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## Threat in dreams: An adaptation?

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### Abstract

Revonsuo's influential Threat Simulation Theory (TST) predicts that people exposed to survival threats will have more threat dreams, and evince enhanced responses to dream threats, compared to those living in relatively safe conditions. Participants in a high crime area (South Africa:  $n = 208$ ) differed significantly from participants in a low crime area (Wales, UK:  $n = 116$ ) in having greater recent exposure to a life-threatening event ( $\chi^2_{[1, N=186]} = 14.84, p < .00012$ ). Contrary to TST's predictions, the SA participants reported significantly fewer threat dreams ( $\chi^2_{[1, N=287]} = 6.11, p < .0134$ ), and did not differ from the Welsh participants in responses to dream threats (Fisher's Exact test,  $p = .2478$ ). Overall, the incidence of threat in dreams was extremely low—less than 20% of dreams featured realistic survival threats. Escape from dream threats occurred in less than 2% of dreams. We conclude that this evidence contradicts key aspects of TST.

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### 1. Introduction

Do humans dream in order to rehearse adaptive responses to survival threats? This is what Revonsuo's (2000a) Threat Simulation Theory suggests was the case for our ancestors. Originally published in the *Behavioral and Brain Sciences* (BBS) special issue on dreaming, Threat Simulation Theory (TST) proposes that dreaming provided an offline context in which threat perception and avoidance skills could be rehearsed without biological cost. Its fundamental premise is that dreaming provided early humans with an adaptive advantage, and was thus selected into our genetic make-up.

Revonsuo (2000a) characterized dreaming as consisting of two stages: *threat recognition*—where salient memory traces are selected and the dream simulation begins; followed by *threat avoidance*—the rapid generation of an appropriate avoidance response. He argued that dream rehearsals provide adaptive advantage as follows: “Threat avoidance simulation primes the connections between specific perceptual-emotional content

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and specific behavioral responses, and rehearses the efficient release of these behavioral responses through the activation of cortical motor programs” (Revonsuo, 2000a, p. 894). Revonsuo stated that threat simulation in dreams is a biological defense mechanism similar to immune mechanisms: it is activated by the presence of waking threat, and, most critically, it remembers the response to any particular threat for future use, thus resulting in improved waking response.

Evolutionary psychology theories are often vulnerable to the charge of being mere speculation: believable but untestable hypotheses. To achieve credibility, some post hoc evidence of the hypothesized mechanism must be produced. Revonsuo (2000a) thus initially marshaled two chief strands of evidence to support his theory. Firstly, he pointed to the marked impact of traumatic or threatening events on dream content—the experience of real life threat frequently results in nightmares of that event, or in extreme cases, in the recurrent dreams of Post Traumatic Stress Disorder (Nader, 1996; Wilmer, 1996). Revonsuo argued that this constitutes strong evidence for his theory—the threat simulation mechanism is uniquely activated when real threats are experienced. Secondly, he argued that decades of empirical research on dream content indicate that ancestral threat scripts predominate even in everyday dreams. In support of this contention, he cited the predominance of negative emotions; the preponderance of aggression and chase themes; (Hall and Van de Castle, 1966 in Domhoff, 1996; Feldman & Hersen, 1967; Hartmann, 1984; Snyder, 1970); and the fact that, particularly for children, dream enemies are mainly male strangers and wild animals (Domhoff, 1996; Hall & Domhoff, 1963, 1964).

The logic of TST drew a fair amount of criticism from commentators in the original BBS publication. Many difficulties were pointed out. Firstly, the impaired daytime functioning of people who suffer from recurrent nightmares and Post Traumatic Stress Disorder (PTSD) was raised. In addition to psychological dysfunction, severe fatigue and concentration problems occur, which would mitigate against threat dreams yielding adaptive advantage (Hunt, 2000; Kramer, 2000; Levin, 2000; Nielsen & Germain, 2000; Schredl, 2000; Zadra & Donderi, 2000). Secondly, biases in dream recall favor dramatic, salient dreams—hence a predominance of threat in recalled dreams may simply reflect this bias rather than the operation of a specific threat simulation mechanism (Bednar, 2000; Chapman & Underwood, 2000; Conduit, Crewther, & Coleman, 2000; Hobson, Pace-Schott, & Stickgold, 2000; Kramer, 2000; Mealey, 2000; Montangero, 2000). Thirdly, the focus on threat was regarded as too narrow: it ignores evidence of many other common types of dreams, and excludes other aspects of life vital to inclusive fitness (Bednar, 2000; Cheyne, 2000; Germain, Nielsen, Zadra, & Montplaisir, 2000; Montangero, 2000; Nielsen & Germain, 2000; Zadra & Donderi, 2000).

