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Hypnagogic and Hypnopompic Hallucinations during Sleep Paralysis: Neurological and Cultural Construction of the Night-Mare

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Hypnagogic and hypnopompic experiences (HHEs) accompanying sleep paralysis (SP) are often cited as sources of accounts of supernatural nocturnal assaults and paranormal experiences. Descriptions of such experiences are remarkably consistent across time and cultures and consistent also with known mechanisms of REM states. A three-factor structural model of HHEs based on their relations both to cultural narratives and REM neurophysiology is developed and tested with several large samples. One factor, labeled *Intruder,* consisting of sensed presence, fear, and auditory and visual hallucinations, is conjectured to originate in a hypervigilant state initiated in the midbrain. Another factor, *Incubus,* comprising pressure on the chest, breathing difficulties, and pain, is attributed to effects of hyperpolarization of motoneurons on perceptions of respiration. These two factors have in common an implied alien ''other'' consistent with occult narratives identified in numerous contemporary and historical cultures. A third factor, labeled *Unusual Bodily Experiences,* consisting of floating/flying sensations, out-of-body experiences, and feelings of bliss, is related to physically impossible experiences generated by conflicts of endogenous and exogenous activation related to body position, orientation, and movement. Implications of this last factor for understanding of orientational primacy in self-consciousness are considered. Central features of the model developed here are consistent with recent work on hallucinations associated with hypnosis and schizophrenia. © 1999 Academic Press

Isolated Sleep Paralysis (SP) is a relatively common phenomenon that constitutes a unique natural laboratory for the study of hallucinoid experiences. SP is a transient, conscious state of involuntary immobility occurring immediately prior to falling asleep or upon wakening and is classified as a parasomnia associated with REM (ASDA, 1990). Although individuals are unable to make gross bodily movements during SP they are able to open their eyes and subsequently to report accurately on events in their surroundings during the episode (Hishikawa & Kaneko, 1965). Approximately 25 to 40% of people report some SP experience (Cheyne, Newby-Clark, & Rueffer, in press; Fukuda, Ogilvie, Chilcott, Vendittelli, & Takeuchi, 1998; Spanos, McNulty, DuBreuil, Pires, & Burgess, 1995), although the incidence may vary across cultures (Fukuda, Miyasita, & Ishihara, 1987; Ness, 1978). The variability in reported incidence of SP results, in part, from the use of different criteria across

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studies and frequent use of small samples (Cheyne, Newby-Clark, & Rueffer, in press). SP has traditionally been linked with narcolepsy and cataplexy as part of the ‘‘narcoleptic tetrad,’’ but is considerably more common than the latter disorders, the incidence of which range from .03 to .16% (Hishikawa & Shimizu, 1995).

A number of anomalous sensory experiences frequently accompany SP. In the present study, these are referred to, collectively, as hypnagogic and hypnopompic experiences (HHEs). The HHEs include an acute sense of a monitoring ‘‘evil presence,’’ combinations of auditory and visual hallucinations, pressure on the chest, as well as suffocating, choking, floating, out-of-body, and flying sensations (Hishikawa, 1976; Hufford, 1982). Although these experiences bear some similarity to non-SP-related pre- and postdormital hypnagogic images and sensations (Foulkes & Vogel, 1965; Mavromatis, 1987; Rowley, Stickgold, & Hobson, 1998; Schacter, 1976), HHEs accompanying SP appear to be substantially more vivid, elaborate, multimodal, and terrifying (Hufford, 1982; Takeuchi, Miyasita, Inugami, Sasaki, & Fukuda, 1994).

It has been conjectured that complex combinations of SP-related HHEs form the basis of diverse worldwide cultural accounts of nocturnal incubus/succubus assaults, spirit possessions, old hag attacks, ghostly visitations, and alien abductions (Adler, 1994; Bloom & Gelardin, 1976; Firestone, 1985; Fukuda, 1989; Hufford, 1976, 1982; Liddon, 1967; Ness, 1978; Wing, Lee, & Chen, 1994). In these accounts, a dreadful and evil presence in the form of a vampiric lamia, demon, spirit, or hag sits on the victim’s chest and smothers or chokes the helpless sleeper. Some of the better-known historical references, in Western culture, to spirits of this sort are Greek—*pan-ephialtes* (pan who leaps upon), *graia*, and *mora* (monster, ogre, spirit, etc.); Roman—*incubus* (one who presses or crushes) and *lamia;* German—*mar/mare, hexendrücken* (witch pressing), and *Alpdruck* (elf pressure); Czech—*muera;* Polish—*zmora;* Russian—*kikimora;* French—*cauchemar;* Old English—*maere* and *hagge;* Old Norse—*mara;* Old Irish—*mar/more;* and Spanish—*pesadilla* (Kiessling, 1977; Leinweber, 1994; Hufford, 1982; Roscher, 1979; Russell, 1995; Simpson & Weiner, 1989). Given the many variants of the term *mare* in this list, it is not surprising that some authors have argued that SP with HHEs constitutes the original referent of the term ‘‘nightmare,’’ which has become conflated with anxiety dreams in modern usage (Hufford, 1976, 1982; Liddon, 1967). To avoid confusion with the modern use of the term, we will use the term night-mare, with a hyphen, to designate SP with HHEs.

