

Revonsuo's Threat Simulation Theory: A comparative study

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ABSTRACT

Revonsuo's Threat Simulation Theory (2000) is a highly influential theory in the dream research community. This theory posits that dreams contain threatening content as preparation for real-life threatening situations. On this theory, the putative threat simulation mechanism uses the fear conditioning system in the brain, which generates avoidant behaviour. Solms' (2000) competing dream theory posits that dream generation takes place in the 'seeking' or 'reward' system (mesocortical/mesolimbic dopamine system), and that dreams are generated by a brain system that fundamentally involves not avoidant but rather approach behaviour. This study compared the incidence of threatening dreams (avoidant behaviour) with that of seeking dreams (or approach behaviour). The data was collected using the Most Recent Dream (MRD) method. Participants were undergraduate psychology students in both a highly violent country - South Africa ($n = 105$) and in a country with low rates of violence - Wales ($n = 105$). Once inter-rater reliability was established, raters coded the dream reports as representing predominantly either approach or avoidant behaviour on the part of the dreamer. The results of this study indicate that there are significantly fewer dreams that represent avoidant behaviour compared to dreams that represent approach behaviour ($\chi^2_{(1)} = 43.89, p < 0.001$). This study also shows that avoidant or approach behaviours in dreams are not contingent on the level of actual threat in the environment, represented by country ($\chi^2_{(1)} = 0.22, p = 0.64$). This study thus yields evidence which strongly contradicts Revonsuo's Threat Simulation Theory, on the grounds that approach dreams are more common than avoidant dreams, even in situations where real-life threats are highly prevalent.

Key words: threat simulation theory; dreaming mechanisms; dream content; threat avoidance; approach behaviours

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Dreaming is a universal human experience. The function of dreams has been widely debated for decades. There is no convincing theory that explains why humans dream while they sleep. In an influential paper entitled “*The reinterpretation of dreams: An evolutionary hypothesis of the function of dreaming*”, Revonsuo (2000) posited that dreams have an evolutionarily preserved function. This function is to rehearse the appropriate avoidance skills associated with threats in the (safe) virtual reality of dreams. The dreamer thus rehearses threat-avoidance skills that can be used in reality. This is known as the Threat Simulation Theory (TST). Revonsuo’s theory is much debated in the dream research community. It has received substantial acclaim and criticism from other researchers and theorists (see Cheyne, 2000; Valli et al., 2005). According to Revonsuo’s (2000) theory, dreams represent avoidant behaviour due to the fear conditioning system being activated during dreaming. The present study aims to evaluate the incidence of threat-avoidance in dreams in comparison to other forms of instinctual behaviour in dreams. It does so by comparing the incidence of threat-avoidance dreams with dreams which display the opposite neurobehavioural tendency predicted by the competing theory of Solms (2000), namely ‘seeking’ behaviours. This study therefore constitutes a critical test of the two competing theories.

In a special edition of the journal *Behavioral and Brain Sciences* (2000), subsequently reprinted as a book (Pace-Schott et al, 2003), these two contrasting theories of the brain mechanism of dreaming were proposed. Solms (2000), basing himself on lesion studies, proposed that dreaming is driven by the ‘reward’ system of the brain. This system controls all ‘seeking’ and most approach behaviour. In contrast to this, Revonsuo (2000), basing himself primarily on dream-content studies, proposed that dreaming is driven by a ‘threat rehearsal’ mechanism, and therefore, by implication, by the fear conditioning system of the brain. This system controls flight/freezing responses and other ‘avoidant’ behaviours. The following review of the literature considers Revonsuo’s Threat Simulation Theory and Solms’ ‘seeking’ theory of dreaming. Evidence for and against the TST will be presented and Revonsuo’s response to criticism will be explored.

Revonsuo’s Threat Simulation Theory

In his Threat Simulation Theory (TST), Revonsuo (2000) postulates that the threat simulation mechanism was specifically selected during human evolution and that dreams have a biologically

adaptive function. This function is to simulate threatening events in dreams (a safe environment) to rehearse the appropriate threat-avoidance skills and behavioural programs. Threatening events and situations are defined as “any adverse events that potentially endanger future reproductive success” (Revonsuo & Valli, 2008, p. 1294). This theory asserts that the dreamer generates threatening situations in the dream in order to solve the problem in a safe virtual environment, in order to carry this information across to real threatening situations. This is seen as practice and preparation for real-life threatening events. In other words, Revonsuo (2000) proposes that threat avoidance in dreams leads to the increased possibility of successfully coping with a real threat, which in turn leads to increased reproductive success.