Other findings pertinent to TST have since emerged from various studies. Space prohibits a full review, so only strictly relevant themes will be highlighted here. Three recent studies, all employing prospective designs, have contradicted the idea that dream threat rehearsals improve waking adaptive functioning. Delorme, Lortie-Lussier, and Koninck (2002) found that students who incorporated threatening examination themes in their dreams used fewer active waking coping strategies, while those who did not, used active problem solving strategies more frequently. Punamaki (1997) found that although Palestinian children living in the chaotic conditions of the Gaza strip had more threat dreams than controls, they also had poorer adjustment, displaying more depressive, anxiety and somatic symptoms. Mellman, David, Bustamante, and Torres (2001) examined dreams in the aftermath of life-threatening injuries, and found that participants who reported dream simulations of their trauma had more severe PTSD symptoms at both initial and follow-up assessments (6 months later). This evidence argues against an adaptive function for threat simulation dreams.

The preponderance of threat themes in everyday dreams is questionable, especially where the definition of ‘threat’ is restricted to that which would seem most relevant to a selection-based argument, i.e. realistic threats to survival. Zadra, Desjardins, and Marcotte (2006) found that only 15% of recurrent dreams featured realistic threats to survival or reproductive fitness. Revonsuo and Valli’s (2000) own data indicated that only 22% of dreams contained life-threatening or physically dangerous threats to the dreamer. Malcolm-Smith and Solms (2004) found that 21% of dream reports contained physical threats, with less than 10% containing realistic life-threats. Earliest recalled dreams appear to contain a slightly higher proportion of threat (34.5%) than evidenced in other studies, and these dreams tend to be both unpleasant and realistic (Bulkeley, Broughton, Sanchez, & Stiller, 2005). It thus appears that the majority of dream content does not feature relevant threats.

More importantly, recent research indicates that threat dreams seldom feature an effective avoidance response. In Bulkeley et al.’s (2005) study of earliest recalled dreams, it was noted that, along with feelings

of fear and danger, a sense of helplessness predominated in the threat dreams, and there was no evidence of enhanced threat avoidance. Revonsuo and Valli (2000) found that only one third of dream threats had 'happy endings' of any sort. Malcolm-Smith and Solms (2004) found that less than 3% of dreams contained realistic escapes from life-threatening events. Similarly, Zadra et al. (2006) found that less than 2% of recurrent dreams featured plausible and effective responses to dangerous realistic threats.

Punamaki's (1999) study indicated that the threat dreams of the Gaza strip children were characterized by featuring the dreamer as an observer, and by unfavorable outcomes. Thus, although threatening stranger dreams were more common in the children exposed to life threats, contrary to TST's predictions these dreams tended not to feature the dreamer actively responding to the threat, and did not normally end in escapes from the threat. Valli et al. (2005) also found that although traumatized Kurdish children dreamed more frequently of more severe threats, they faced death or severe losses as a consequence of these threats more frequently—the Finnish control group never reported death or severe losses. These findings are critical, given that Revonsuo has repeatedly predicted that the threat simulation mechanism should be most active in children, particularly those exposed to severe threatening events. Even where there appears to be an increase in threat dreams, there is no corresponding increase in threat avoidance responses. A second analysis of Punamaki's data (Valli, Revonsuo, Palkas, & Punamaki, 2006) indicated no differences between the groups in response to dream threats, with 'no-one responds' occurring with greater frequency in the Trauma group. The fact that Palestinian and Kurdish children, living lives that incorporate high levels of trauma, prolonged stress and upheaval, tend to have an increased frequency of bad dreams is hardly surprising. This result could be explained by any number of dream theories, including Domhoff's 'current concerns' theory, or in terms of PTSD theory, where nightmares are viewed simply as memory intrusions. Without evidence of active and appropriate response to the dream threats, there is nothing in these results that requires TST to explain them.

Only the two studies mentioned above (Valli et al., 2005, 2006) specifically set out to compare threat in dreams of groups living under threatening vs. non-threatening conditions. Both compared dreams recorded in diaries by traumatized and non-traumatized children. This method of dream collection has been criticized (Domhoff, 1996), particularly as it has been shown that individuals tend to dream in series. The aim of the current study was to contribute to this knowledge base, using the Most Recent Dream method, which has been shown to yield representative content samples (Domhoff, 1996). We tested TST's prediction that the threat simulation system can be differentially activated, with the lowest level of activation occurring in a safe environment, largely free from stress and fear; and the highest in an environment featuring threats to life and physical well-being (Revonsuo, 2000b).