Despite cultural variations in beliefs about the provenance and meaning of the night-mare, the consistencies in the fundamental experience across time and locale are consonant with what has been called the experiential-source hypothesis for the origins of folklore and legend (Hufford, 1982, 1988; McLenon, 1994). The essence of the experiential source hypothesis is that cultural accounts of supernatural and paranormal events are not cut from whole cloth as metaphysical allegories and metaphors, but are coherence rendering construals of concrete human experiences. On this view, a deeper understanding of such legends rests, in part, upon a more thorough understanding of the structure of their experiential basis.

In the present paper we set ourselves two tasks. We review evidence that SP is a REM state and argue that virtually all HHEs can be related to specific physiological conditions identified for REM. We argue further that clusters of HHEs lend themselves to interpretation by specific evolutionarily relevant scenarios, or micronarratives, that render meaningful the REM induced sensory experiences.

SP AND REM

It is well established that sleep consists of two distinct states: REM and NREM (Aserinsky & Kleitman, 1953; Jouvet, 1967). These two sleep states, plus waking, constitute three major states of consciousness (Coenen, 1998; Hobson & Stickgold, 1994). Dreaming is more common and vivid during REM than during NREM sleep (Dement & Kleitman, 1957). In addition to the characteristic desynchronized cortical low-voltage fast EEG activity, there are numerous physiological, behavioral, and sensory features associated with REM, such as muscle atonia, partial gating of sensory input, rapid eye and middle ear movements, as well as heart rate and respiration changes (Carskadon & Dement, 1994; Symons, 1993).

SP has been experimentally linked to REM states, particularly with sleep-onset and sleep-offset REM (Hishikawa & Kaneko, 1965; Nan'no, Hishikawa, & Koida, 1970). Hishikawa and Shimizu (1995) speculate that SP may be produced by hyperactivation of cholinoceptive and/or cholinergic Sleep-on neural populations or, they deem more likely, hypoactivation of noradrenergic or serotonergic Sleep-off populations in the pons. Thus, SP may reflect an anomaly of the functioning of the monoaminergic systems and/or their inhibition of cholinergic systems (Hishikawa & Shimizu, 1995). Sensory thresholds for awakening are relatively high during REM, suggesting that there may be, at best, weak and inconsistent cortical sensory processing during REM (Llinás & Paré, 1991). REM associated with the night-mare, however, appears to differ from dream-related REM in that there is little or no blocking of exteroceptive stimulation and no loss of waking consciousness (Hishikawa, 1976; Hishikawa & Kaneko, 1965). In any case, the throughput of sensory information along thalamocortical pathways during REM may be quite variable and, at times, exceed that during waking states (Inoue, Duysens, Vosser, & Coenen, 1993; van Hulzen & Coenen, 1984). During phasic SP, periods of high thalamic ''transfer ratio'' (Coenen & Vendrick, 1972) may result in high levels of both exteroceptive input and quasi-random activation originating in the brain stem. A major and distinctive feature of SP, we will argue, is the anomalous combination of high levels of exogenous and endogenous sources of cortical activation. Finally, the immobility of SP is also consistent with the general atonia maintained during REM by marked and sustained hyperpolarization of the spinal motoneurons (Chase & Morales, 1989).

HHES AND REM

A major function of central nervous system activity, and perhaps most particularly of reciprocal thalamocortical and amygdalocortical interactions, is the generation of coherence and meaning. Such coherence may be accomplished with or without sensory input (Llinás & Paré, 1991) or, alternatively, with input of either exogenous origins or of endogenous sources that mimic exogenous input (Hobson & McCarley, 1977). SP constitutes an anomalous REM state involving complex combinations of endogenous and exogenous inputs that create particularly challenging conditions for coherent and meaningful interpretation. These combinations are not entirely random, however, their patterning being constrained by preexisting predispositions of the brain to be active in particular ways (Llinás & Paré, 1991).

The present model of SP and associated HHEs is an extension of the activation-synthesis theory of dreaming (Hobsosn & McCarley, 1977; McCarley & Hobson, 1979). According to that theory, REM is initiated via inhibitory activity of the REM-off cells. These brain-stem mechanisms inhibit motor output and sensory input and provide the cortex with internally generated activation. A major function of the cortical centers is one of synthesizing quasi-random activation into meaningful patterns.

We have previously presented evidence of significant associations among a subset of HHEs consistent with an imagined threatening person or entity nearby (Cheyne, Newby-Clark, & Rueffer, in press). Further analyses suggested that the major initiating event of such hallucinations is the experience of a sensed presence accompanied by intense fear. We argued that when the SP episode persists, the presence motivates continuing efforts at disambiguation and increasingly elaborate interpretations of other HHEs, consistent with external threat, arising endogenously, via pontine-driven oculomotor or middle ear activity, or exogenously, as shadows and ambient sounds. Such sensations are frequently interpreted as approaching footsteps, whispering voices, or apparitions that are taken to be concrete instantiations of the threatening presence. The resulting cluster of presence, fear, and auditory and visual experiences is consistent with limbic mechanisms underlying responses to predation (e.g., Ledoux, 1996) and with a narrative of stalking and threat of attack.

