Effects of somatosensory stimulation on dream content in gymnasts and control participants: Evidence of vestibulomotor adaptation in REM sleep

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Abstract

Somatosensory stimulation of the leg muscles in REM sleep appears to perturb virtual orientation in dream experiences. According to our model of vestibulomotor adaptation (Sauvageau, Nielsen & Montplaisir, 1996), the dreaming mind attempts to compensate for such destabilizing stimulation by increasing eye movement activity or modifying dream content, among other possible reactions. Effective compensation is thought to be more easily achieved by subjects who are adapted to the disruptive stimulation or who possess highly developed vestibulomotor skills. To further examine this possibility, we studied the effects of somatosensory stimulation on the dreams of 6 gymnasts and 6 control subjects aged 9 to 16 years. Results provide some support for the expectations that 1) imposed somatosensory information is processed by the central nervous system in REM sleep, 2) unilateral stimulation induces an upset in virtual orientation, 3) gymnasts are more resistant to these disruptive effects of stimulation than are control subjects, and 4) because of long-term adaptation, the dream content of gymnasts does not differ markedly from that of controls. Though preliminary and in need of replication, the findings are compatible with the notion that the developed vestibular skills of gymnasts protects them to some extent from the effects of a disruptive somatosensory stimulus during sleep.

Introduction

We have previously demonstrated that unilateral somatosensory stimulation of the leg muscles during REM sleep leads to a slight decrease in eye movement density in normal subjects, while in subjects with extensive vestibular training—Olympic caliber gymnasts—it increases eye movements (Sauvageau, Nielsen, Ouellet & Montplaisir, 1993). Since it is known that proprioceptive signals from leg muscles interact with vestibular and visual signals to correct balance (e.g., Allum, Honegger & Acuna, 1995; Fitzpatrick & McCloskey, 1994), it is also possible that our stimulation-induced proprioceptive signals produced the changes in eye movement density during REM sleep by influencing central vestibular processes.

Vestibular processes have been proposed to be primordial to the perception-like organization of dream imagery (Bosinelli, Cicogna & Molinari, 1974; Nielsen, 1986; see also review in Antrobus, 1990). The implication of vestibular processes in dreaming may account for the sustained sense of orientational and perceptual (or ‘virtual’) reality during dreaming. Just as the waking self’s orientation to gravity and the visual world depends upon a dynamic interplay between visual and vestibular processes, so too may the dreaming self’s apparent orientation to the dream setting and other characters depend upon dynamic interactions between visual imagery and vestibular processes. The involvement of vestibular processes in dream orientation is supported by the finding that patients with vestibular lesions report dreams containing dramatic orientational distortions such as vertigo and lateropulsion (Eisinger & Schilder, 1929; Doneshka & Kehaiyov, 1978). The latter are movement illusions produced by perturbations of vestibular processes in the awake state; they may also be induced by vibratory stimulation of leg muscles (Lackner & Levine, 1979). Vestibular lesions also produce other, nonobvious effects on both perception and dream content; such as the *reduplication* of perceived objects or persons (e.g., Eisinger & Schilder, 1929).

Other research suggests a relationship between vestibular functioning and lucid dreaming, i.e., dreaming during which there is both self-reflective awareness and a heightened sense of perceptual reality (LaBerge, 1985). For example, subjects with a high self-reported frequency of lucid dreaming show (1) better performance on an oscillating balance board (Gackenbach, Sachau & Rokes, 1982) and (2) increased resistance to vestibular disorientation following rotational stimulation (Hunt, 1989). Moreover, lucid dreams often contain vivid vestibular themes such as flying, floating or spinning (LaBerge, 1985). It may be that an intensification of central vestibular activity permits both lucid self-awareness and a heightened sense of perceptual reality in such dreams.

The vestibulomotor adaptation model of REM sleep

Elsewhere (Sauvageau, Nielsen & Montplaisir, 1996) we have elaborated a model to explain how somatosensory stimulation may modify REM sleep eye movements in normal subjects and trained athletes. This model, which we refer to here as the *vestibular adaptation model*, specifies that unilateral somatosensory stimulation to leg muscles in REM sleep induces an afferent barrage which disturbs the virtual orientation of the dreaming experience, a disturbance for which the dreamer’s central vestibular system attempts to compensate by—among other mechanisms—intensifying eye movement activity.