Revonsuo (2000b) has argued that the comparatively safe modern context does not activate the threat simulation mechanism properly. Ecologically valid threats—i.e. those present, or similar to those present in our ancestral past—are required for its function to be fully realized in dreams. Uniquely modern threats would not form part of any inherited ancestral threat scripts, and thus cannot be expected to properly activate the mechanism, or to cue efficient simulations. Further, it must be noted that Revonsuo's definition of threat is problematic. Revonsuo's dream threat rating scale includes psychological and social threats. We consider this invalid. Psychosocial adjustment either is or is not relevant to his selection-based argument: Revonsuo cannot on the one hand argue, as he has done repeatedly (Revonsuo, 2000b; Valli et al., 2005) that exposure to psychosocial threats is not sufficient to properly activate the threat simulation mechanism and that waking psychosocial impairment is not evidence against his theory, and on the other hand include dream threats of this type as evidence for TST. We consider a reasonable and defensible approach to include only realistic threats to physical survival.

We thus aimed to research dreams originating in two very different contexts: one in which ecologically valid threat cues are present and one in which they are largely absent. TST predicts more threat simulations, and more effective simulated responses, in the dreams of people living in the high threat context. Violent crime—comprising murder, rape, assault, and armed robbery—is an ecologically valid threat in terms of TST, in that threats of this nature were undoubtedly present in our ancestral past. This study contrasted dream content from a region where violent crime is prevalent with that from a region where it occurs very rarely. The incidence of physical threats, life-threats, and realistic escapes in dreams was compared across the groups.

## 2. Method

### 2.1. Sample

Purposive sampling targeted groups living in two contexts: the Western Cape in South Africa, and North Wales in the UK. The UK and South Africa are known to differ markedly in levels of violent crime. For the period in which data was collected (February–April 2004), North Wales ranked significantly lower than the UK national average (Dodd, Nicholas, Povey, & Walker, 2004); while the Western Cape ranked higher than the South African national average (Leggett, 2004). Unfortunately, idiosyncratic categorization of crime prevents a direct comparison between the Western Cape and North Wales on the specific categories of interest here—only national UK statistics are available. However, it is evident that the figures for North Wales would be far lower than these (Dodd et al., 2004).

Table 1 indicates a comparison between the Western Cape and the UK. There is a marked contrast across the regions, with extremely high levels of violent crime occurring in the Western Cape, and a very low level occurring in the UK/Wales. Consider the figures (WC vs. UK; figs per 100,000): 62 vs. 1 for murder; 80 vs. 2 for attempted murder; 138 vs. 21 for rape; and 808 vs. 33 for assault/GBH. Ecologically valid threats in the form of violent crime clearly differ markedly in the two contexts: hence the decision to sample specifically from these regions.

Participants were undergraduate psychology students at the University of Cape Town in the Western Cape ( $n = 208$ ), and the University of Wales in Bangor ( $n = 116$ ). The median ages were 20 and 19 for the Western Cape and North Wales participants, respectively. Revonsuo (2000a, 2000b) asserts that the threat mechanism should be optimally active in children and adolescents, partly because of the short life span of ancestral humans, but also because he hypothesizes that in younger humans, the conditions of modern living have had less impact, and ancestral dream scripts should be more active. In addition, Domhoff (2003) has shown that older individuals' dream content does not differ, except that aggression and negative emotions are reduced. Using samples of students was thus apt in this case.

Participation was voluntary and informed consent was obtained. Participants were not informed of the pertinent aims of the study, but were told it entailed detailed analysis of dream content and its relationship to real life events. The number of participants accessed in the two universities differed (SA:  $n = 208$ ; Wales:  $n = 116$ ). Avila-White, Schneider, and Domhoff (1999) established that 100–120 Most Recent Dream (MRD) reports will successfully approximate the established Hall and Van de Castle dream content norms, thus sample sizes for the two contexts were considered sufficient. The ratio of females to males was consistently higher in both samples (See Table 2). The possible impact of this gender imbalance on reported threat in dreams is examined in Section 3.