Revonsuo's 6 propositions

Revonsuo's Threat Simulation Theory consists of 6 propositions. Each proposition looks at a different aspect of dreaming and dream content. Proposition 1 states that dream content is not disorganized, it is too organized to have arisen by chance. Proposition 2 states that dreams are specialized in the reproduction of threatening incidents. This proposition is derived from the fact that there are more negative emotions experienced in dreams, with the common emotion being fear (Domhoff, 1996). Proposition 3 states that threats experienced during waking will affect subsequent dream content. These threatening events will activate the threat simulation mechanism. The fourth proposition states that the threats experienced in dreams are realistic and therefore appropriate practice of threat avoidance responses. Proposition 5 states that simulation of threatening events leads to improved performance in real-life threatening situations, even if the simulation episodes were not remembered by the dreamer. These simulations involve perceptual, motor and cognitive behaviours. Proposition 6 can be summarized as follows: the ancestral environment in which humans lived contained frequent dangerous situations that influenced reproductive success (Revonsuo, 2000). These ecologically valid cues would continually activate the threat simulation mechanism in the dreamer. According to Revonsuo and Valli (2008), propositions 2 and 3 are central to the Threat Simulation Theory.

The threat simulation mechanism

The Threat Simulation Theory (TST) centres on the avoidance of threats in dreams. TST says that “dream consciousness is essentially a mechanism for simulating threat perception and

rehearsing threat-avoidance responses and behaviors” (Revonsuo, 2000, p. 882). The emphasis here is on avoidance and avoidant behaviours. The dreamer generates imagery of threatening events and practices avoiding the threat in order to be successful and survive. During dreams, the threatening situation stimulates the fear conditioning system in the brain, which, in turn, activates imaginary avoidant behaviour. This system controls avoidant behaviours such as the freeze/flee reactions. Revonsuo (2000) hypothesizes that the amygdala is heavily involved in the above process. He believes that the threat simulation mechanism that produces the avoidant behaviour is the amygdala and the surrounding areas. Revonsuo (2000) explains that this is evident when threatening content is in one’s visual field. The amygdala will activate to evaluate the potential threat and then assist in selecting the appropriate avoidance response. Research by Le Doux (2000) is consistent with this theory. Le Doux (2000) has found that there is a set of circuits in the amygdala that are specialised in the detection and response to danger. These circuits are strongly involved in fear conditioning (Le Doux, 2000). Neuroimaging studies further highlight the involvement of the amygdala during REM sleep and dreaming (Braun et al., 1997; Maquet et al., 1996). These studies indicate preferential activation of the limbic regions during dreaming, particularly during REM sleep, compared to waking activation. Hobson, Pace-Schott and Stickgold (2000) show that during REM sleep and dreaming there is significant activation of the amygdala. It has been found that during REM sleep the amygdala is activated to levels above those seen in waking (Hobson, 2009). This supports Revonsuo’s hypothesis of the amygdala being the proposed threat simulation mechanism.

Threatening environments and dreams

Revonsuo hypothesizes that living in a threatening environment will stimulate and activate the threat simulation mechanism. The third proposition of the TST states that real experiences of dangers or life-threatening events are highly likely to be incorporated into one’s dreams (Revonsuo, 2000). According to the TST, individuals who live in a threatening environment that contain life-threatening events (such as environments plagued by war or famine) will have more threatening dreams than those who live in environments that are not physically threatening. Those who live under less threatening conditions will still have their threat simulation mechanism activated, but not to the extent of those living in more trying conditions. The threat

simulation mechanism is therefore differentially activated. There is some evidence of this being true. This evidence will be explored below.

Evaluation of the TST

Domhoff (2000) provides evidence for the TST. Although Domhoff does not fully agree with and support Revonsuo's theory, he does believe (on the basis of quantitative dream-content studies) that recurrent dreams are linked to the fear conditioning system of the amygdala (Domhoff, 2000). According to Revonsuo, this system is the proposed threat simulation mechanism. When looking at recurrent dreams, Zadra, Desjardins and Marcotte (2006) also believe that the fear conditioning system is involved. They have found that "simulation of threat recognition during dreaming (and presumably REM sleep) may very well fulfil the goal of priming an amygdalocortical network to perform rapid and appropriate emotional evaluation of the potential danger" (Zadra et al., 2006, p. 462). They argue that the amygdala is involved in the threat simulation process, which agrees with Revonsuo's hypothesis that the amygdala is the putative threat simulation mechanism.

Various other studies provide evidence for the TST. A study conducted by Valli and colleagues (2005) provides evidence in support of Revonsuo's third proposition. This proposition emphasizes the effect traumatic events have on dream content and the threat simulation mechanism (Revonsuo, 2000). According to the TST, people exposed to real life threats will fully activate the threat simulation mechanism, which, in turn, leads to more frequent and intense threat simulations during dreams (Valli et al., 2005). Valli et al. (2005) compared traumatized Kurdish children from Northern Iraq (a war-torn country) with non-traumatized Finnish children living in a relatively threat-free environment. This study found that children who were exposed to severe real-life threats reported more dreams and that these dreams included threatening events more often than the dreams of children exposed to less threat, or not exposed to threatening real-life events. Their study found that children living in threatening conditions had dreams that contained more dangerous threats than those children who were living in less threatening conditions (Valli et al., 2005). This study suggests a marked impact of threatening situations on dream content in children living in threatening conditions.