In brief, afferent signals are thought to be conveyed via the spinocerebellar tracts (Pompeiano, 1976) to the spinocerebellum, the vestibular nuclei, and the oculomotor nuclei, where they shape the eye movements of REM sleep and, potentially, penetrate dream content. Because this pathway implicates a circular vestibulo-cerebellar network with adaptive properties, it is expected that somatic afferent signals will also alter the orientational or virtual qualities of dream imagery.

Goals of the study

The primary goal of the study was to examine the vestibulomotor content of dream mentation in normal subjects and gymnasts after experimental somatosensory stimulation in REM sleep. Based upon our model, we had four principal expectations: (1) Somatosensory stimulation will influence oniric content, thus confirming that somatic signals are conveyed to the brain during stimulation. Such findings would replicate findings from previous studies that somatosensory stimulation during REM sleep is especially likely to effect CNS processes (e.g., Wolpert & Dement, 1958; Koulack, 1969; Nielsen, 1993; Nielsen, Ouellet & Zadra, 1995). (2) Somatosensory stimulation will produce an upset of virtual orientation in dream content. Such an effect would confirm findings from previous studies of leg muscle stimulation (Nielsen, 1986, 1990, 1993). (3) An upset of virtual orientation will be less evident in trained gymnasts than in vestibularly untrained control subjects. In our model, gymnasts compensate for stimulation-induced virtual destabilization by an increase in eye movement activity; thus the content of their stimulated dreams should not differ much from that of their non-stimulated dreams. On the other hand, subjects who can not easily compensate for stimulation with an eye movement response may instead express the upset explicitly in dream content. (4) The typical vestibulomotor features of the retrospectively scored or laboratory dreams of gymnasts and normal control subjects will not differ markedly or will reflect stable (adapted) vestibulomotor function. Such a finding would be consistent with the suggestion that, over the long term, adaptive processes normalize the vestibulomotor content of dreams even in subjects with extensive daily athletic experience.

Participants

The participants, twelve girls aged 9 to 16, included six gymnasts (mean age 13.07 ±1.97 years) and six age- and sex-matched controls (13.23 ±2.25 years). The gymnasts were of high caliber and were referred to us by the Quebec Federation of Gymnastics. Some of the participants were considered to stand a strong chance of participating in the 1996 Atlanta Centennial Olympic Games. On average, the gymnasts had practiced their discipline for six years and had devoted 18 hours weekly to their training. Control participants were recruited informally through family and friends. They reported not having intensively practiced any sport, apart from standard activities in the school curriculum. During the structured intake interview, none of the participants reported having had any psychiatric or neurologic problems. All participants were interested in dreams and stated that they were pleased to participate in the experiment. Gymnasts and control subjects had approximately the same self-reported frequencies of habitual dream and nightmare recall; specifically, on 5-point scales (*1: <1/yr, 2: 1-12/yr, 3: 1-4/mo, 4: 1-3/wk, 5: 4-7/wk*) gymnasts and control subjects scored similarly on *nightmare recall* (M = 2.3 vs. 2.2, ns) and *bad dream recall* (M = 2.2 vs. 2.2, ns); on *dream recall* there was a slight tendency for gymnasts to score higher than controls (M = 4.0 vs. 3.3, $p<.08$). Gymnasts also reported sleeping more on week nights (M = 9.2 ± 1.2 hrs) than did controls (M = 8.2 ± 2.1 hrs), but this difference was not significant. Subjects were not paid for their participation and their parents or tutors signed consent forms.

Procedures

In the laboratory, participants slept in a quiet, electrically shielded room containing a single hospital bed. An overhead video camera and microphone ensured that they could be monitored visually and acoustically at all times. Participants were also monitored with a standard sleep staging electrode montage: C3/A2, C4/A1, O2/A1, LOC/A2, ROC/A1, and mental EMG (Rechtschaffen & Kales, 1968). For administration of somatosensory stimulation, each participant was fitted above either knee with a 15 cm-wide, velcro-strap blood pressure cuff. Four gymnasts and four controls slept two nights each in the laboratory while two gymnasts and two controls slept only one night each. Before going to bed, participants completed a questionnaire on their everyday dream content, which specifically targeted orientational and bodily aspects of this content (see ‘Scoring criteria’ below). Participants were instructed not to use drugs or consume alcohol in the week before the recording nights.