It was anticipated that the Welsh sample would be mainly white: this would be in keeping with targeting a low threat exposure group. The South African group was mixed, with two thirds of the participants being white (See Table 2). It may be argued that white South Africans are not exposed to crime to the same degree as blacks. It is thus possible that this group may not have been exposed to the high levels of violence indicated by crime statistics. Self-report data on experience of actual threats, and on perceived exposure to threats, was used to examine this possibility (see Section 3), and to verify relative threat exposure for both groups.

### 2.2. Materials

Participants were given a questionnaire that began with a Most Recent Dream (MRD) report, using Domhoff's (1996) standard instructions. It then asked whether participants had experienced an actual life-threat-

Table 1  
Violent crime in the Western Cape and UK

	Western Cape	UK
Murder	62	1
Attempted murder	80	2
Rape	138	21
Assault/GBH	808	33

Figures p/100,000.

Table 2  
Sample composition

Sample	Gender	Ethnicity		Total
		White	Black	
SA	Male	28	8	36
	Female	108	61	169
Total		136	69	205 <sup>a</sup>
Wales	Male	27	2	29
	Female	78	9	87
Total		105	11	116

<sup>a</sup> Three SA participants did not respond to the questionnaire item 'Population Group'.

ening event; if so, to describe it and note when it happened. Participants were then asked to estimate how many physical threats they generally encounter per week, and to list the types of threat encountered.

### 2.3. Procedure

Questionnaires were distributed during a dedicated lecture period. Participants were instructed not to read ahead, as the focus on threats later in the questionnaire might have primed recall on the Most Recent Dream (MRD) report.

Six independent raters, unaware of both TST and the aims of the study, coded the responses. The MRD report codings specified whether the dream contained a realistic, physical threat to the dreamer; if the threat was life-threatening; if the dreamer escaped; if the escape was realistic; and whether the threat was ancestral or modern (defined below). The raters then coded the descriptions of exposure to real life threats reported by the participants. Only instances coded as Actual Threats, i.e. where the description featured immediate real possibility of death or severe harm to the participant, were included for analysis. The real life threat descriptions were also rated as ancestral or modern. Percentage of perfect agreement (Domhoff, 1996) between raters on the MRD ratings was 91.5%, and was 87% for the real life threat codings.

Note that the ancestral threat category contained threats that constitute violent crime (viz. murder, rape, assault and robbery); that is, threats that are ecologically valid in terms of Revonsuo's argument. Following a decision made in a previous study (Malcolm-Smith & Solms, 2004) threats involving guns were coded as ancestral: the rationale was that being threatened with a gun or shot at is similar to being threatened with any deadly weapon (e.g. spears or stones). This decision is also consistent with Revonsuo's (2000a) inclusion of traumatic dreams of these types of events as evidence for his theory. The modern threat category included major surgery, traffic accidents, airplane disasters, and court-related death threats.

## 3. Results

### 3.1. Exposure to threat across the samples

Assuming that participants actually were exposed to crime along the lines indicated by the crime statistics for the two contexts, particularly given the high number of white participants in the SA sample, might have been an ecological fallacy. Participants were thus requested to indicate whether their lives had ever been in danger and to describe the incident. As mentioned above, only incidents where raters coded the descriptions as featuring immediate real possibility of death or severe harm to the participant were included. Furthermore, only recent incidents (i.e. those which occurred during the past 4 years) and those which were rated as ancestral-type threats were included in the analysis.

49.15% of SA participants were rated as having experienced an ancestral-type life-threatening event during the past four years, compared to 21.59% of Welsh participants.  $\chi^2$  analysis indicated that this distribution was significantly unequal ( $\chi^2_{[1, N=186]} = 14.84, p < .00012; \Phi = 0.28$ ); and analysis of standardized residuals indicated

where the differences lie. More South Africans than expected reported experiencing a life threat ( $p < .03$ ), whereas Welsh participants reported fewer life-threatening experiences ( $p < .008$ ), and more instances of never having had their life endangered ( $p < .02$ ).

The magnitude of this difference can perhaps best be understood by calculating the odds ratio (this is unaffected by sample size and is less ambiguous than  $\Phi$ ; Howell, 2002). The odds of recent exposure to a life-threatening experience, given that the participant is South African, are 58/60. The odds for a Welsh participant are 14/54. The odds ratio (SA/Wales) is 3.7, telling us that South Africans were almost four times more likely than Welsh participants to have been exposed to a recent ancestral-type life-threatening event.

