

Dream Research

Pain in Dreams

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Summary: Little is known about pain in dreams. Some studies indicate that it is rare and that it may be beyond the representational capability of dreaming. However, the present study describes experiences of dreamed pain that were reported incidentally in experiments on the effects of somatosensory stimulation administered during rapid eye movement (REM) sleep. Dreams were selected from five subjects who had reported at least one instance of dreamed pain in these studies. The subjects had undergone 42 stimulation trials over 20 nights and had reported a total of 13 dreams (31%) with one or more references to pain. Most often, these references appeared to be direct, untransformed incorporations of real sensations produced by stimulation. Pain was the principal motivating agent in a majority of these dreams and was in many cases associated with strong emotion—typically anger. Dreams often depicted the subjects' attempts to obtain relief from pain, in some cases by repetition of actions, in others by metaphoric renditions of the goal. The results indicate that although pain is rare in dreams, it is nevertheless compatible with the representational code of dreaming. Further, the association of pain with dream content may implicate brainstem and limbic centers in the regulation of painful stimuli during REM sleep. **Key Words:** Pain—Dreaming—REM sleep—External stimulation.

Little is known about the relationship of pain to dreaming. Dreams appear to respond to the psychological pains of waking life, such as the death of loved ones (1-3) and divorce (4,5), but there is little evidence concerning the frequency and nature of physical pain in dreams. Some content analyses indicate that dreamed pain may be rare, perhaps even absent altogether. Freud (6) noted no instances of pain in the manifest dream (p. 325). Large studies of dream content (7-9) also make no mention of dreamed pain. A more recent study (10) found that pain was completely absent from two series of 80 and 100 dream reports that had been scored specifically for references to sensory events, and a second study (11) found only a single ambiguous reference to pain in a sample of 119 rapid eye movement (REM) sleep reports.

This low frequency of dreamed pain could reflect the fact that pain is relatively infrequent in waking life and is thus not mirrored in dream life—a corollary of the

“continuity hypothesis” of dreaming (12). However, if this were true one would expect to see pain more frequently in the dreams of patients with painful medical conditions. To our knowledge, no such effects have been reported (cf. 13), although some interesting anecdotal accounts can be found in Garfield (14, p. 120).

On the other hand, the lack of pain in dreams may reflect a limitation on the sensory modalities that dreaming is able to represent. One possibility is that pain is beyond the representational capability of image formation processes—that neither pain memories nor pain images are reproducible in the dreaming mode. A second possibility is that the sensory systems that might contribute to the representation of pain imagery are not functional during dreaming. This possibility is consistent with the finding that the high threshold polysynaptic afferent fibers that conduct pain sensations (e.g. 15) are actively inhibited during REM sleep in cats (16).

Clinical case studies of painful medical conditions provide some support for both of these explanations of how pain representation may be restricted during dreaming. Such studies reveal not only that there is

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little pain in the dreams of patients who suffer pain, but also suggest that pain influences dream content only indirectly. In one study of the dreams of migraine patients (13) the singularly most frequent content category associated with throbbing migraine awakenings was terror (14/23 or 61%), but not pain. In fact, none of the dreams described in this report depicted physical pain. Such results suggest that during dreaming pain sensations may be represented in indirect, conceptually compatible forms, such as terror or other intense emotions.

Another indirect type of pain representation in dreams is illustrated by one of Freud's dreams (6). For several days Freud had endured a large, excruciating boil near his scrotum and could walk only with extreme pain. In his dream he found himself riding painlessly on horseback, an activity that he appreciated as absurdly inappropriate for his physical condition (pp. 325-328).

It remains to be demonstrated that pain sensations can be integrated directly into the dream imagery of REM sleep as can sensations from other sensory modalities (17,18). If so, instances of dreamed pain might provide useful clues to the cognitive and neurophysiological processes that regulate pain sensation during REM sleep. The goal of the present study was to provide laboratory findings relevant to the relationship between pain and the dreams of REM sleep. Several instances of dreamed pain were recorded incidentally during pilot testing of a method for administering pressure stimulation during REM sleep (17). Induction of pain in dreams was not the goal of the research, and the observed references to pain were unexpected. Nevertheless, in light of the scarcity of information on this subject, more specific analyses of the dreams seemed warranted.

METHODS

Subjects

The five authors (two male, three female) served as pilot subjects in two exploratory studies of somatosensory stimulation during REM sleep. Their dream reports were selected for analysis because each subject had reported at least one dream that contained an explicit reference to pain. At the time of the studies, four subjects were graduate students in psychology with a primary focus on dream research and one was an undergraduate student in art therapy with a strong interest in dream research. All subjects had been fully informed as to the nature of the procedures and were told that they were free to discontinue participation at any time. Subjects' ages ranged from 25-37 years (mean = 29.7). They were not paid for their participation.

Procedures

The goal of the first pilot study was to determine whether the typical hyper-excitation (pins and needles) or hypo-excitation (paralysis) produced by ischemia of limb muscles (19,20) during REM sleep would evoke concomitant hyper- and hypo-excitation in dreamed limb activities. The goal of the second study was to replicate and further explore anomalies in dream content produced by pressure stimulation. Ischemia was induced by gradually inflating a broad-band blood pressure (BP) cuff worn above either the right or left knee, according to previously published procedures (21,22). On all trials with BP cuff inflations, at least 5 minutes of REM sleep were allowed to elapse before the BP cuff was inflated. The inflation was effected by very slowly pumping a hand-held sphygmomanometer bulb that was located in the next room and connected to the BP cuff by a rubber tube. Cuff pressure was monitored with a standard gauge. For reasons of safety, the cuff was never inflated to more than 220 mm Hg or for longer than 25 minutes. These values are more conservative than those typically used in research that employs this methodology (22,23). Higher pressures over periods of up to 1 hour have been used safely in both experimental and clinical procedures (21,22). Subjects were administered a brief trial of maximum pressure stimulation before lights out. None reported that the sensations produced were painful or very uncomfortable. However, stimulation for a period of several minutes does occasionally evoke mild but tolerable pain in the waking state. It is typically diffuse rather than acute pain, consisting of dull throbbing, mild aching or pins and needles sensations.