The TST states that the teleological purpose or biological function of dreams is to prepare one for future threatening events in real life. In a study conducted by Revonsuo and Valli (2008),

it was found that threatening events are overrepresented in dreams. These threatening events are overrepresented in presumed comparison with real life and positive dream events. This overrepresentation can be seen in their study that 60- 77% of dreams collected from young adults contained threatening events (Revonsuo & Valli, 2008). Revonsuo believes that this vast amount or 'overrepresentation' of threatening events is consistent with his theory.

Another study conducted by Valli et al. (2008) with a sample of Finnish university students indicated that 67.8% of their collected dream diaries contained realistic threats. A further 20.8% of the dream diaries contained possible threats. Furthermore, it was found that the dream self frequently responded to the threatening event when it was a life threatening situation and the dream self was the main target in these dreams. This study also demonstrates that the threatening situation was more often than not resolved and negative consequences were avoided (Valli et al., 2008). It was found that the dream reports of all the participants contained at least a few threatening events (Valli et al., 2008). This provides further evidence that the TST is an effective method of threat rehearsal. However, it is important to note that these authors looked at the incidence of threat-related dream content only. They did not compare the incidence of threat-related content to that of other instinctual neurobehavioural systems. This makes it difficult to interpret the findings. It is interesting to note that the raters used in the above studies (conducted by Revonsuo himself) were not blind to Revonsuo's hypotheses.

Other attempts to test Revonsuo's theory have produced disconfirming evidence. In a study conducted by Malcolm-Smith and Solms (2004), it was found that 21.19% of dreams contained physical threat. It was also found that less than half of the reports actually contained successful threat avoidance (Malcolm-Smith & Solms, 2004). The same study found that only 2.74% of the collected dream reports contained practical escapes from life-threatening incidents (Malcolm-Smith & Solms, 2004). It was also discovered that approximately two thirds of the few life-threatening events experienced in dreams (8.48%) are not followed by effective and successful avoidance action (Malcolm-Smith & Solms, 2004). This study presents considerable disconfirming evidence for Revonsuo's theory. It also shows that the threat-avoidance mechanism is not effective and does not realistically help the dreamer. It can be concluded from this study that TST is neither an effective nor an adaptive mechanism.

In a study conducted by Valli et al. (2005), it was predicted that there would be greater activation of the supposed threat-rehearsal mechanism in those living in threatening conditions.

The TST assumes that all dreamers will react to the threats experienced in their dreams. However, Valli et al. (2005) found that only 35% of dreamers reacted to the threatening event in the dream. This shows that only 35% of the dreamers activate and use the putative threat simulation mechanism when confronted with a threat. In this study, it was not determined how many dreamers managed to successfully evade the threatening event. These findings are not fully supportive of the TST.

In a study of recurrent dreams, Zadra et al. (2006) similarly found that less than 15% of the total sample of recurrent dreams included realistic threats. They also found that 80% of the dreams contained unrealistic threats. These unrealistic threats were usually fictitious in nature and were unlikely to transpire in waking life (Zadra et al., 2006). This study reveals that many dreams do not contain threats relevant to the dreamer; therefore, the threat simulation mechanism is not a useful or effective mechanism.

Further disconfirming evidence is found in a more recent study by Malcolm-Smith, Solms, Turnbull and Tredoux (2008). This study found that Welsh participants (living in a relatively threat-free environment) were two and a half times more likely to have dreams that contained realistic threatening events than South African participants (living in highly threatening conditions). This directly contradicts Revonsuo's third proposition and the findings of the Valli et al. (2005) study. South Africa and Wales differ significantly with respect to crime rates. This can be seen with the "extremely high levels of violent crime occurring in the Western Cape, and a very low level occurring in the UK/Wales" (Malcolm-Smith et al., 2008, p. 1284). This study also revealed that only 1.4% of South African participants' dreams contained realistic escapes and less than 1% of the Welsh participants' dreams contained realistic escapes (Malcolm-Smith et al., 2008). However, according to Revonsuo's theory, the South African participants' dreams should have contained more threatening situations and realistic escapes. This study shows the opposite trend to that predicted by the TST.

Schredl (2000) makes an important point that strongly questions the TST. He argues that classical conditioning of avoidant-type behaviours usually occurs very quickly; therefore, the need for repetition of avoidant behaviours is unnecessary (Schredl, 2000). There seems to be no logical need to have a mechanism that helps one practice a behaviour that occurs naturally and instinctively.

Critique of disconfirming evidence

Valli and Revonsuo tend to ignore or brush over the disconfirming evidence produced in some of their studies, and in other studies. Their interpretation of the evidence comes across as faulty and they usually consider the disconfirming evidence as partially supportive of the TST. For example, in the study by Valli et al. (2008) it was found that “threats are more frequent in dreams than during wakefulness” (p. 851). It was then concluded from this information that this is significant evidence for the TST and the threat simulation mechanism. This seems to be faulty reasoning as the information does not prove that the threat simulation mechanism was activated or used during the dreams. It also does not prove that dreams are specialized in the simulation of threatening events.