Stimulation could be administered in any REM period except the first, unless the latter occurred later than 2:30 am. For stimulation trials, inflation of the BP cuff was initiated after at least 2 minutes of REM sleep had elapsed and was continued for a maximum of 6 minutes to a maximum pressure of 100 mmHg. Stimulation consisted of gradual inflation of the cuff in slow, pulsatile increments. Stimulation was stopped just prior to the experimental awakening unless the participant was awakened by the stimulus. Stimulation to the right or left leg on any given trial was randomized. For non-stimulation trials, the experimenter awakened the participant after a minimum of 5 minutes of REM sleep had elapsed.

On all trials, the participant was awakened by the experimenter (who was not blind to sleep stage) knocking sharply on the door, entering, and repeating her name. Dream reports were elicited and recorded on video and audio tape for later transcription. Each participant was asked to report her dream in detail, followed by a series of prompts requesting clarification of any dreamed body movements or other actions and the specific use of her arms or legs in the dream sequence. Dreams on audiotape were later transcribed, omitting all elements referring to participants' associations and the experimental conditions. In the morning, participants were asked to complete a questionnaire on each dream recalled during the night; these results are not reported here.

Two judges blind to the experimental conditions independently scored the dreams on 5-point scales for several vestibulomotor imagery categories: repetitive action, movement precision, balance uncertainty, enhanced balance, transformation of body image, postural inversion, unusual postural position, lateropulsion (fictive sideways motion), anteropulsion (forward motion) and circularvection (turning motion) (see Nielsen, 1986). The vestibulomotor imagery score consisted of an average of scores on these items. Judges similarly scored dreams for *degree of incorporation of the BP cuff, intensity of leg activity*, and *visual bizarreness*. In general, the lowest score on these scales ('1') corresponded to an absence of the element (e.g., no mention of the BP cuff), a moderate score ('3') corresponded to presence of the element but not in a striking way (e.g., 'you were going to put a BP cuff on me'), and a high score ('5') corresponded to a striking depiction of the element (e.g., 'the BP cuff was squeezing my leg'). *Character duplication* was defined simply as the number of characters in the dream (minus the self).

Participants also completed a retrospective questionnaire concerning vestibulomotor qualities of their dreams. Five-point Likert-type scales (*1: doesn't apply, 2: applies slightly, 3: applies moderately, 4: applies well, 5: applies very well*) were provided for the scoring of sensory elements in general (e.g., paralysis, pressure, touch, temperature, pain) and vestibular sensations in particular (e.g., flying, floating, turning, jumping, dizziness).

Some 4-point scales (*1: never, 2: rarely, 3: occasionally, 4: often*) were used to rate occurrences of falling and somersaults, dream control, and reality quality.

All scores were averaged within stimulation and non-stimulation conditions for each subject. Homoscedascity of variance was ascertained and group comparisons made using either two-tailed t-tests (equal variance assumption) or nonparametric two-tailed Mann-Whitney U tests (with either exact *p* or z-adjusted *p* depending upon sample size) as appropriate. Cohen's h-statistic was used to evaluate differences in proportions of dreams containing BP incorporations (Domhoff, 1996).

Results

For two stimulation trials, spontaneous awakening of the participants interrupted stimulation at 80 and 90 mmHg; these data were nevertheless included in the analyses as their exclusion did not substantially modify the results. A total of 43 dreams were available for analysis. Of this number, 21 were dreams from gymnasts (11 stimulated, 10 non-stimulated) while 22 were from control subjects (10 stimulated, 12 non-stimulated).

Since correlations for the scores provided by the two judges varied from 0.8 to 1.0 for all categories, inter-judge reliability was deemed adequate. Scores from the more experienced judge were used for the analyses.

Stimulation induced more dreams with BP cuff incorporations (i.e., scores > 1) (42.9%) than did an absence of stimulation (0.0%; h=1.41, p<.01); the mean intensity of the incorporation ratings was also significantly higher for stimulation (M=2.5±1.6) than for non-stimulation

(1.0±0.0; U=15.00, z-adjusted p=.003) conditions (Table 1). BP cuff incorporations were more likely in the stimulated dreams of control subjects (6/10 or 60.0%) than they were in the stimulated dreams of gymnasts (3/11 or 27.3%) (h=0.68, p<.06). Similarly, the incorporation intensity scores for stimulated (vs. non-stimulated) dreams were increased for control subjects (M=3.1±1.8 vs. 1.0±0.0; U=3.00, exact p=0.03) but not for gymnasts (M=1.60±0.71 vs. 1.0±0.0; U=4.00, exact p=0.34). Stimulation had no effects, however, on the *leg activity intensity* or *visual bizarreness* measures.