Additional HHEs associated with SP include experiences consistent with traditional accounts of the Old Hag or incubus attack described earlier, in which a creature is perceived to sit on the chest while strangling the sleeper. Hishikawa and Shimizu (1995) point out that the motor paralysis of REM will lead to the experience of breathing difficulties when the person attempts to breathe deeply, sometimes experienced as choking or suffocating sensations. The inability to breathe deeply may also be interpreted, we suggest, as being caused by a weight or pressure on the chest. Thus, we hypothesize that there is a cascading series of events initiated by motor inhibition leading to experiences of breathing difficulties, thoracic pressure, and ultimately of physical assault, possibly involving pain, consistent with the traditional accounts of the incubus or Old Hag. These experiences share with the previous cluster of intruder-related experiences the notion of the possible role of an external agent. We therefore hypothesize further that these two sets of experiences will be positively associated.

In contrast to the experiences centered on sensed presence or pressure, other HHEs, such as floating and out-of-body experiences, do not necessarily imply threatening external agency but are intimately associated with bodily orientation and movement in space. We hypothesize that these two experiences will be closely associated with one another but are unlikely to be strongly associated with the two previously discussed sets of experiences. In summary, we argue that the HHEs associated with SP can be organized into groupings consistent with both underlying neurophysiology and phenomenologically meaningful scenarios. Both of these will influence the occurrence, selection, and organization of experiences that will be reflected, in the subsequent reporting of the experiences, as separate groupings of experiences or factors.

STUDY 1: EXPLORING THE STRUCTURE OF HHES

Method

Student Sample

The Waterloo Unusual Sensory Experiences Survey (Cheyne, Newby-Clark, & Rueffer, in press) was administered to 1273 (815 females, 458 males) undergraduates in several introductory psychology classes. An initial question asked participants if they had ever experienced a brief period of immobility immediately prior to falling asleep or upon awakening (1) Never, (2) Once, (3) Two to five times, or (4) More than five times. Participants who indicated they had experienced SP at least once were instructed to answer additional questions (see Cheyne, Newby-Clark, & Rueffer, in press, for discussion of methodological issues in assessing components of complex experiences). Using the same metric, participants indicated whether they: experienced a sensed presence, felt pressure on their chest or other body part, felt any pain associated with the experience, experienced fear, saw a form or shape, heard sounds, experienced breathing difficulties, felt like they were floating, or experienced out-of-body sensations. To determine the vividness and clarity of the hallucinoid experiences, we asked participants to rate the intensity of these experiences on a seven-point Likert scale. The questionnaire contained items addressing more peripheral experiences, including whether or not participants were able to open their eyes, sleeping position, secondary emotions, as well as basic demographic information. Space was provided for respondents to describe the experiences in their own words.

WWW Sample

A web version of the survey was placed on the WWW. The items were the same as those described for the student sample except for an item referring to feeling of ‘‘bliss’’ included in the web version. This latter item was added because a small subset of participants in earlier work suggested that, rather than experiencing the intense fear reported by many, they found the experience spiritually enjoyable and even ‘‘blissful.’’ Participants responded to items by clicking on radio buttons and checkboxes. Text boxes were also provided for respondents to add comments and leave e-mail addresses for follow-up questions and clarification. The Study 1 data from the web survey were collected from September 1997 through May 1998.

Results

Initial Analyses

Student sample. SP experiences were reported by 360 (28.4%) of the 1273 students surveyed. Women were significantly more likely to report SP (32.4%) than were men (21.4%), $\chi^2(1, N = 273) = 17.42$, $p < .001$. No age associations or sex differences were found for intensity of any of the HHEs. Eye opening and sleeping position were unrelated to HHEs and are not discussed in this report. All tests of significance for tests involving HHEs were Bonferroni corrected.

WWW sample. The web survey yielded responses from 220 women and 173 men. Participants in the WWW sample were also asked to indicate how long it had been

TABLE 1
Means and Standard Deviations of Intensity Measures of HHEs for the Two Samples in Study 1

	Sample			
	Student[a]		WWW[b]	
HHE	*M*	*SD*	*M*	*SD*
Sensed presence[c]	1.79	2.40	4.35	2.85
Fear[c]	3.33	2.65	6.06	1.69
Auditory hallucinations[c]	1.74	2.33	3.50	3.09
Visual hallucinations[c]	1.35	2.24	2.96	3.04
Floating[c]	2.19	2.49	2.52	2.91
Out-of-body[c]	0.98	1.99	1.97	2.93
Bliss[d]	—	—	1.03	2.18
Breathing[c]	0.54	1.52	2.87	2.85
Pressure[c]	2.11	2.47	3.91	3.05
Pain	1.28	2.08	1.50	2.47

[a] $N = 360$.
[b] $N = 392$.
[c] Sample means differ significantly at $p < .05$.
[d] Not assessed in student sample.

since their last episode. A substantial majority (64%) reported their last SP experience to have occurred within the previous month, 16% reported SP within the last 24 h, and 12% reported their last SP episode occurring over 1 year ago. There were no age or sex differences for the reported intensity of any of the HHEs. Eye opening and sleeping position were unrelated to HHEs. Tests of significance were Bonferroni corrected.