The results of the study with the Kurdish children and the Finnish children reveal more evidence of faulty reasoning and interpretation on the part of Valli and Revonsuo. This study indicates that only 35% of dreamers react to threatening events and it was determined that this was the most common type of response amongst dreamers (Valli et al., 2005). This evidence indicates that the threat rehearsal mechanism is, in fact, not fully activated and utilized in the dream by the dreamer. The aim of the threat rehearsal mechanism is to simulate threat-avoidance behaviours in a safe environment (the dream) and carry this information across to real-life threatening situations. However, Valli and Revonsuo argue that this evidence is partly supportive of the TST. This is not the case because the TST states that the dreamer will activate the threat simulation mechanism when he or she is experiencing a threatening event. The evidence shows that only 35% of dreamers activate the threat simulation mechanism. Therefore, there appears to be a flaw in Revonsuo’s reasoning and theory. This point seems to have been ignored by Valli and colleagues.

Another example of their faulty reasoning is from the same study. Valli and colleagues try to explain the reason for 65% of the sample not displaying a reaction to threats in their dreams. It was said that:

“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” (Valli et al., 2005, p. 206).

This seems to contradict the essence of Revonsuo's theory. The threat simulation mechanism simulates threats so that the dreamer can practice threat-avoidance techniques and behaviours. It seems implausible for a child to dream of threatening situations that are beyond the child's capabilities of solving. This was not considered as evidence that contradicted Revonsuo's theory and the authors tried instead to argue their way out of this predicament by suggesting that a more detailed analysis should be carried out.

These are just some examples of the faulty arguments Revonsuo and his colleagues present. A theory based on such faulty reasoning and misinterpretation of data is in need of revision.

Solms' alternative theory of dreaming

Solms' theory of dreaming focuses attention on a different neurobehavioural system in the brain. Solms (2000) postulates, mainly on the basis of lesion evidence (Solms, 1997) that the mechanism involved in the generation of dreams is the mesocortical/ mesolimbic dopamine system. This system is known as the 'seeking' system or the 'reward' system (Panksepp, 1998). It actively controls positive seeking and other 'approach' behaviours. Panksepp (1992) has found that the mesocortical/ mesolimbic dopamine system "mediates anticipatory incentive processes (foraging-expectancy)" (p. 557). On this basis, Solms' theory posits that dreams are not typically threatening in nature, and predicts that there is far more approach behaviour in dreams than there is avoidant behaviour. The dreamer actively seeks or approaches things in dreams instead of avoiding them. The predicted approach behaviour reflects the seeking nature of the mesocortical and mesolimbic dopamine system being activated during dreaming.

Dahan et al. (2007) discovered that dopamine neurons are highly activated during REM sleep and dreaming. It is believed that the persistence of dopamine release during REM sleep explains certain characteristics of dreaming. These characteristics include visual hallucinations, the bizarre nature of dreams and the lack of self-reflective awareness (Hobson, 2009).

Fear conditioning system vs. 'seeking' system

The fear conditioning system and the approach (seeking) system are mutually exclusive systems activating different areas of the brain and controlling opposite actions or behaviours (Panksepp, 1998). The seeking or approach system is the mesocortical/ mesolimbic dopamine system.

According to Panksepp (1992), the function of this system is to support a variety of motivated goal-seeking behaviors. In other words, this system motivates the animal to go out into the world and seek or approach things.

The fear conditioning system, by contrast, is an avoidance system (Le Doux & Schafe, 2004). This system consists of the amygdala (and surrounding areas) and controls avoidant behaviours. It has been found that the central nucleus of the amygdala, in particular, is important for behaviours such as fleeing and freezing. The amygdala generates the species-specific responses that trigger all basic defensive behaviours (Le Doux & Schafe, 2004). Toronchuk and Ellis (2007) likewise conclude that the fear system activates behaviours that cue escape from external dangers.

Provisional conclusion

The literature reveals a clear contradiction. There is much evidence to both support and disconfirm the Threat Simulation Theory. To date, however, there has been no study that has investigated the incidence of threatening content in comparison to the opposite neurobehaviour. All studies conducted on this topic only look at the incidence of threatening content in dreams. An appropriate test of Revonsuo's theory would therefore require a comparison between the proportions of dreams with threatening content versus content representing other, non-threatening basic emotional situations of biological significance. Testing this theory using the fear conditioning system and the 'seeking' system (mutually exclusive neurobehavioural systems) in the brain is an excellent way of either confirming or disconfirming Revonsuo's theory.

Aim

The present study aims to begin to evaluate the incidence of threatening dreams in these, relative terms. The incidence of threatening dreams and dreams which display the opposite neurobehavioural tendency suggested in the competing theory of Solms (2000), namely 'seeking' behaviours will be compared. It does so by looking at dream reports obtained from two differing countries - one with high levels of violence and threat (South Africa), and one with low levels of violence and threat (Wales). This study therefore constitutes a critical test of the two competing theories of Revonsuo (2000) and Solms (2000).

