in every fourth dream (Bilu, 1989). These results are in contradiction with Foulkes's (1993) assumption that children's dreams are mainly repetitions of trivial everyday events. This might be the case with children living in safe, peaceful environments with no real threats present, but it is not the case with children growing up in traumatizing conditions.

4.3.4. The reaction to the threatening event

The distribution of different types of reactions to the threatening event was similar in the three subject groups. The dream self reacted to the threat in approximately 35% of the threatening events, and this was the most common type of reaction. It was almost as likely, however, that no one reacted. This does not seem to support the prediction of the TST that when the dream self is in danger, he is more likely than not to display a reasonable and realistic defensive action. On the other hand, the severely traumatized children have a higher number of threatening events in their dreams than the less traumatized or the non-traumatized children, and therefore, the traumatized

children simply have a greater number of threatening events to react to and will in any case rehearse reactions to the threats more often than non-traumatized children.

The present result does not support the previous findings according to which traumatized children are less active in their dreams than non-traumatized children (Bilu, 1989; Levine, 1991). Furthermore, the dreams were sometimes discontinuous, or the dream report ended right after the dream self had encountered the threat, and therefore, no action was displayed or reported. Also, no action might have been displayed because a large proportion of the dream threats might have been too overwhelming for the child, or might have been far beyond the capabilities of the child to defend himself. In any case, the prediction that traumatized children should react more often to the threats was not fulfilled. A more detailed analysis of the reactions to the threat and especially the causes for the failure to act should be carried out in future studies to find out what determines whether or not a relevant action is performed. For example, a previous study on Finnish students' dreams (Revonsuo & Valli, 2000) showed an increased frequency of reaction to severe as opposed to minor threats.

4.3.5. The consequences of the threatening event

In the dreams of the Trauma group, the consequences of the threatening event were severe losses (death of self, severe injury to self, or death of parents) more often compared with the dreams of the Finnish children, who had more minor losses and no losses to self. Thus, the more traumatizing experiences the children had had, the more severe were the consequences of the threats. Consequences are, however, seldom simulated. The dream reports often lacked any description of the consequences (ca. 40%), as the dream might have been discontinuous or the dreamer might have woken up in the middle of the dream just after having encountered the threat. Furthermore, the threat did not cause any losses in ca. 20% of the threatening events.

4.4. The effect of age on results

The difference in the number of reported dreams was not explained by the age difference between the children. Even though the Finnish children were younger (7–12 years) than the Kurdish children (9–17 years), and younger children tend to remember fewer dreams than older children (Foulkes, 1982), a similar difference in the number of reported dreams was found when comparing children of matched age. When only the 9- to 12-year-old subjects were taken into consideration, the Trauma group children still reported more dreams than the Control group or the Finnish children.

Furthermore, we found that the dreams of the Finnish children incorporated reactions to the threat as often as the dreams of the Kurdish children. Thus, our results indicate that the age of the children was not associated with their reactivity to the threat. Strauch and Meier (1996) and Resnick, Stickgold, Rittenhouse, and Hobson (1994) have also noticed that young children are active participants in their dreams. These findings are in contradiction to Foulkes's (1982) idea that younger children are passive observers in their dreams instead of active participants.

4.5. The effect of gender on results

In the Trauma group, the girls reported more dreams than the boys. Punamäki (1997) has reported a similar gender difference in the dream recall frequency of traumatized and non-traumatized Palestinian children. Girls usually report more dreams than boys of the same age (Strauch

& Lederbogen, 1999), and in the present study, the non-traumatized Finnish girls also reported more dreams than the non-traumatized Finnish boys. Thus, the finding of better dream recall in traumatized girls than in traumatized boys can be explained by the general gender difference rather than by the trauma.

The dreams of both the Trauma group boys and the Finnish boys showed more direct physical aggression than the dreams of the girls. Likewise, previous results indicate that boys have more physical aggression in their dreams than girls (Avila-White et al., 1999; Strauch & Lederbogen, 1999). This difference can be found in adults as well. According to Revonsuo and Valli (2000), male university students' dreams had direct physical aggression twice as often as female students' dreams. Therefore, this finding also seems to be a result of general gender difference.

4.6. The effect of culture

In the present study, two groups of Kurdish children were included to ensure that any emerging difference between the groups would have to be a result of a difference in the degree of traumatization, not a difference of cultural variation. Furthermore, as all the Kurdish children were more or less traumatized, we wanted to include an independent comparison group consisting of non-traumatized children to investigate the activation of the threat simulation response in children unexposed to real life threats. Could the threat content of dreams differ across cultures independent of periods of strife or conflict, and explain the differences that emerged between the groups in the present study?