Stimulation produced a significant *decrease* in the character duplication measure (t=-2.32, p=.033), but post-hoc tests revealed that this was due entirely to a decrease among gymnasts (from 4.55±0.53 to 2.97±0.26; t_6=5.36, p=.002) and not among controls (from 3.71±0.78 to 3.63±0.41; t_9=0.19, p=.852).

The effect of stimulation on the vestibulomotor scale for all subjects together was marginal (1.19±0.26 v. 1.33±0.68, t=0.88, p=.210). However, on some scale items examined post hoc there was a slight tendency for stimulation to have an effect, i.e., an increase in balance uncertainty (p=.097) and circularvection (p=.128) (Table 1).

Table 1. Judges' ratings for content categories on trials with and without pressure stimulation.

	Control trials		Stimulation trials		
Category	**M**	**sd**	**M**	**sd**	**Statistical test (2-tail)**
BP cuff incorporation intensity	1.00	*0.00*	2.45	*1.56*	U=15.00, p=.003
Vestibulomotor Scale	1.21	*0.10*	1.43	*0.38*	t=+1.30, p=.210
Character duplication	4.05	*0.79*	3.34	*0.40*	t=-2.32, p=.033
Leg activity intensity	1.79	*0.65*	1.84	*0.70*	t=+0.17, p=.870
Visual bizarreness	2.53	*1.58*	1.74	*1.80*	t=-1.21, p=.242

Control participants' dreams made more numerous references to the BP cuff (60.0%) than did the gymnasts' dreams (27.3%; h=0.68, p<.05).

Qualitative features of dream content

Some examples of stimulation effects on dreamed balance, movement and BP cuff incorporations appear below. The likely stimulation effects appear in italics.

Balance uncertainty:

> **Gymnast subject J, Night 1, Dream 11:** I stood up and went to the right and went into a house. It wasn't like my family's house, but it was my house in the dream. I walked through the kitchen and *the floor and cupboards were all crooked, at an angle. I walked along at an angle*. Then I went into the living room and about 6 of my friends were there on the couch. I sat down on another couch and watched TV. I was really squished down and I was really hot like someone was sitting on top of me. I was changing channels over and over and over again. I was hungry but thought it wasn't worth it to go into the kitchen.
>
> **Control subject MF, Night 1, Dream 27:** My friend and I are walking when we decide to ride on top of a car. *We are going fast and I am afraid of falling*. We go by a small kids' swimming pool and *throw ourselves off the car into the pool.* The water is cold.

Circularvection and anteropulsion:

> **Control subject MF, Night 1 (D#28)**: I had received all 0%s on my tests. My mother was pleased. She said "That's good, continue like that and you'll pass your year". She said "to celebrate that, I will take you to eat at McDonald's," because at the end of the year I always have a present

> and that is always what I want. At McDonald's there were some rides and at the end of my dream I've having fun on the rides. (Can you explain?). *There was a spiral slide that I was in.* And after that I got in this other thing, you sit down on a bench, you push a button and *it turns*. There was another one, you sit on it and *it rocks back and forth* like this (moves front and back). And there was something else, there was a table and we sat down and *the chairs turned by themselves*. I didn't even push a button and *I was turning around by myself on my chair*. (How did you feel?) *I felt, like, a bit dizzy*.(On the other rides, did you feel dizzy?) A little bit. (Did they turn quickly?) Quick enough, yes. (When you were in the chair did you see yourself or feel yourself turning?) *I felt myself turning, and that one was going faster than the other*. (Did it turn for a long time?) Well, a bit, no, not too long.

BP Cuff Incorporation:

> **Gymnast subject J, Night 1 (D#10):** I was in our school gym bleachers. I decided to go join some gymnasts on the floor. It was really crowded with people; I've never seen so many. I was making my way through the crowd all out of breath and there was this big woman with a scarf. *The scarf got hooked on my leg and I couldn't get it off*. I could feel it there; it didn't hurt, but it bothered me that I couldn't take it off.
>
> **Control subject MF, Night 2 (D#25):** A bunch of us were at 'La Ronde' sitting on some benches. I was reading. *I had a feeling of 'pins and needles' in one foot, I don't know which.* A man who everybody knew came along; that made me mad because I don't like him. I kept reading.

Comparisons of the dreams of gymnasts and control subjects

The laboratory dreams of gymnasts and controls differed only slightly. Compared with the dreams of control subjects, gymnasts' dreams had more repetitive actions (1.81±0.71 vs. 1.32±0.50) (t_{10}=1.76, p=.096), more 'good balance' themes (1.40±0.50 vs. 1.06±0.20)

(t_{10}=2.06, p=.056); and fewer cutaneous sensations (2.03±1.15 vs. 3.02±1.09) (t_{10}=1.90, p=.074).