Hypotheses

According to Revonsuo's Threat Simulation Theory, the following hypotheses are proposed:

- (1) According to the TST, dreams are specialized in the simulation of threatening situations. Therefore, there should be more avoidant behaviour than approach behaviour in dreams.
- (2) According to the third proposition of the TST, those living in a threatening environment should experience more threatening dreams (and therefore exhibit more avoidant behaviours) than those living in a relatively threat-free environment. Therefore, those living in South Africa should display more avoidant behaviour in dreams than those living in Wales.

METHOD

Sample

This study used purposive sampling which allows for Revonsuo's TST to be directly tested. Dream reports from a country with high levels of violence, and hence more threatening situations, were used (South Africa). These dream reports were compared to dream reports obtained from a country with low levels of violence, and hence fewer threatening situations (Wales). Dream reports from South Africa were used because South Africa is renowned for its high crime rates. Statistics reflect the high level of crime and violence associated with South Africa. In 2007-, there were 18 487 homicides in South Africa (Seedat, Van Niekerk, Jewkes, Suffla, & Ratele, 2009). According to Seedat et al. (2009), nearly half of South Africa's deaths are caused by interpersonal violence, which is four and a half times the proportion worldwide. According to the same authors, these rates are primarily driven by violence (Seedat et al., 2009). The above statistics reflect the incidence of violence in South Africa and show that using dream reports from South Africans is beneficial for this study. According to Revonsuo (2000), these high levels of violence will strongly activate the threat simulation mechanism. Dream reports from Wales were used because Wales has very little crime and violence, especially in comparison with South Africa. According to Roe, Coleman and Kaiza (n.d.), there were 648 recorded accounts of homicide in Wales in the 2008-9 year. These statistics differ significantly from South Africa's 18 148 homicides. This highlights that the violence and crime in Wales is

substantially lower than that of South Africa. According to Revonsuo (2000), these low levels of violence in Wales will activate the threat simulation mechanism, but not as strongly as the South Africans' mechanism.

Participants were undergraduate psychology students from the University of Cape Town (SA) and the University of Bangor (Wales). None of the participants were familiar with Revonsuo's Threat Simulation Theory and they were not informed of the research hypotheses or aims of the study. Participation was voluntary and informed consent was obtained from the participants. Participants were told that they could withdraw from the study at any stage and that participation was not compulsory. Confidentiality and anonymity were ensured as the participants were not required to write their name on the MRD report. A total of 210 dream reports were obtained (SA= 105; Wales= 105). Domhoff (1996) ascertained that approximately 100 to 120 Most Recent Dream reports would yield a fair representation of the Hall- Van de Castle dream content norms.

Inclusion and exclusion criteria

According to Hobson, Pace- Schott, and Stickgold (2000), cited in Domhoff (2003), dream experiences require a minimum of 50 words to describe. All dream reports that were less than 50 words long were excluded. This led to a total of 210 dream reports being used.

Design

This quasi-experimental study obtained written reports of the participants' (South African and Welsh groups) dreams. The data collected from the two groups were compared to each other. This study is a critical test of two competing dream theories.

Materials

Domhoff's 'Most Recent Dream' method (MRD) was used to collect the dream reports (Hall & Van de Castle, 1966; Schneider & Domhoff, 2009). This method obtains data that is just as reliable and valid as the data collected from the REM awakenings method. The information obtained by the Hall-Van de Castle method is of the same quality and kind as the information obtained by REM awakenings (Domhoff, 1996). The 'Most Recent Dream' method requires no more than 30 minutes of the participants' time, whereas REM awakenings require the

participants to spend at least one night in a sleep laboratory. The MRD method has been used successfully in a South African context in previous years (Badenhorst, 2006; Gouse, 2004; Kinnear, 2005; Malcolm-Smith, 2002; Malcolm-Smith, 2005).

Data analysis

The data obtained by the 'Most Recent Dream' method was analyzed quantitatively. The data comparing the sample's dream behaviour was analyzed using the chi-squared goodness of fit test. This reflects the frequencies of the avoidant and approach dreams in the sample. The data comparing South African and Welsh dream behaviours was analyzed using the chi-squared test of contingency. This determines whether the behaviour experienced in dreams is contingent on the country.

Procedure

The Most Recent Dream (MRD) reports were distributed during a lecture period. The participants were asked to write down their most recent dream in as much detail as possible (see Appendix A). The dream reports were then sorted according to the inclusion and exclusion criteria mentioned above and coded by blind raters.

Operationalizing approach and avoidant behaviour

The behaviours represented in dreams were coded as either approach or avoidance behaviour. As the dreamer may exhibit both approach and avoidance behaviour during the dream, it was decided that the overarching or the predominant behaviour in the dream was coded. 'Threat avoidance' was operationalized as avoidant behaviour because the dreamer is avoiding, or moving away from, the threat in the dream. According to Revonsuo's theory, the dreamer will not approach a threat. If a threat is noted, the dreamer will freeze or move away. Any behaviour generated by the fear conditioning system was considered as avoidant behaviour. Zadra and colleagues (2006) found that in most threatening dreams "the subject is fleeing, attempting to hide, or helplessly watching" (p. 452). These examples were used to illustrate avoidant behaviour.