Domhoff (1996) reports the results of a wide range of cross-cultural studies on dream content and concludes that the content analysis scale developed by Hall and Van de Castle (1966) provides similar results in most of the cross-cultural samples of dream reports studied. The gender differences in dreams also seem to be cross-cultural, and the variations in dream content from culture to culture seem to relate to unique cultural patterns, which become understandable in terms of what is known about the culture.

The exposure to severe threats in real life does have its effect on dream content, but as TST predicts, the subsequent dream content will be affected by a traumatizing event in any person regardless of culture. There might be a certain degree of unexplored “cultural noise” in the frequency or quality of threatening events in the dreams of the Kurdish and the Finnish children, but its role in explaining the results seems small. As mentioned, all the children in the present study dreamt about similar kinds of threatening events, the dream self was most often the target of the threat, and the children reacted to the threats in a similar manner. In any case, cultural noise cannot explain the differences that emerged between the Trauma group and the Control group in the frequency and quality of threatening events.

4.7. Can alternative theories explain the findings?

Even though our results mostly lended support to the Threat Simulation Theory, alternative explanations of the data are conceivable. For example, it has been argued that dreaming solves emotional problems by helping a person to adjust psychologically to those real-life situations that trouble the dreamer (e.g. Cartwright, 1996; Hartmann, 1998; Kramer, 1993). Post-traumatic nightmares, in which the emotional content of the traumatic event is repeated over and over again until the trauma is resolved, and the dreamer is better adapted to his current situation, are seen as

exemplary cases of the function of dreaming in progress (Hartmann, 1998). One problem for this view is that post-traumatic nightmares may continue for years after the original event (Kinzie, Sack, Angell, Manson, & Rath, 1986; Terr, 1983) which does not contribute to psychological adaptation, quite the contrary. Second, dreaming has not been proven to reduce the negative psychological consequences caused by real-life traumas.

The Continuity hypothesis (CH) states that dreaming simply *reflects* waking life experiences, i.e., there is a continuum between waking experiences and experiences within dreams, and several studies actually demonstrate that waking life experiences are incorporated into dreams (e.g. Domhoff, 1996; Hartmann, 2000; Schredl, 2000; Schredl, in press; Strauch & Meier, 1996). The predictions and hypotheses of CH have not, however, been put forward in a clear manner. The general form of CH seems to predict that a certain type of waking life event will be incorporated into subsequent dream content as a similar kind of event. The Continuity hypothesis therefore indicates that the frequency and nature of any real events will be correlated with the frequency and nature of similar dream events. There is a vast amount of evidence that real life threatening events are incorporated to subsequent dream content (e.g. Nader, 1996; Nader et al., 1990; Pynoos & Nader, 1988; Pynoos et al., 1987; Terr, 1979). The Continuity hypothesis would not, however, predict that a *single* exposure to any type of event should lead to persistent, recurring dreams about that event. Contrary to CH, even a single exposure to a life-threatening event may lead to persistent threat dreams.

In addition, there is very little evidence that the frequency of all neutral and positive events encountered during wakefulness is reflected as such in subsequent dream content. Hartmann (2000) showed that reading, writing, typing, and calculating are rarely found in dreams. Success and good fortune are also quite infrequent (Hall & Van de Castle, 1966), and positive experiences and emotions seem to be overshadowed by negative ones (Hall & Van de Castle, 1966; Snyder, 1970; Strauch & Meier, 1996), even though there are also conflicting findings (Strauch & Meier, 1996; Schredl & Doll, 1998; Fosse et al., 2001). Schredl (in press) concluded, based on both previous results and his own, that the Continuity hypothesis in its general form is not valid. Contrary to CH, TST predicts that powerful negative stimuli during wakefulness leads to a strong and long-lasting threat simulation response, whereas powerful positive stimuli during wakefulness will not have a comparable impact on subsequent dream content.

Theories that do not hold dream phenomenology biologically functional have no explanation as to why dreams include threatening events so frequently. If the dream images are created by random activation (Crick & Mitchinson, 1983, 1995; Hobson, 1988, 1994; Hobson & McCarley, 1977), by the neurophysiological processes operating in the brain during REM sleep, then the dream images should be more or less random as well. The theories attributing no function to the specific features of dream content (Antrobus, 1993; Flanagan, 1995; Foulkes, 1985; Solms, 1997) also fail to provide an explanation for the high frequency of threats in dreams. Thus, the alternative theories do not seem to have a convincing explanation for the organization and content of dreams observed in this study.