Sample differences. A 2 (sample) × 2 (sex) ANOVA with age as the dependent variable revealed that the WWW sample was significantly and substantially older ($M = 28.40$, $SD = 11.71$), $F(1, 743) = 171.92$, $p < .001$, and more variable in age, $t(750) = 13.69$, $p < .001$ (Levene, 1960), than the student sample ($M = 18.91$, $SD = 5.74$). The women were significantly older ($M = 30.14$, $SD = 11.21$) than the men ($M = 26.21$, $SD = 12.00$), only for the WWW sample, $t(382) = 3.30$, $p < .001$).

A 2 (sample) × 2 (sex) MANOVA was conducted with intensity ratings of the nine HHEs as dependent variables. The only significant multivariate effect was that of sample, $F(9, 731) = 40.72$, $p < .001$. Univariate *F* ratios revealed that means for the WWW sample were greater than those for the student sample for all HHEs except pain (see Table 1).

Exploratory Factor Analysis

Student and WWW samples. Separate factor analyses were conducted on intensity ratings for all HHEs for each of the samples. Eigenvalue-greater-than-one and scree plot criteria from the principal components analyses suggested three-factor solutions for both samples. Varimax rotation generated three orthogonal factors each accounting for 15–20% of the total variance for both samples. The factor structure and order-

TABLE 2
Factor Loadings for HHEs and Factor Variance Percentages for WWW and Student Samples

	Sample					
	Student[a]			WWW[b]		
HHE	*Intruder*	*Unusual Bodily Experiences*	*Incubus*	*Intruder*	*Unusual Bodily Experiences*	*Incubus*
Sensed presence	**.81**	.21	.07	**.79**	.18	.05
Fear	**.71**	−0.06	.25	**.68**	−0.10	.11
Auditory hallucinations	**.62**	.17	.27	**.64**	.24	.08
Visual hallucinations	**.76**	.18	−0.08	**.61**	.25	.15
Floating	.15	**.78**	.05	.17	**.84**	.07
Out-of-body	.17	**.78**	.19	.15	**.84**	.09
Breathing	.00	.30	**.66**	.04	−0.15	**.82**
Pressure	.15	.38	**.63**	.33	.16	**.62**
Pain	.16	−0.15	**.76**	.13	.26	**.60**
% Variance	24.82	17.68	17.61	22.47	18.71	16.34

[a] $N = 360$.
[b] $N = 392$.

ing of the factors was very similar for the two samples (see Table 2). The first factor consisted of sensed presence, fear, and auditory and visual hallucinations and was labeled *Intruder*. The second factor comprised floating sensations and out-of-body experiences and was labeled *Unusual Bodily Experiences.* The third factor comprised feelings of pressure on the chest, breathing difficulties, and pain and was labeled *Incubus*. Parallel analyses carried out for both student and WWW samples combined, as well as for females and males separately, generated the same factor structure. The only difference was a reversal in the order of the *Incubus* and *Unusual Bodily Experiences* factors for females. The same results were produced using principal axis factoring.

WWW sample: bliss. We repeated the principal components analysis for the WWW sample with the added variable of bliss. Results for the entire sample as well as females and males separately produced a three-factor solution suggested by eigenvalue-greater-than-one and scree plot criteria. The factors replicated those from the first set of analyses and bliss loaded most strongly on the *Unusual Bodily Experiences* factor (see Table 3). To determine whether time between the experience and reporting introduced any systematic bias, separate analyses were conducted for participants who had experienced SP within the last month and those for whom more time had passed. The factor structure in Table 3 was replicated in both cases.

STUDY 2: TESTING THE THREE-FACTOR MODEL OF HHES

Although the results of the exploratory factor analysis were highly consistent, we sought to conduct a more rigorous test of the three-factor model and to pursue the hypothesis regarding the association between the *Intruder* and *Incubus* items. Common criticisms of exploratory factor analysis include the fact that criteria for extrac-

TABLE 3
Factor Loadings for HHEs, Including Bliss, and Factor Variance Percentages for Females and Males: WWW Sample

	Gender					
	Females[a]			Males[b]		
HHE	*Intruder*	*Unusual Bodily Experiences*	*Incubus*	*Intruder*	*Unusual Bodily Experiences*	*Incubus*
Sensed presence	**.79**	.24	.06	**.82**	−0.01	.13
Fear	**.64**	−0.17	.21	**.63**	.09	−0.10
Auditory hallucinations	**.70**	.14	−0.06	**.60**	.29	.12
Visual hallucinations	**.55**	.25	.17	**.61**	.28	−0.08
Floating	.17	**.78**	.07	.29	**.74**	.01
Out-of-body	.23	**.74**	.17	.23	**.77**	−0.10
Bliss	.07	**.74**	−0.10	.04	**.61**	.28
Breathing	−0.04	−0.21	**.75**	.05	.03	**.84**
Pressure	.28	.16	**.65**	.43	.05	**.62**
Pain	.11	.14	**.62**	.11	.48	**.49**
% Variance	20.08	19.62	14.92	21.41	19.17	14.88

[a] $N = 213$.
[b] $N = 171$.

tion of factors are arbitrary and inexact and that the procedure does not permit a test of the final solution achieved (Briggs & Cheek, 1986; Mulaik, 1975). In confirmatory factor analysis, a direct solution is applied to a data set based on an identified a priori model. This model may then be tested against alternative models. Confirmatory factor analysis also permitted us to specify correlated factors for some of the models.