'Seeking' behaviours were operationalized as approach behaviours because the dreamer is actively approaching something, or showing an interest in the world around them. Behaviours

generated by the seeking system were considered as approach behaviour. All types of goal-seeking behaviour and interactions with the world were used. These are generally appetitive behaviours, like foraging (Panksepp, 1992), as the dreamer actively goes out to do something in the dream.

Raters and inter-rater reliability

Three raters were used to code the dreams. Raters were graduate students who volunteered their time. They were paid for coding the dreams. All of the raters were blind to the hypotheses of the study and the Threat Simulation Theory. The raters were given examples of what approach and avoidant behaviours were. They then judged the dream reports, deciding on whether a dream contained approach behaviour or avoidant behaviour. A dream was only coded as having either avoidant or approach behaviour. If a dream contained both behaviours, the raters were required to decide which of the behaviours was the predominant behaviour in the dream. The behaviour was then coded as such.

Following these instructions, and in order to establish inter-rater reliability, the raters were given a small sample ($n = 20$) of dream reports to individually code. These dream reports were not used in the actual study. If raters independently identified the same behaviour in a dream as either 'approach' or 'avoidance', it was considered a unanimous identification. Domhoff's (1996) percentage of perfect agreement was calculated to be 80%. This method is a stringent and specific method of calculating inter-rater reliability. All raters have to unanimously and independently produce the same coding. Once 80% inter-rater reliability was established, each rater was given 70 randomly chosen dream reports to code as predominantly representing either approach or avoidant behaviour. A total of 210 reports were accordingly coded.

RESULTS

Avoidant behaviours in dream reports

Out of the total of 210 dream reports, 27.14% ($n = 57$) were classified as containing predominantly avoidant behaviours. The data shows that 25.7% of South African dream reports contained avoidant dream reports (27 of 105) and that 28.6% of Welsh dream reports contained avoidant dream reports (30 of 105). This data indicates that South Africans experience fewer avoidant dreams, and thus threatening dreams, than the Welsh do.

Approach behaviours in dream reports

Out of a total of 210 dream reports, 72.86% ($n = 153$) were classified as containing predominantly approach behaviours. This shows that there is a high level on non-threatening content in dreams as the vast majority of dreamers approach objects or situations. The data obtained shows that 74.3% of South African dream reports contained approach behaviours (78 of 105), and that 71.2% of Welsh dream reports contained approach behaviours (75 of 105). This indicates that there is a substantial amount of approach behaviour in dreams in general. South African dream reports contained more approach behaviour than the Welsh dream reports.

Table 1.

Incidence of Approach and Avoidant Behaviours in Total, South African, and Welsh Samples

Sample	Approach Behaviour	Avoidant Behaviour
Total (%)	72.86	27.14
South Africa (%)	74.29	25.71
Wales (%)	71.43	28.57

A chi-squared goodness of fit test looking at all the approach and avoidant behaviours in the dream reports yielded a significant result, with $\chi^2_{(1)} = 43.89$, $p < 0.001$. This indicates that the behaviours experienced in dreams are not random and the data does not fit the expected pattern. Equal numbers of approach and avoidant behaviour were expected. This test shows that more approach behaviour than avoidant behaviour was experienced in the total sample of dream reports. The difference between the behaviours experienced in dreams is significant.

A chi-squared test of contingency was used to test whether the behaviour experienced during a dream is contingent on the country of the dreamer, and hence the level of threat the dreamer is exposed to. The analysis did not yield a significant result, $\chi^2_{(1)} = 0.22$, $p = 0.64$, which suggested that the behaviour in dreams is not influenced by the level of threat experienced by the dreamer. This shows that the amount of violence or threat one is exposed to does not influence the type of behaviour experienced in the dream.