4.8. *Evaluation of the present study*

First, data in the present study consisted of home-based dream reports, not a representative sample of dreams during different sleep stages or different REM-periods. Analysis of dream reports collected at different intervals during sleep might reveal that threatening events do not occur at the

same frequency throughout the night. Even though home-based dream reports and reports collected in laboratory situations have proved to be rather similar (Domhoff, 1996), the question of the frequency of threatening events in different sleep stages should be directly addressed in future studies.

Second, the children participating in this study kept dream diaries only for a period of seven consecutive nights, and thus, the long-term effects of the trauma remain unclear. TST predicts that the effect of a real-life trauma on threat simulation mechanism may last throughout life and, therefore, a longitudinal study would be needed. Furthermore, because the dream diary period was quite short, some dream diaries, especially several of the Finnish children's, included only one or two threatening events. This does not form a representative sample of a subject's threatening events, and a small number of threats may even bias the data somehow. Therefore, we suggest that in future studies longer dream diary periods should be used.

Third, the division of the Kurdish children into the Trauma and the Control group according to the children's own reports of traumatic experiences can be criticized. Some of the children assigned to the Control group may have been severely traumatized, and should have been assigned to the Trauma group. Both Kurdish groups lived in an area characterized by military threat and insecurity. Children in both groups were probably aware of the ethnic cleansing and persecution of their nation. Yet, the children in the Trauma group reported that they were personally exposed to the consequences of this persecution in their family life, while the Control group children had lived less traumatizing lives. Additional background information would have been beneficial for a more reliable measure of the level of exposure to trauma. Interviewing the children instead of using a questionnaire might have been a more accurate way of measuring the degree of traumatic experiences.

In an ideal research setting, we would have had detailed information about the kind of threats the children had been exposed to and about the dangers the children face every day in their lives. In this study, we were not able to compare the frequency or the quality of those real-life threats to the threats dreamt about. This kind of comparison might have revealed a more direct relationship between real threats and the threat simulation in dreams at the individual level.

The TST states that the system is most sensitive for simulating ancestral threats and that the mechanism is best activated by encountering threats that resemble the threats present in the original evolutionary environment. Some of the real-life threats the children had been exposed to, however, are not in any correspondence with the threats in the ancestral environment, and thus, were probably not the most ecologically valid threat cues possible for the system. Nevertheless, the threat simulation system was more highly activated in the traumatized than in the non-traumatized children, indicating that any kind of real life threat will activate the mechanism.

Finally, the question whether dreams containing threat scenarios exerted an effect on the future waking responses of the children in threatening circumstances was not addressed in the present study. The "evolutionary" yardsticks for better adaptativeness are higher survival rate and ultimately, the number of offspring produced by the individual and his kin. Obviously, the present study is unable to provide evidence that children dreaming frequently about threatening events had any behavioral advantage in dealing with future threats, leading to higher survival rate and greater number of surviving offspring. The true evolutionary currency, the number of surviving offspring, could only be measured in generations of subjects, who all live in an environment closely resembling the ancestral one. If it could, however, be shown that threat perception and avoidance behaviors consist of such perceptual, cognitive and motor skill components that

become faster and more efficient through repetition, mental training, and implicit learning, the predictions of TST would indirectly gain support.

Furthermore, the threat simulation mechanism evolved in an environment quite different from the present one, and the threats encountered during the Pleistocene era were dissimilar to present ones as well. Nocturnal training does not necessarily improve the probability of producing more offspring in the present environment, nor does TST predict that it should. Thus, the conclusion from the present study is that the threat simulation system is still sensitive to threat related cues and generates a threat simulation response whenever such cues are detected in the environment, but in the present environment it cannot properly fulfill its original function: to contribute to the inclusive fitness of the individual. In the ancestral environment, only the selected few ever got the chance to reproduce successfully, while in the present environment, the selection pressures are less severe and come from sources dissimilar to the ancestral ones.

The evolutionary perspective has proven to be useful in dream research as it has managed to unite a large amount of data under one extensive framework. Nevertheless, the evolutionary approach to the study of the human mind and behavior is still full of controversy (e.g. Gould & Lewontin, 1979; Horgan, 1995; Lewontin, 1990; Panksepp, 1998; Panksepp & Panksepp, 2000; Pinker, 2002). Ketelaar and Ellis (2000) conclude, however, that the procedures for testing evolutionary hypotheses adhere to well-established principles of the contemporary philosophy of science, even though caution and consideration are recommended to those who wish to pursue scientific inquiry using the evolutionary perspective (Panksepp & Panksepp, 2000).