Method

To test the three-factor model of HHEs identified in the exploratory factor analysis, and to examine relations among the three factors, a second WWW sample was collected from June 1998 through January 1999. The data from this sample were submitted to a confirmatory factor analysis: first, to test the relative improvement of the specified three-factor model over a more parsimonious single factor model, and second, to assess the improvement, if any, in fit of a model that included correlations between factors, particularly between the *Intruder* and *Incubus* factors.

Results

Initial Analyses

The basic sample characteristics were very similar to those of the first WWW sample. The sample yielded responses from 262 women and 197 men. Information regarding age was provided by 214 women and 160 men. The mean age of females, $M = 30.84$, $SD = 10.08$, was slightly but significantly greater, $t(372) = 2.49$, $p < .01$, than that of males ($M = 28.26$, $SD = 9.71$). A majority (61%) reported their last SP experience to have occurred within the last month, 17% reported experiencing

TABLE 4
A. Fit Indices for CFA Models of HHEs Associated with Sleep Paralysis

Model	χ^2	*df*	GFI	RMSEA	χ^2_{diff}	*p*
Model 1. One Factor	271.51	35	.88	.12	—	.01
Model 2. Three Factors	183.01	35	.92	.10	—	.01
Model 3. Two correlated factors	109.85	34	.95	.07	—	.01
Model 2–Model 3	—	1	—	—	73.16	.01
4. Three correlated factors	79.94	32	.97	.06	—	.01
Model 3–Model 4	—	2	—	—	29.91	.01

B. Correlations among Three Factors for Model 4

	Unusual Bodily Experiences	*Incubus*
Intruder	.37	.64
Unusual Bodily Experiences		.34

Note. GFI, goodness-of-fit index; RMSEA, root mean square error.

SP within the previous 24 h, and 14% reported that more than 1 year had passed since experiencing SP. There were no significant correlations between age and intensity of any HHE and Bonferroni *t* tests revealed no sex differences. The means and standard deviations of intensity of each of the HHEs correspond quite closely to those obtained for the first WWW sample (see Table 5, column 1).

Confirmatory Factor Analysis

WWW sample. The data from the 407 respondents were subjected to a series of confirmatory factor analyses assessing a variety of related models. The first model tested (Model 1 in Table 4A) was one assuming a single underlying factor (although factors are referred to as ''latent variables'' in structural equation model terminology, to avoid a confusing switch in terminology we will continue to refer to these by the older term). This model produced very poor fit indices (χ^2, GFI, and RMSEA). The χ^2 is, however, exceedingly dependent on sample size and is not a good guide with large samples (Judd, Jessor, & Donovan, 1986). Nonetheless, the standard goodness-of-fit index (GFI) was below .90 and the root mean square error (RMSEA) was unacceptably high. Less than .90 for the former index and above .10 for the latter are considered to indicate a very poor fit (Kline, 1998). Model 2 represents the (independent) three-factor structure produced by the exploratory factor analysis in Study 1 with the added constraint that the variance of each of the items is uniquely determined by one factor (i.e., there are no cross-loadings permitted as in exploratory factor analysis). Although these first two models are not nested, and hence not amenable to direct statistical comparison, it is clear that the χ^2, though still large, is substantially reduced for the three-factor model, the GFI is acceptable, and the RMSEA is marginally acceptable. Model 3 removes the constraint that the *Intruder* and *Incubus* factors are uncorrelated. This model further reduces the χ^2 and, because Model 3 is nested within Model 2, it was possible to test the improvement in fit of Model 3 over Model

TABLE 5
Means, (Standard Deviations), Standardized and Unstandardized Factor Loadings, and Standard Errors for the Correlated Three-Factor Confirmatory Factor Model of HHEs

	Mean (*SD*)	Standardized factor loading	Unstandardized factor loading[a]	*SE*
Intruder				
Sensed presence	4.29 (2.86)	.73	1.00	---
Fear	5.97 (1.82)	.51	.44	.05
Auditory hallucinations	3.37 (2.99)	.47	.67	.09
Visual hallucinations	2.71 (3.02)	.52	.75	.09
Incubus				
Breathing	3.07 (2.89)	.39	1.00	---
Pressure	3.73 (3.02)	.68	1.83	.34
Pain	1.46 (2.44)	.41	.90	.18
Unusual Bodily Experiences				
Floating	2.31 (2.79)	.78	1.00	---
Out-of-body	1.74 (2.77)	.72	.92	.11
Bliss	.99 (2.13)	.42	.41	.06

Note. $N = 407$. Dashed line indicates regression coefficient not tested (*SE* = standard error of loading).
[a] All testable factor loadings are significant.

2. This test resulted in a significant χ^2 (see Model 2–Model 3, Table 4A) indicating that allowing this correlation produced a substantial improvement in fit. Moreover, the GFI and RMSEA for Model 3 are both well within the acceptable range. The final model tested was one in which all three factors were allowed to be correlated. This produced a further and significant improvement in fit, although the resulting χ^2 is only half of that for the first comparison (and with 2 *df* rather than 1). This model produced very acceptable GFI and RMSEA values. Factor loadings for Model 4 are presented in Table 5.