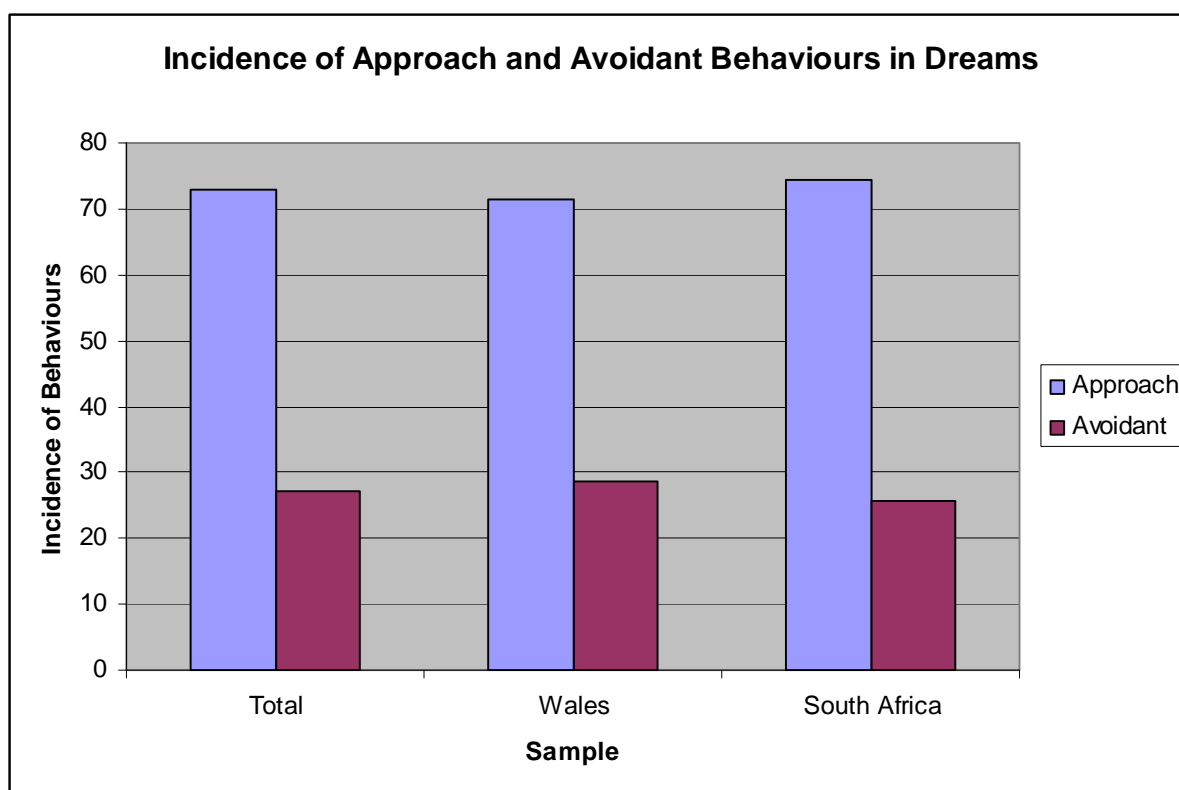


Figure 1. Incidence of Approach and Avoidant Behaviours in Dream Samples

DISCUSSION

Previous attempts to test Revonsuo's Threat Simulation Theory have provided both confirming and disconfirming evidence. The aim of this study was to evaluate the incidence of threatening content (avoidant behaviour) and non-threatening content (approach behaviour) in a sample of dream reports. Seeking behaviours were operationalized as any approach behaviour. Some examples of behaviours activated by this system are: moving towards an object, seeking a solution, displaying an interest in something, etc. Threat avoidance was operationalized as any avoidant behavior. Some examples of behaviours activated by this system are: the freeze/flee response, running or moving away from an object, or avoiding a person, etc.

Evidence against Revonsuo's TST

This study has found that there is far more approach behaviour experienced during dreams than there is avoidant behaviour. The chi-squared goodness of fit test indicated a significant difference between the approach and avoidant behaviours in the total sample of dreams, with $\chi^2_{(1)}$

= 43.89, $p < 0.001$. Closer inspection of the data illustrated that almost three quarters (72.86%) of the total sample of dreams contained approach behaviour. These data also show that there is far less avoidant behaviour experienced in dreams (27.14%), when compared to approach behaviours (72.86%). The chi-squared test of contingency revealed that levels of violence or exposure to threat do not have an effect on this aspect of dream content, $\chi^2_{(1)} = 0.22$, $p = 0.64$. This result is not significant. Dream reports did not contain more threatening content, and therefore more avoidant behaviour, in a sample exposed to large amounts of threat (country with high levels of violence and threat). This can be seen when the dream reports from South Africans were compared to the dream reports of the Welsh. Revonsuo's theory asserts that more avoidant behaviour will be experienced during dreams. This is due to the fear conditioning system (threat simulation mechanism) being activated. The present study indicates that this is not so. The 'seeking' system is evidently activated far more often than the fear conditioning system. This can be inferred from the vast amount of approach behaviours being exhibited during dreams. Other studies have shown the same trend (Malcolm-Smith & Solms, 2004; Malcolm-Smith, 2005; Malcolm-Smith et al., 2008).

This study shows similar findings to that of the Malcolm-Smith and Solms (2004) study. Both studies have found that the incidence of threat in dreams was lower than predicted by Revonsuo's theory. They also revealed that the vast majority of dreamers do not dream of threatening events and display avoidant behaviour. There is also little evidence showing that the threat simulation mechanism is being activated during these dreams.

The present study contradicts the study conducted by Valli et al. (2005). Their study indicated that the threat simulation mechanism was highly activated in children living in threatening environments. The present study contradicts this finding, as South African dreamers (living in a highly threatening environment) displayed more approach behaviour and hence, they experienced fewer threatening dreams. The information obtained by the present study also contradicts findings from the Revonsuo and Valli (2008) study. Their study indicated that there was an overrepresentation of threatening content in dreams. The present study found the opposite trend to be true. There was far less avoidant behaviour, and hence threatening content in the total sample of dreams. It is important to note in this regard that the incidence of avoidant behaviour in all previous studies was not compared to any alternative behaviour. This made it difficult to

determine objectively whether the incidence of threat-avoidance in dreams was objectively 'high' or 'low'.