Responses on the retrospective questionnaire also showed few differences between gymnasts and control subjects. Control subjects stated that they fall in their dreams while this was less the case for gymnasts. When gymnasts do fall, it is more controlled, i.e., to the ground (100%) rather than into space, than it is for control subjects (30%) (t_5=3.16, p=0.025). Furthermore, gymnasts more often have the impression of “living the dream as real” (M=4.0) than do controls (M=3.5; t_5=2.24, p=0.049), and of dreaming about performing somersaults (M=4.2) than do controls (M=2.0; t_{10}=3.31, p=0.008).

Discussion

The present results provide strong support for the first of our expectations concerning the processing of stimulation by the dreaming mind during REM sleep. Globally, the results are similar to results obtained in previous studies using pressure stimulation (Nielsen, 1986, 1990, 1993): stimulation produced an increase in BP cuff incorporations into dream content. The latter was at a level (42.9%) lower than that previously observed with the same stimulus (80%; Nielsen, 1993) but completely consistent with results for other, milder types of somatosensory stimulation. These include a spray of water on the skin (42%) (Dement & Wolpert, 1958) and an electrical pulse train to the hand (45%) (Koulack, 1969). Two factors may explain why the incorporation effect in the present study was so much lower than that in the Nielsen (1993) study. First, a shorter stimulation period was employed in the present study (3 to 6 mins) than in the previous (5 to 15 mins). Second, subjects in the present study were younger (ages 9-16) than in the previous study (ages 25-45). In fact, children in the 11 to 15 age range are quite impervious to sensory stimulation in REM sleep and their dreams are very unlikely to incorporate somatosensory stimulation; children 9 to 11 incorporate more of such stimulation, but the influence remains low (Foulkes, 1982).

To a limited extent, the present results also support our second expectation, based on observations from previous studies (e.g., Nielsen, 1986, 1990, 1993), that unilateral stimulation of the leg muscles will lead to an upset of virtual orientation in dream experience. The comparison of stimulated and non-stimulated dreams demonstrates that stimulation tends to modify the dreamer's orientation within the visual dream scene. This manifests in subtle forms, such as a sense of balance uncertainty ('fear of losing one's balance') or of the body turning in space. It also affects the representation of characters. Note that the effects may not be specific to unilateral somatosensory stimulation; a more elaborate design using both unilateral and bilateral stimulation would be needed to eliminate the confound of unilateral stimulation with stimulation *per se* in the present design.

The third expectation from the adaptation model, i.e., that stimulation would be processed differently by subjects with differentially trained vestibular systems, also obtained only limited support. BP cuff incorporation rates were higher in the stimulated dreams of control subjects than those of gymnasts, whereas character duplication diminished with stimulation for the gymnasts alone. It is possible that gymnasts were more resistant to the disruptive stimulus by, on the one hand, waylaying direct incorporation of the stimulus and, on the other, reducing the duplication of characters. As disruption of vestibular function leads to an increase in duplication of dream imagery (Eisinger & Schilder, 1929), then extended training of the vestibular system might be expected to produce a decrease as we observed. In this regard, it is of interest that in a previous analysis these gymnasts showed an increase in eye movement density (+3.33 2-sec epochs per 2 minutes) after stimulation, whereas the control subjects showed a decrease (-.050; p=.08) (Sauvageau, Nielsen & Montplaisir, 1993). The stimulation effects on dream content reported here may be related in some reciprocal way to this change in eye movement density, e.g., an increase in eye movements may reflect concurrent increases in sensory threshold or in processes preventing transformation of oniric hallucinations. According to our vestibulomotor adaptation model (Sauvageau, Nielsen & Montplaisir, 1996), an adaptation period would prevent control subjects from reacting to a oniric disturbance with eye movement acitivity, causing them to incorporate the source of stimulation more directly into dream content. As this possibility is based both planned and post-hoc comparisons, it clearly must remain speculative until more subjects are studied.