The test of Model 4 produced estimates for the covariances among the three factors. The standardized covariances (correlations) among these are presented in Table 4B. As expected the highest correlation was between *Intruder* and *Incubus*, although all three correlations were significant and positive. More relevant to the present study, the correlation between *Intruder* and *Incubus* was significantly greater than the correlations between *Intruder* and *Unusual Bodily Experiences*, $t(458) = 6.45$, $p < .01$, and *Incubus* and *Unusual Bodily Experiences*, $t(458) = 7.29$, $p < .01$. The latter two correlations did not differ significantly from one another. These results are consistent with the notion that *Intruder* and *Incubus* together constitute a superordinate factor consistent with a narrative of nocturnal assault by a malevolent agent.

Discussion

The reported incidence of SP among the student sample was consistent with proportions reported in recent comparable studies (Cheyne, Newby-Clark, & Rueffer, in press; Spanos, McNulty, DuBreuil, Pires, & Burgess, 1995). Participants from the WWW sample reported that they were much more frightened by the experience than were those from the student sample. Indeed, a majority of WWW respondents (64%)

gave this item the maximum rating in both WWW samples. The strong affective response was further underscored by numerous spontaneous comments to the effect that the word ‘‘fear’’ did not do justice to the abject terror associated with the experience. Although less extreme than for fear, sample differences were found in the intensity ratings for all HHEs. This pattern suggests that those more troubled by the experience are more likely to search for information about their experiences. In contrast to members of traditional cultures (Adler, 1994; Bloom & Gelardin, 1976; Hufford, 1982; Ness, 1978), few of the respondents from either sample indicated that they had heard of any account of the phenomenon, scientific or traditional, prior to having the experience. Moreover, many of the WWW respondents had learned of the term ‘‘sleep paralysis’’ just before beginning their web search leading them to our site. Many respondents expressed astonishment and relief when they encountered many of the questions because they had previously assumed that their experiences were unique.

There were significant and substantial sample differences in age, sex composition, and reported intensity of HHEs, as well as in motivation and vested interest in understanding the phenomenon. Despite these differences and the relative cultural and scientific vacuum in which most participants in both samples experienced night-mares, the similarity and robustness of the factor structure across samples and in the replication using confirmatory methods was remarkable.

Sensed presence, fear, and auditory and visual hallucinations consistently combined to produce the first factor. We suggest that the experience of the *Intruder* begins with brain-stem-induced amygdaloid activation producing a hypervigilant state (Eysenck, 1992; Ledoux, 1996; Rosen & Schulkin, 1998) in which detection thresholds are lowered and biased toward cues for threat or danger. The pervasiveness of fear and sensed presence in the phenomenology of SP suggests that the role of the amygdala is central in understanding the night-mare. Recently, moreover, evidence from neuroimaging studies with humans has highlighted the significance of limbic structures for REM dreams (Hobson, Stickgold, & Pace-Schott, 1998). In particular, significant activation in the amygdaloid complex and anterior cingulate during REM dreams has been reported (Maquet et al., 1996). The anterior cingulate has the most extensive cortical connections of any cortical area with the amygdaloid complex, is strongly implicated in emotional experience, and appears to serve as an interface between attention and affect (Devinsky, Morrell, & Vogt, 1995). We suggest that the experience of a threatening presence during SP is associated with thalamic projections to the amygdala and/or interactions among the amygdaloid complex, anterior cingulate, and structures in the pontine tegmentum. During REM, bursts of activation originating in the brain stem pass through the thalamus, which has direct projections not only to specific cortical areas but also to the amygdala (Charney, Grillon, & Bremner, 1998; Ledoux, 1994). The subcortical thalamoamygdala pathway provides a coarse-grained analysis of stimuli sufficient to ensure that dangerous or threatening events are responded to with emergency reactions without the delay of detailed analysis via the sensory cortex (Ledoux, 1994, 1996). In normal emergency fear reactions the immediate sensing of danger is quickly confirmed or disconfirmed. Reciprocal projections to the polymodal association cortex directly from the amygdala enhance analysis of critical features of the threatening stimulus and corroborate the nature and seriousness of the threat (Ledoux, 1994). In the absence of exogenous origins, attempts to analyze the source of fear will inevitably fail to produce corroboration. Hence a state of apprehension that normally might last only milliseconds may last many seconds or even minutes during SP. Under such conditions subjects might experience a protracted but insubstantial conscious awareness (Smythies, 1997) of an indefinite presence strongly associated with fear and/or misinterpretation of benign internal and external sources of activation.

Body pressure, breathing difficulties, and pain—events commonly reported in the context of the traditional Old Hag attack—also loaded on a unique factor, but one substantially correlated with the *Intruder* factor. A structural model including such a correlation produced very satisfactory goodness-of-fit coefficients. The covariation of these clusters constitutes the necessary and sufficient conditions for the generation of the traditional nocturnal assault night-mare. Folklorists (e.g., Hufford, 1982) have stressed the remarkably uniform interpretations of the night-mare experience across diverse cultures, consistent with a strong version of the experiential-source hypothesis. The present study provides evidence of a high degree of similarity in basic structure among people largely innocent of *any* cultural tradition regarding the experiences. This similarity should no longer be surprising given the characteristics of REM neurophysiology outlined above.