The results of the present study indicate that less avoidant behaviour is experienced in dreams than approach behaviour ($\chi^2_{(1)} = 43.89, p < 0.001$). This is direct evidence to the contrary of Revonsuo's TST. The results of the chi-square test of contingency also provide evidence that contradicts Revonsuo's third proposition. These results indicate that the behaviour experienced during dreams is not dependent on the levels of violence experienced in a country. The test showed that any such difference was non-significant, with $\chi^2_{(1)} = 0.22, p = 0.64$. This information shows that threatening circumstances do not affect dream content. Living in threatening circumstances or a threatening country do not cause the dreamer to have threatening dreams or display avoidant behaviours in the dream, in comparison to approach behaviours. Whether one displays approach or avoidant behaviours in dreams is not dependent on the threatening conditions one lives in or is exposed to.

The information obtained from the present study does not support Revonsuo's second and third propositions, the central propositions of his theory (Revonsuo & Valli, 2008). The second proposition states that the "dream experience is specialized in the simulation of threatening events" (Revonsuo, 2000, p. 883), while the third proposition states that "encountering real threats during waking has a powerful effect on subsequent dream content: real threats activate the threat simulation mechanism" (Revonsuo, 2000, p. 887). Analysis of the data does not produce evidence of TST being accurate and a functional and adaptive theory. For example, according to Revonsuo's theory, the South African dreamers' threat simulation mechanism should be more activated than that of the Welsh. South Africans should experience more threatening dreams and display more avoidant behaviour than the Welsh display. This study contradicts this proposition. The data shows that South Africans experienced fewer traumatic dreams and displayed less avoidant behaviour than the Welsh displayed. It was found that only 25.7% of South African dreams contained avoidant behaviour, and 28.6% of Welsh dreams contained avoidant behaviour. Although this is a small difference between the two countries (2.9%) it indicates that, if anything, there is less avoidant behaviour experienced in South African dreams.

This study shows that, although dreams do contain negative emotions and content (Domhoff, 1996), dreams are not specialized to simulate threatening events. The data also show

that traumatic experiences and conditions do not necessarily influence dream content and behaviour.

Evidence for Solms' dreaming theory

The evidence obtained from the present study provides support for Solms' competing theory of dreaming. Solms argues that the dream generating mechanism is the mesocortical/mesolimbic dopamine system. This system activates and mediates goal-seeking (Panksepp, 1992) and approach behaviours. With a substantial amount of the total dream reports containing approach behaviour (72.86%), it seems reasonable to infer that the mesocortical/mesolimbic dopamine system is highly activated during dreaming. This system mediates and activates the approach behaviours experienced by the sample of dreamers. This study supports evidence of the dopamine neurons are indeed activated during REM sleep and dreaming, as argued by Dahan et al. (2007).

The established inter-rater reliability was adequate, with unanimous agreement being 80%. The Most Recent Dream method has the same reliability and validity as REM awakenings and this method obtains the same information as REM awakenings (Domhoff, 1996). Both the method and inter-rater reliability were accurate enough for this study.

Limitations

This study used a fairly small sample size when compared to other studies (e.g. Malcolm-Smith & Solms, 2004; Valli et al., 2008). Although the sample of each country ($n= 105$) was within the range suggested by Domhoff (1996), a larger sample from each country would be more representative of the populations in the country.

CONCLUSION

Revonsuo's Threat Simulation Theory asserts that dreamers generate threatening content in order to practice the appropriate threat-avoidance skills and behaviours, in order to carry across the information to real-life threatening situations. According to this theory, there will be substantial threat-avoidance behaviour during dreams due to the threat simulation mechanism (fear conditioning system) being activated. The substantial amount of approach behaviour experienced

in dreams provides further evidence for Solms' (2000) dreaming theory. This theory predicted that there would be a greater amount of approach behaviour represented in dreams than avoidant behaviour.

This study has disproved the central propositions Revonsuo's Threat Simulation Theory. Revision of this theory is in order as the two central propositions have been refuted by this study. This study has shown that there is an overwhelming difference between the incidence of approach and avoidant behaviour being represented in dreams. It has shown that there is substantial approach behaviour being represented in dreams, and comparatively less avoidant behaviour. Furthermore, this study has also shown that there is a small difference between the behaviours experienced by South African and Welsh dreamers. It has been established that South African dreamers generate substantially more approach behaviours in dreams when compared to avoidant behaviours. South African dreamers also experience more approach dreams than the Welsh dreamers. This shows the opposite tendencies as explained in the TST. This study joins the ever growing body of disconfirming evidence for Revonsuo's Threat Simulation Theory and suggests that the theory needs to be revised.

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APPENDIX A**Hall- Van de Castle 'Most Recent Dream' test**

What was the date (approx) when you had this dream? _____

Please write down the last dream you remember having, whether it was last night, last week or last month. Please describe the dream exactly, and as fully as you can remember. Your report should contain, whenever possible, a description of the setting and people (or animals, objects, etc). If possible, describe your feelings during the dream. Tell exactly what happened during the dream, even if it doesn't make sense or seems bizarre. Continue on the other side of the page if necessary.

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