Furthermore, the data generated by asking participants to list the types of threats they face routinely was analyzed specifically for mention of crime, to obtain an impression of subjective sense of threat. It is important to note that this question was specifically phrased so as not to cue mainly crime reports. Participants were asked to list any and all physical threats they might encounter on a weekly basis (e.g. traffic hazards; sports injuries; etc.). 'Crime' was simply one of several listed examples, and was not elaborated any further. This was thus an open-ended question designed to elicit spontaneous reporting of any threats that might be of current concern to the participants.

There were 15 listings of crime threats from Welsh participants ( $n = 116$ ); and 199 from South African participants ( $n = 208$ ). The sense of threat from crime thus appears disproportionately high in the South African sample.

The crime threats cited by Welsh participants were 'Assault' (11 $\times$ ); 'Crime' (3 $\times$ ); and 'Murder' (1 $\times$ ). South African participants listed 'Assault' (62 $\times$ ); 'Being mugged' (46 $\times$ ); 'Being hijacked' (23 $\times$ ); 'Rape' (22 $\times$ ); 'Crime' (17 $\times$ ); 'Being robbed' (13 $\times$ ); 'Being shot' (8 $\times$ ); 'Murder' (4 $\times$ ); and 'Being stabbed' (4 $\times$ ). Thus, it would appear that South Africans' sense of threat from crime is also elevated in terms of a proliferation of types of crime threats perceived. Additionally, the level of violence inherent in the threats listed by South Africans is noteworthy.

Thus, it seems that both in terms of objective threat experiences and subjective sense of threat, the profile of threat exposure for the groups echoes that found in the crime statistics for the Western Cape and North Wales. It can be regarded as established that the two samples differ in terms of exposure to threat cues, with South Africa being a high threat context, and Wales being a low threat context.

### 3.2. Threat content in Most Recent Dream reports

The following analyses look at MRD threats coded as realistic physical threats to the dreamer. Once again, following the logic that the threat simulation mechanism evolved to cope with threat in our ancestral past, only dream threats coded as ancestral were included. 'Realistic' was defined as anything that could conceivably occur in real life.

#### 3.2.1. Gender differences in realistic physical threat in MRD reports

Because the Hall and Van de Castle dream content norms indicate a gender difference in aggression (Domhoff, 1996: males have more aggressive interactions), it was important to check whether there was a gender difference in incidence of realistic physical threats in MRD reports. Our previous study (Malcolm-Smith & Solms, 2004) and Revonsuo and Valli's (2000) work indicated no such gender difference, and the current results confirm this. No significant gender differences were found within the SA group ( $\chi^2_{[1, N=185]} = 0.88$ ,  $p < .3474$ ); or the Welsh group ( $\chi^2_{[1, N=102]} = 0.78$ ,  $p < .3779$ ). Males and females were thus equally likely to report realistic physical threats in their dreams, so the preponderance of female participants in both groups did not impact on the MRD analyses.

#### 3.2.2. Realistic physical threat in MRD reports

The results indicate that the MRD reports of Welsh participants contained more realistic physical threats than those of South Africans (18.63% vs. 8.65%; See Fig. 1). This difference was found to be significant ( $\chi^2_{[1, N=287]} = 6.11$ ;  $p < .0134$ ;  $\Phi = 0.14$ ). Analysis of standardized residuals indicated the difference lies in the Welsh sample—significantly more realistic physical dream threats than expected were reported by this group ( $p < .03$ ). [Note that for the South African group, MRD reports of realistic physical threats were on the low

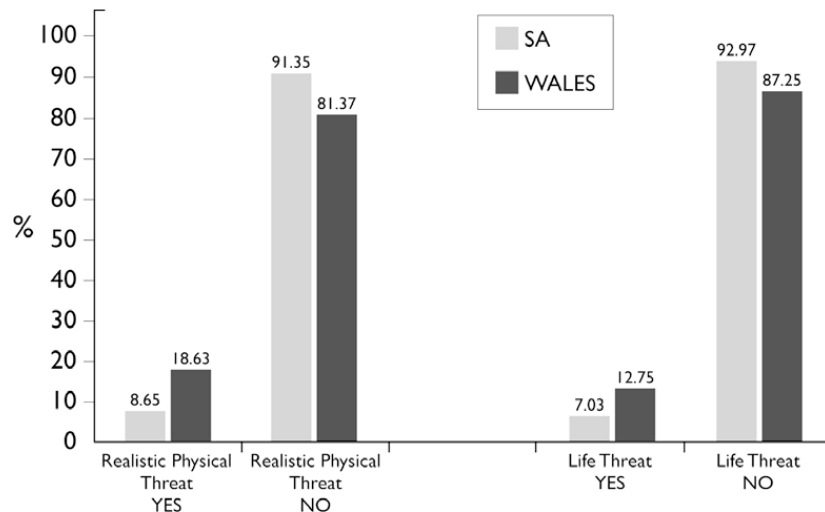


Fig. 1. Incidence of realistic physical threat and life threats in most recent dream reports.

end of the distribution:  $p < .08$ ]. Thus, the group living in the low threat context reported the highest proportion of ancestral threat dreams. The direction evidenced by these results is opposite to that predicted by Revonsuo.