5. Conclusions

Our results reveal that children exposed to severe real-life threats report more dreams and that their dreams include threatening events more often than the dreams of children less exposed or not exposed to threatening real-life events. The threatening events in the dreams of severely traumatized children are more dangerous than the threats in the dreams of less traumatized or non-traumatized children. The traumatized children's dreams more often include life-threatening or otherwise severe threats. In addition, the threats of severely traumatized children incorporate more aggression and have more severe consequences than the threats of less traumatized or non-traumatized children. These results support the predictions of TST. The severely traumatized children, however, do not react to the threat in their dreams more often than less traumatized or non-traumatized children. More research would be needed to find out what determines whether a relevant reaction to the threat is performed or not, and under what conditions the dream becomes an ideal threat simulation. Overall, the results of the present study lend support to the hypothesis that a threat simulation response is elicited after experiencing a real-life trauma and that the threat simulation system is activated in the presence of threat cues in the environment.

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Appendix A

Examples of identification and classification of threatening events in the dreams of 18 illustrative subjects

The original dream diaries by the Kurdish children were translated into English from two Kurdish dialects, Sorani and Badinani. Obvious misspellings of the following reports have been corrected by the authors of the present article, but no major changes have been made to the original translation. The following examples of the Finnish children's dream reports were also translated into English.

The identified threatening events in the dream reports are marked with *italics*, and numbered consecutively. The classification of these threatening events in further detail is presented in Table 4. The background information available on the Trauma group subjects is also given. No background information was available on the Control group subjects or the Finnish children.

A.1. The Trauma group

Subject 1001, girl, 16 years

The mother of the subject burnt herself to death in 1993 because of bad socio-economical conditions and as a result of her husband maltreating her. The husband was imprisoned because he was caught stealing.

I dreamt that (1) *I return back from school & a car followed me, then I went back to school & I told the school manager that this car followed me.*

Subject 1007, girl, 13 years

The father of the subject was martyred.

I dreamt that (2) *me with Suzan went to the water & Suzan sank in the water & drowned & I cried more & more & became very unhappy because she was the loveliest friend to me.*

Subject 1008, girl, 17 years

The mother of the subject died a natural death when she was about 3 years old. Her younger sister was killed in front of her eyes in war between the Kurdish people and the Iraqi regime in 1992, when she was approximately 9 years old. Her father has also died. At the time of the study she lived in an orphanage.

I dreamt that (3) *a man came & pulled me & he wanted to kill me & I screamed & shouted. Then he hit me & I cried & seeked for help, but no one helped me, and this dream came [= was repeated] many times.*

Table 4

The classification of the threatening events in the dreams of the Trauma group, the Control group, and the Finnish children

The number of the threatening event	I. The nature of the threatening event	II. The target of the threatening event	III. The severity of the threatening event	IV. The reaction to the threatening event	V. The consequences of the threatening event
1	Escapes & Pursuits	Self	Life-threatening	Self reacts	No losses
2	Accidents & Misfortunes	Significant others	Psychologically, socially, or financially severe	No one reacts	Losses to others
3	Direct physical aggression	Self	Life-threatening	Self reacts	Not reported
4	Escapes & Pursuits	Self, Significant others	Life-threatening	Self reacts	No losses
5	Direct physical aggression	Self	Life-threatening	Someone else reacts	Death of self
6	Direct physical aggression	Significant others	Psychologically, socially, or financially severe	No one reacts	Severe loss to self
7	Catastrophes	Self, Significant others, Insignificant others	Life-threatening	Someone else reacts	Severe loss to self
8	Accidents & Misfortunes	Self, Significant others	Life-threatening	Self reacts	Losses to others
9	Direct physical aggression	Self, Significant others	Life-threatening	No one reacts	Death of self
10	Escapes & Pursuits	Self	Life-threatening	Self reacts	No losses

11	Failures	Self	Trivial for the self	Self reacts	Mild losses to self
12	Direct physical aggression	Self	Psychologically, socially, or financially severe	Dream report ends	Not reported
13	Escapes & Pursuits	Self	Trivial for the self	Dream report ends	Not reported
14	Accidents & misfortunes	Self, Significant resources	Life-threatening	Discontinuous	Not reported
15	Accidents & misfortunes	Self	Physically dangerous	Discontinuous	Not reported
16	Direct physical aggression	Self	Life-threatening	Self reacts	Not reported
17	Failure	Self	Trivial for the self	No one reacts	Mild losses to self
18	Accidents & Misfortunes	Self	Trivial for the self	No one reacts	Mild losses to self
19	Failures	Self	Trivial for the self	Discontinuous	Not reported
20	Non-physical aggression	Self, Insignificant resources	Psychologically, socially, or financially severe	Dream report ends	Not reported
21	Accidents & Misfortunes	Significant Others	Trivial for the self	No one reacts	Losses to others
22	Failures	Self, Significant Others	Trivial for the self	Self reacts	Not reported
23	Escapes & Pursuits	Self, Significant Others	Trivial for the self	Self reacts	No losses
24	Non-physical aggression	Significant resources	Trivial for the self	Dream report ends	Mild losses to self

Subject 1129, boy, 14 years

The family members are refugees from another village. The area where they live now has been occupied by PKK (Kurdistan Worker's Party) until recently.