Incubus features of the night-mare are consistent with several characteristics of REM respiration, including shallow rapid breathing, hypoxia, hypercapnia, and occlusion of airways (Douglas, 1994). Both tidal volume and breathing rate are sometimes quite variable during REM, and because of paralysis of the major anti-gravity muscles, thoracic contribution to breathing is lower during REM than during NREM sleep (Douglas, 1994). Moreover, even in the absence of apnea or blood chemistry changes, people will sometimes attempt to breathe deeply, just as they attempt other voluntary movements during SP (Hishikawa & Shimizu, 1995). When attempts to control breathing are unsuccessful, the sense of resistance will readily be interpreted as pressure. In addition, increased airflow resistance because of hypotonia of the upper airway muscles and constriction of the airways can result in feelings of choking and suffocation leading to panic and strenuous efforts to overcome the paralysis. This sequence of events is consistent with a report by Hobson, Goldfrank, and Snyder (1965) of a dream immediately following apneic respiration during REM in which the dreamer reported being choked in a dream play. Finally, because of the paralysis, the absence of dampening proprioceptive feedback following execution of motor programs associated with struggle may further lead to painful spasms (Ramachandran, Rogers-Ramachandran, & Cobb, 1995) also consistent with the nocturnal assault scenario. Alternatively, the pressure may feel sufficiently intense to be perceived as pain. At least one respondent spontaneously offered this as a possibility, claiming of such chest pressure ‘‘that I could possibly confuse it with pain.’’ Interestingly, 13 respondents, all women, explicitly described their SP experience as feeling very much like being sexually assaulted or raped. All of these reported very intense pressure on the chest and pain. Lacking traditional narratives for such HHEs these women drew upon what is likely a highly available narrative of assault for many women.

Analyses consistently yielded a factor comprising floating sensations, out-of-body experiences, and (in the WWW samples) feelings of bliss. Additional comments by respondents indicated that these experiences were rarely the rather passive sensations suggestions by the term ‘‘floating,’’ but often consisted of more vigorous sensations of flying, acceleration, and even wrenching of the ‘‘person’’ from his or her body. In response to questions about floating sensations respondents spontaneously reported a variety of inertial forces acting on them, which they described as rising, lifting, falling, flying, spinning, and swirling sensations or similar to going up or down in an elevator or an escalator, being hurled through a tunnel, or simply accelerating and decelerating rapidly. Associated feelings of light-headedness and dizziness were also occasionally described. The impressions of strong inertial forces may also explain why some respondents experienced the out-of-body experience as a violent extraction of the self from the body. Several people reported feeling forcibly pulled or sucked from their bodies, sometimes through the forehead and sometimes through the feet, and one person described a sensation of ‘‘falling out of’’ his body.

In the waking state, medial and superior vestibular nuclei contribute, along with cortical, thalamic, and cerebellar centers, to coordination of head and eye movements. Vestibular nuclei located in the pontine brainstem are closely associated with pontine centers controlling the sleep–wake cycle (Hobson, Stickgold, Pace-Schott, & Leslie, 1998). During REM sleep there are neither head movements nor retinal images when cells in the pontine tegmentum activate vestibular neurons (Peterson, Franck, Pitts, & Daunton, 1976; Pompeiano, 1970, 1980). Thus, in the absence of correlative motor pattern generation with corollary discharge or appropriate proprioceptive feedback, vestibular activation is interpreted as floating or flying. Such experiences are consistent with sensations of angular acceleration associated with the vestibular organs (Howard, 1986). We hypothesize that this impossible conflict between movement and nonmovement, between simultaneously floating above, and lying on, one’s bed, is resolved by a splitting of the phenomenal self and the physical body, sometimes referred to as an out-of-body experience. There have been previous reports that out-of-body experiences in other contexts are sometimes preceded by, or associated with, feelings of floating (Devinsky, Feldman, Burrowes, & Bromfield, 1989) and flying (Blackmore, 1988). Out-of-body experiences have also been indirectly associated with REM states in the context of lucid dreaming (Irwin, 1988). Although out-of-body experiences, when accompanying trauma and/or seizures, can be associated with fear (Devinsky, Feldman, Burrowes, & Bromfield, 1989), broader surveys have reported strong associations with feelings of calm, peace, and joy (Twemlow, Gabbard, & Jones, 1982) consistent with the association for bliss found in the present study.

Autoscopic experiences were described by 17 respondents, in which they viewed themselves lying on the bed, usually from a location above the bed. In one case, a respondent experienced falling sensations and subsequently reported an autoscopic experience as seen from the floor. No one ever indicated seeing an image floating above the bed from a position on the bed, rather what was seen was invariably one’s body lying in bed. It appears that, in these cases, the self goes with the action, whether resulting from corollary discharge of motor programs or vestibular activation, even if, ultimately, it means (apparently) leaving the body. Consistent with the association with bliss, and in marked contrast to the *Intruder* and *Incubus* experiences, some respondents reported that they desired to repeat these experiences, an observation concerning out-of-body experiences that has been made in other contexts (Blackmore, 1988).