Once again, the odds ratio can clarify the extent of the difference between the groups: the odds of having a realistic physical threat in dreams, given that the participant is Welsh, are 19/83; while those for SA participants are 16/169. The odds ratio (Wales/SA) = 2.4. Welsh participants were thus two and a half times more likely to have realistic physical threats in their dreams.

### 3.2.3. Life-threats in MRD reports

It was still possible that life-threatening dream events, rather than simply physical threats, occurred with greater frequency in the group exposed to the most waking threat cues. Welsh participants once again had more life-threats in their MRD reports than SA participants (12.75% vs. 7.03%; see Fig. 1). This time, however, the difference between the groups was not found to be statistically significant ( $\chi^2_{[1, N=287]} = 2.61$ ;  $p < .1062$ ).

### 3.2.4. Realistic escapes from realistic physical threats in MRD reports

Only four SA dreams and two Welsh dreams featured realistic escapes from realistic physical threats. Expressed as a proportion, 1.4% of SA MRD reports and less than 1% of Welsh MRD reports contained realistic escapes from realistic physical threats. Due to low expected frequencies, Fisher's Exact Test was conducted. No difference was found between the groups ( $p = .2478$ ; 1-tailed).

## 4. Discussion

These results indicate that most dreams do not contain realistic physical threats to the dreamer: between 81% (Wales) and 91% (South Africa) of dreams did not feature this type of threat. Welsh participants reported significantly more realistic physical threats than the SA group: they were two and a half times more likely to report these dream threats than South Africans.

Very few dreams contained life-threatening physical threats to the dreamer: between 87% (Wales) and 93% (SA) of dreams did not contain life-threatening events. Welsh participants again reported more of these threats than South Africans, but this difference was not found to be statistically significant.

Finally, most realistic physical dream threats were not followed by a realistic escape, and there was no difference in this trend across the SA and Wales groups. 1.4% of SA and less than 1% of Welsh MRD reports contained realistic escapes from realistic physical threats.

This study was an investigation of Revonsuo's claim that the threat simulation mechanism will activate differently depending on the level of ecologically valid threat cues operational in waking life. The different levels

of exposure to valid threats in the two samples were established—firstly by examining official statistics for violent crime; secondly by ascertaining the proportion of participants in each group who personally experienced a recent ancestral-type life-threatening event; and thirdly by obtaining an impression of the participants' subjective sense of relevant threats faced routinely. The participants' responses confirmed the pattern indicated by the crime statistics. The SA sample was exposed to a significantly higher level of relevant threat, being four times more likely to have been the target of a recent ancestral-type life-threatening event.

The dreams of South African participants should thus have contained more severe threats, and more appropriate responses to these threats than those of Welsh participants. The results indicate precisely the opposite pattern to that predicted by Revonsuo's TST: Welsh participants had significantly more realistic physical threats in their dreams, being two and a half times more likely to report these than South Africans. Welsh participants also reported more life-threats in their dreams, but this difference was not found to be significant. There was no difference across the groups in the low rate of escape from dream threats. There is thus no indication of more dream threats, life-threats or escapes occurring in the high threat exposure sample. Revonsuo's prediction of a gradient of activation in the threat simulation mechanism, dependent on the level of exposure to ecologically valid cues, is thus not supported.

These results are inconsistent with the findings of two recent studies by Revonsuo and Valli (Valli et al., 2005, 2006). They report that children exposed to greater threat/trauma had more dreams, with more severe threat content, than children living in non-threatening conditions. Differences in method and interpretation of data go some way to account for this discrepancy.