I dreamt that we went with my friends to cut hay for the cows & (4) *we saw a lion & he followed us. & We ran to a cave & we saw that the lion walking near to the entry to the cave & left. Then after it left we returned to home.*

Subject 1013, boy, 9 years

The subject came to the orphanage in 1995, due to separation of parents. His father had died, but the subject does not remember any traumatic event because he was very young when he came to the orphanage.

I dreamt that I was in a forest. There were many trees, big and tall, and grass. (5) *Then I was surrounded by animals like foxes and lions and other frightening animals. Then the animal ate me, after a while mother came to help me, but she could not. (6) The animal ate my mother too. Part of my mother's body and me remained. Nobody was there to help us.*

Subject 1107, boy, 12 years

The subject's father and four uncles were killed by the PKK in fighting. They were shepherds. The family members are refugees from another village. The area where they now live has been occupied by PKK until recently.

I dreamt that (7) *I went to the fighting [= war] & I was injured & my friends wanted to take me home & (8) on the way we saw mines, in the middle of the road [Note: the area is mined badly] & the mine exploded & we ran away after we lost some friends. We ran away, faraway & we saw a dead dinosaur & we slept in this place until the morning & we woke up & (9) saw another dinosaur & he attacked us & ate us.*

A.2. The Control group

Subject 1208, girl, 14 years

I dreamt last night that I went to a strange area and (10) *when I turned my face, I saw a big snake and I got very scared and the snake came nearer & made a ssss sound. Then I hit its head with a big stone & I killed him.*

Subject 1220, girl, 14 years

I was very sad because it was the day of the examination. (11) *I was running very quickly but I did not reach school. At last I reached the school, but there was nobody except the manager & he said that "you fail because you did not reach the examination at time."*

Subject 1310, girl, 12 years

I dreamt that (12) *my father beat me, & I was at home*

Subject 1218, boy, 15 years

(13) *I was in a garden & ate lunch. I was afraid.* (Subjective threat, no objective threat is reported to accompany the feeling of fear.)

Subject 1303, boy, 11 years

I dreamt that I was younger & had a beautiful car & I drove it. (14) *Then I had an accident. Then I saw that I went to the market & (15) fell into a dark hole in the ground. (16) There, in*

the hole, many wolves attacked me & I ran away from them. Then I woke up, because I was afraid.

Subject 1303, boy, 11 years

I dreamt that (17) *my answers in the exam were bad & I was very sad. Then I dreamed that I failed in the exam. I was very sad.* Then I woke up at 06.20 & studied till school time.

A.3. The Finnish children

Subject 711, girl, 8 years

We moved to the country and I got a horse as a present, a dog, gerbils, and turtles. Sampsa got a dog and a pony. My mother got a horse and my father a station wagon he had always dreamt of. I think that Marika and Monica moved into the same house. Marika also got a horse.

Subject 747, girl, 11 years

We were at the cottage fishing. A pike took my bait. When I was pulling out the bait (18) *a wasp came and stung me.* I do not recall more.

Subject 752, girl, 11 years

I was going to school. (19) *On my way there I realized that I had left my books and everything at home.* (20) *Then I went somewhere in a car, and some people stole the car.*

Subject 726, boy, 10 years

(21) *I was a car racer and raced with my friends. One of my friends was hit by a car but he didn't die. He just broke his legs.* After that we went to a park for a walk. We sat down on a bench.

Subject 733, boy, 12 years

(22) *I, my father and my mother were at our cottage and there was a swamp and a monster which woke up if we made loud noise and of course we woke it up. It was big and slimy. We ran up the hill and escaped with a car and* (Subjective threat, totally impossible in waking life.) (23) *the monster followed us with a car but we had a head start and had time to put a mine on the road and the monster exploded and never caught us.* (Subjective threat, totally impossible in waking life.)

Subject 712, boy, 8 years

(24) *I had a mouse, but my friends took it away from me. Then they said that they will show me a rat.*

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