With respect to our fourth expectation concerning long-term changes in dream content, there was mixed support. Overall, the gymnasts' typical dream content did not differ dramatically from that of the control subjects. And on some specific items they differed in a direction which could be taken as evidence that their dream content had successfully adapted to their intensive vestibulomotor training. Specifically, gymnasts find their dreams to be more realistic than do controls, and they dream less of falling out of control. In this respect, it is of interest that the attributes of dream control and reality quality are particularly characteristic of lucid dreaming (Gackenbach & Schillig, 1983; Hearne, 1983), which has a demonstrated association to vestibular functioning as discussed in the Introduction. These features may thus constitute long-term vestibulomotor adaptations. On the other hand, the laboratory dreams of gymnasts had more repetitive actions and 'good balance' themes whereas their retrospective questionnaire responses indicate that they dream more about executing somersaults. These differences, as well as the difference concerning controlled falling, may all be due to the widely recognized continuity between waking and dreaming experience (Schwartz et al, 1978; Kramer et al, 1981). However, even such obvious continuities between waking life and dreaming supports the notion that long-term training of the vestibular system can influence dream content.

If the present results confirm that somatosensory information can be processed during REM sleep, it remains to be demonstrated by what specific route this information is conveyed to the brain. It is known that the posterior columns and spinothalamic tracts are almost completely inhibited in REM sleep (Pompeiano, 1970). However, the spinocerebellar tracts appear to be less affected (Pompeiano, 1970, although cf. Soja, et al., 1995); the latter are thus possible candidates for this role in the vestibulomotor adaptation model of dreaming.

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Appendix 1. Summary of Vestibulomotor Adaptation Model

1. Afferent signals are conveyed to supraspinal centers via the spinocerebellar tracts, which may not be totally inhibited during REM sleep (Pompeiano, 1976).

2. These tracts carry information to the spinocerebellum and on to the vestibular nuclei, which directly influence activity in the oculomotor nuclei and thus the final dynamics of the eye movements of REM sleep. Information may also penetrate dream content.

3. En route to the oculomotor nuclei, these impulses are mediated by a circular loop from vestibular nucleus to vestibulocerebellum back to vestibular nucleus. This loop is a complex neuronal network which includes cerebellar climbing fibers which fire only in the presence of new information and which stop firing after a period of adaptation has been traversed.

4. For normal (non-adapted) subjects undergoing stimulation, there is a period of adaptation during which stimulation activates climbing fibers. This has the final effect of inhibiting (via mossy fibers) the cerebellar nuclei which eventually determine the eye movement response.[a] Normal subjects do thus not compensate for a threat to the virtual balance in their dream imagery by increasing eye movement activity. However, activity of the vestibulocerebellar loop may lead to disruption of dream content.

For gymnasts, whose vestibular systems are stimulated to a high degree, the adaptation period during stimulation is inconsequential. Mossy fibers activate Purkinje cells without the modulation of climbing fibers. Purkinje cells are free to inhibit the cerebellar deep nuclei, producing adequate inhibition of antagonists and an increase in rapid eye movement activity. Dream content is relatively less disrupted.

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[a] *Information enters the cerebellum via climbing fibers which reduce, by heterosynaptic inhibition, the strength of mossy fiber input to the Purkinje neurons. This decreases the firing of Purkinje cells and increases the output (due to disinhibition) of neurons in the cerebellar deep nuclei. The result is a deficient inhibition of antagonist muscles and a lack of increase in eye movement activity.*

Note: This appendix was not published in the original Dreaming article. It summarizes our vestibulomotor adapation model published in a French version only (see Sauvageau, Nielsen & Montplaisir, 1996).

French Abstract:

Selon l'hypothèse de l'adaptation, la stimulation somatosensorielle unilatérale au membre inférieur en sommeil paradoxal entraîne un déséquilibre chez le rêveur, déséquilibre qu'il tente de compenser par une augmentation des mouvements oculaires. Or cette compensation n'est possible que chez les sujets adaptés à une telle stimulation ou possédant un système vestibulaire très développé. Afin de vérifier la validité de cette hypothèse, nous avons étudié l'effet de la stimulation somatosensorielle sur les rêves de 6

gymnastes et de 6 contrôles de 9 à 16 ans. Les résultats de l'étude semblent démontrer que 1) la stimulation unilatérale en sommeil paradoxal occasionne effectivement un déséquilibre chez le rêveur, 2) l'information somatosensorielle en sommeil paradoxal est traité par le système nerveux central, 3) le déséquilibre induit par la stimulation chez les contrôles transparaît dans le contenu onirique tandis que chez les gymnastes, ce déséquilibre est compensé par une hausse des mouvements oculaires et n'influence pas le contenu du rêve, 4)les gymnastes font plus de rêves réels que les contrôles. Ces résultats viennent donc corroborer la validité de l'hypothèse de l'adaptation.