A difference in method concerns the sampling of dream content. It has been repeatedly confirmed that the Most Recent Dream method yields a representative sample that reproduces dream content norms, given a sample size of over 100 dream reports (one from each participant; Avila-White et al., 1999; Domhoff, 1996, 2003). Valli et al. use the Dream Diary method of collecting a sample of dreams—thus each individual may contribute a varying number of dream reports. Domhoff (1996) has indicated that in order to obtain a representative sample of an individual's dream content, 75–100 reports need to be collected from each person. This requirement is not met in the short collection periods used in both studies (Valli et al., 2005, 2006).

Regarding interpretation of the results, spontaneous dream reports are an extremely poor indicator of actual frequency of dreaming. The most robust finding in dream research is that the vast majority of dreams are forgotten (Domhoff, 1996; Hobson et al., 2000). Yet even people who say they do not dream, are able to report dreams on REM awakening. Individual differences in spontaneous dream recall are large, and appear to be influenced by numerous variables. Most notably, it has been demonstrated that mood and anxiety disorders lead to increased frequency of dream recall (Lavie, Katz, Pillar, & Zinger, 1998; Nielsen et al., 2000). Thus, finding that traumatized children, who are likely to exhibit at least elements of anxiety or mood disorders, show a higher frequency of dream recall provides at best tenuous support for TST. It does not provide strong evidence of greater activation of the dreaming mechanism in these children.

The authors claim that the traumatized children in both studies have more threats in their dreams. In the 2005 study, the Kurdish Trauma group reported more 'aggressive threats'. The category 'aggressive threats' includes 'physical aggression'; 'escapes/pursuits'; and 'non-physical aggression'. When these subcategories are examined separately, there is no difference between the groups on 'physical aggression' or 'escapes/pursuits'—the types of aggressive threat most clearly relevant to TST's ancestral threat script and selection-based argument. The trauma group only differed markedly on increased 'non-physical aggression'. This is not what TST predicts. The analysis of severity of threat is not well reported, with the authors claiming that the Trauma group reported more severe threats than the other groups. All four categories ('life-threatening'; 'psychologically, socially or financially severe threat'; 'physical threat'; and 'minor threat') were included in the group comparison  $\chi^2$  analysis, and no post hoc contrasts were done. It is thus impossible to determine precisely where the significant difference occurs. It is also interesting to note that in the original coding scale, 'severity of threat' had only 3 subcategories: 'life-threatening or physically dangerous'; 'psychologically, socially or financially severe'; and 'trivial'. In this 2005 paper, a 4th subcategory—'physical threat'—is introduced. The Finnish Control Group showed the highest incidence of 'physical threat'. In Revonsuo's original coding system, this would have been incorporated into the first category ('life-threatening or physically dangerous'), thus equating the groups on the most relevant type of threat, and leaving the Trauma group to score higher only on 'psychologically, socially or financially severe threats'.



This pattern is repeated in the 2006 study, where the traumatized Palestinian children had a greater degree of threat in their dreams. Yet, looking at the subcategories, it is clear that this difference is only due to their having more ‘psychologically, socially or financially severe threats’. Thus, the increased frequency of reported threat in the traumatized children’s dreams reflects the inclusion of threats that are less relevant to TST’s predictions than those on which the groups do not differ.

We find the inclusion of a broad array of threats questionable. TST revolves around arguments involving natural selection, the operation of ancestral threat scripts in dreams, and the bestowal of waking adaptive advantage from dream simulations. Evidence relevant to these arguments should thus center around realistic, ancestral-type threats to physical survival or reproductive success.

In the rating scale developed by Revonsuo and Valli, psychosocial threats in dreams are rated as severe, and are used to provide important evidence in favor of TST. The logic of this is questionable, given the authors’ repeated arguments that the mechanism of dreaming has nothing to do with psychosocial adjustment. They consistently argue both that only ecologically valid threats activate the dream system, and that poor waking psychosocial function is not evidence that threat dreams are maladaptive. If waking psychosocial threat and psychosocial function are irrelevant to the theory, then dream threats of this nature should not be included as evidence for TST. Alternatively, if the dream threat simulation mechanism *does* handle psychosocial threats, then waking psychosocial threats should activate the system. This would mean that predictions about threat dreams in exposed individuals would expand to include any people who experience severe psychological and social threats—which occur in every society.

Our impression is that when the definition of threat in dreams is broadened to the extent found in Revonsuo and Valli’s coding scale, the proportion of dreams containing threat is inflated. This creates a misleading impression that dream content supports TST’s assertions. Not all threat is relevant to their selection-based argument. When threat is more precisely defined, the presence of relevant threat in dreams drops drastically.