This interpretation of out-of-body experiences also has several implications for our understanding of that center of consciousness called the ‘‘I.’’ James (1890) suggested that the ‘‘self of selves’’ was associated with ‘‘cephalic motions’’ (p. 301) or, more generally, with ‘‘bodily activities’’ (p. 302) and that the sense of the ‘‘I’’ of consciousness was at the center of that activity. The locational correspondence of the self and the body is, on such an account, a derivation from the embodied nature of experience. Also consistent with the present findings is the notion that the most important experiences relating to the self are orientational (Gross, 1996). One’s current position in space as a station point or viewing platform is, on this view, the most fundamental experience for the ‘‘I’’ consciousness.

Concluding Remarks

Activation-synthesis theory appears to have useful application to the HHEs associated with SP. That it should be applicable follows from the common REM physiology underlying dreams and the night-mare. The night-mare shares with dreams hallucinoid imagery, bizarreness, and strong emotions. Points of difference should not be overlooked, however. With regard to emotions fear appears to be much more common in the night-mare. In the present study, 90% of the student sample and 98% of the WWW sample reported fear, whereas fear is reported in only about 30% of dreams (Merritt, Stickgold, Pace-Schott, Williams, & Hobson, 1994; Schredl & Doll, 1998). Moreover, HHEs associated with SP also do not appear to be so uncritically accepted as does dream imagery, and that imagery is not as overwhelmingly visual.

The current findings and arguments also have implications for hallucinations more generally. A major conclusion of the present research is that nocturnal hallucinations associations with sleep paralysis begin with an affectively charged ‘‘sense of presence’’ leading to interpretive efforts to corroborate that conviction. This view is consistent with recent observations regarding hallucinations in other contexts (Bentall, 1990; Woody & Szechtman, 1999). Moreover, the notion that hallucinations involve interactions between the amygdaloid complex and prefrontal cortical structures, such as the anterior cingulate, is consistent with recent work on REM dream imagery (Calvo & Fernández-Guardiola, 1984; Hobson, Stickgold, & Pace-Schott, 1998; Marquette et al., 1996), schizophrenia-related hallucinations (Cleghorn et al., 1992; Silbersweig et al., 1995), and hypnotically induced hallucinations (Szechtman, Woody, Bowers, & Nahmias, 1998). Szechtman et al., for example, found positive associations between regional cerebral blood flow (rCFB) in rostral portions within the right anterior cingulate and hallucinating subjects’ ratings of externality and clarity of hallucinations. Szechtman et al. suggest further that the attention of people prone to hallucinations may be more affectively laden than those of nonhallucinators and such affective links to the anterior attentional systems direct subjects’ attention to an external frame of reference and to subsequent misattributions of the source of affective arousal. Woody and Szechtman (1999) suggest that the interactions between the amygdaloid complex and the anterior cingulate are responsible for the ‘‘feeling of knowing’’ and familiarity. Damasio (1994, 1997) has provided considerable information on implications of disruption of such feelings of knowing, when cognitions no longer give rise to ‘‘gut feelings’’ of knowing following lesions to the ventromedial portions of the prefrontal cortex. Woody and Szechtman suggest, consistent with arguments presented here regarding the role of a ‘‘sensed presence,’’ that positive hallucinations reflect just the opposite sort of problem and that disconnected feelings of knowing precede and stimulate percepts. Such a state may be chronic, in the case of hallucinating schizophrenics, or rare and transient, in the case of hypnosis. They may also be very common and transient, in the form of REM states constituting a unique state in which internal processing is functionally isolated from input from, or output to, the external world (Hobson, Stickgold, & Pace-Schott, 1998; Llinás & Paré, 1991).

In summary, HHEs accompanying SP were found reliably to be comprised by three correlated factors. The *Intruder* and *Incubus* factors were substantially correlated and appear to interact to produce a set of experiences consistent with worldwide cultural accounts of supernatural nocturnal assaults. The sense of a nearby threatening presence with corroborating visual and auditory experiences provides an agent to perpetrate the assaultive experiences of the Old Hag experience. The mapping is such that little needs to be added to this cluster of experiences and everything available fits well with a narrative of assault by a strange intruder. *Unusual Bodily Experiences,* on the other hand, fit less well with the nocturnal assault scenario. This lack of fit may explain why the former experiences are somewhat less discussed in a literature that typically relies on spontaneous accounts focusing on the nocturnal assault scenario. The narrative accounts, however limited, do draw together a variety of endogenously and exogenously generated experiences. The degree to which the narratives are constrained by the raw experiences is, however, quite striking. It is of interest to note that the two implicit narratives embedded in the structure of these experiences are among the most primordial conceivable, detection of external threat and monitoring body position and orientation in space. In the former case, traditional narratives of demons, shades, spirits, and lost souls offer labels, narrative coherence, and explanations rather than additional features. Consistent with the universal consistency of these cultural accounts there appears to be little filling in with additional experiences added simply for purely narrative effect. All of these observations are consistent with a view of the neurological primacy of such anomalous conscious experiences and their elaboration.

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