We do not believe that the finding in our current study of Welsh participants reporting more physical threat in dreams is particularly meaningful. There was no difference between the groups on life-threatening events in dream reports. The salient point is that both groups reported a low incidence of threat in their dreams. Thus, the current results confirm our previous finding of a low proportion of relevant threat in dreams (Malcolm-Smith & Solms, 2004), and are similar to Revonsuo and Valli’s (2000) report that only 22% of dream threats were coded as physically dangerous or life-threatening, and Zadra et al.’s (2006) finding that only 15% of recurrent dreams contained threats to survival or reproductive success<sup>1</sup>. The figures all clearly indicate that most dream content does not feature physical threats, and thus contradict Revonsuo’s contention that dreams specialize in representing threats relevant to TST.

It has been argued that even this small percentage of threat, if treated as a proportion of the four dreams per night average, would multiply out to represent considerably more severe threat experiences in a year than we encounter in waking life. Threat in dreams is thus argued to be over-represented compared to threat in waking life. This may be the case, but it could also be true of all dream elements—for instance, flying, having your teeth fall out, or appearing naked in public certainly occur more frequently in dreams than in any given waking time span. To argue convincingly that relevant threats are over-represented in dreams, this needs to be empirically demonstrated in relation to other categories of dream content.

Critically, most of the few dream threats that did occur were not followed by an escape. This finding features across all studies (Bulkeley et al., 2005; Malcolm-Smith & Solms, 2004; Punamaki, 1999; Revonsuo & Valli, 2000; Valli et al., 2005, 2006; Zadra et al., 2006) with some indication that consequences in the dream are severe (Valli et al., 2005). We would argue that threat avoidance is the pivotal feature of Revonsuo’s proposed function for dreams. The threat simulation mechanism cannot provide adaptive advantage simply through rehearsal of noxious experiences: successful avoidance responses must also occur. Only simulations of escape can lead to improved performance in real life. Valli and Revonsuo’s (2006) current attempt to argue away the importance of threat avoidance in the face of this disconfirming evidence, is inconsistent both with

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<sup>1</sup> It is not possible to include percentage comparisons of life-threatening or physically dangerous threat elements from Valli et al. (2005, 2006), as they report only proportions of types of threat (i.e. of the coded threats, how many were life-threatening, etc.), and not proportions of the total sample.

the original formulation of the theory and with any logical conception of how dream rehearsals could bestow adaptive advantage.

Clearly, all the methodological problems inherent in the field of dream research apply to this study. Most importantly, we cannot be entirely certain about what dream recall biases exist, although it seems that salient, dramatic dreams tend to be remembered better. Domhoff (1996, 2003) indicates that home reports (vs. lab REM-awakenings) produce more reports of aggression and misfortunes—this bias may impact on the present results. However, the possibility that these biases have affected these results only strengthens the argument against TST—despite biases favoring their recall, reports of threat simulation dreams are rare.

Another concern is the investigation of escape in dreams—so few occurred (two reported by Welsh participants and four from South Africans) that statistical analysis was problematic. Obtaining a large enough sample of MRD escapes to enable statistically satisfactory analysis of differences between groups would not be easy. Given that escapes from realistic physical threats in dreams seem to occur in around 2% or less of reports (Malcolm-Smith & Solms, 2004; Zadra et al., 2006; current results); getting a sample of only 50 escapes would require around 2500 MRD reports, clearly a daunting task. It could be argued that the mere fact that realistic escape from realistic physical threat occurs so infrequently as to cause this problem, calls into question a theory of function based on this exceedingly rare element.

#### 4.1. Implications for TST

The crux of the matter is that TST is an evolutionary theory. For dreaming to have become a salient part of our genetic make-up through natural selection it must have provided an adaptive advantage. Empirical evidence, however, indicates that dreams do not predominantly feature threat simulations. Moreover, those that do occur hardly ever feature effective responses, even in dreams simulating the most relevant scenarios: ancestral threats to physical survival. If any dream scenarios should form part of a set of inherited threat scripts, it should be these. Revonsuo's analogy, likening the threat simulation mechanism to the human immune system therefore does not hold. He explicitly stated (Revonsuo, 2000a) that the critical factor in the threat simulation mechanism's selection was that it remembers the response to a particular threat, rendering future responses far more efficient. We see no evidence for this.

TST is an interesting theory, and the concept of applying an evolutionary perspective to the question of the function of dreaming is, we believe, valuable. In the light of the available evidence, however, it seems Revonsuo's theory is implausible. A broader consideration of other testable evolutionary theories is called for.

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