On many trials, subjects either awoke spontaneously before the maximal values of the BP cuff were attained or they were awakened by the experimenter shortly after a gross body movement had disrupted REM sleep. Otherwise, they were awakened according to a predetermined schedule (at least 5 minutes of REM sleep for the first period, 10 minutes for every period thereafter) by the experimenter calling their name and entering the sleep chamber. Dream reports and descriptions of physical sensations in the legs were tape-recorded and transcribed. One of the authors (T.N.) subsequently reviewed all of the transcripts, identifying words describing pain sensations in the dream (e.g. painful, aching, cramping) and in the leg immediately after awakening. Procedures were approved by local ethics review committees.

RESULTS

A description of experimental nights, trials and pain dreams appears in Table 1. There were 89 awakenings,

63 of which (70.8%) produced usable dream reports. Of these, 42 were stimulation trials. Pain sensations of some type were mentioned in 13 of the 42 reports (31.0%). They were mentioned more frequently by Subject B (7/10 dreams) than by any other subject. By contrast, only one of 21 nonstimulated dreams (4.8%) contained a reference to pain.

Edited transcripts of all 14 dreams containing references to pain appear in Table 2. A total of 27 pain words or phrases were counted in the entire dream series. These are italicized in the table. For one of these references (dream 14), the pain word was used in a figurative sense ("that dog is a *pain*"). In another instance (dream 9), the reference to pain was made at the end of the dream, but the subject confirmed on questioning that it had indeed occurred as part of the dream content. A third pain reference (dream 13) was ambiguously described in terms of a pain memory involving a leg injury.

Some dreams showed evidence of multiple incorporations of pain. In one instance (dream 12), two different pain experiences in two distinct dream episodes occurred within a single report (i.e. running and hurting the heels and lying in bed with the leg in pain). In a second instance (dream 5) two distinct pain experiences occurred within the same dream episode (i.e. feeling pain from the BP cuff and having the leg struck by the experimenter). In dream 2, pain was present both at the beginning and the end of a fairly lengthy imagery sequence.

In all cases but two, pain sensations were referred appropriately to the stimulated leg. In one exception (dream 12), pain was felt in both heels and in another (dream 6), pain was attributed to the legs of another character. References to pain occurred across a broad range of stimulus durations (6–11 minutes) and pressures (60–180 mm Hg). That the pressure stimulus had produced some degree of pain during REM sleep could be verified objectively for many of the reports by subjects' descriptions of pain in the stimulated leg on awakening, e.g. "crampy pressure", "tingling", or "hurting a bit". However, the pain reported on awakening was usually much less intense than the sensations of pain reported for the dreams.

In contrast to the previous findings, there occurred three trials on which no pain was mentioned for the dreams, yet mild pain was reported on awakening. Also, one nonstimulated dream (dream 14) contained a reference to pain (see Table 2). In this case, the subject dreamed sensations of pain and cold in the gluteus muscle while lying on a board. This imagery was followed by an apparent pun—that they had "reached rock bottom" in the bed. A similar verbal association to pain occurs in the immediately preceding episode of this report ("that dog is a *pain*").

TABLE 1. Dreams with references to pain reported by five subjects over 20 nights of stimulation during REM sleep

	# Nights	# Stimu- lation dreams	# Dreams with pain (%)	# Pain words in report
Subject				
A	6	16	1 (6.3)	1
B	8	10	7 (70.0)	13
C	1	3	1 (33.3)	2
D	3	9	2 (22.2)	5
E	2	4	2 (50.0)	4
Total	20	42	13 (31.0)	25

DISCUSSION

The present results demonstrate that for some subjects and under some conditions pain can occur in the dreams of REM sleep. Dreaming is apparently not impervious to the representation of pain when long-duration ramp pressure stimulation is administered. There is apparently also a high level of individual variability in susceptibility to dreaming about pain (6–70% of reports). Such variability may be related to a person's previous pain experiences—experiences of pain in the legs especially. In fact, Subject E, who had the second-highest proportion of pain dreams (50%), described one instance of dream pain with direct reference to a previous leg injury involving pain. Subject B, who had the highest proportion of pain dreams (70%) reported having undergone knee surgery several years earlier and was still experiencing occasional paresthesia in the affected knee. Thus, long-past traumatic experiences associated with pain may continue to influence the representation of "imaginary" pain in dream reports, much as is the case for phantom limb pain (24).

Nevertheless, other possible sources of pain in the present dream series should be considered. One possibility is that the dreamed pain was primed, i.e. was due either to subject expectations or to memories of pain that were experienced before sleep during the BP cuff test inflations. Although these effects cannot be ruled out definitively, they are unlikely (1) because the original goals of the experiment, as understood both by experimenters and subjects, did not include the induction of pain dreams and (2) because presleep BP cuff inflations were not typically experienced as painful by the subjects. A second possibility is that pain sensations were oneiric metamorphoses of intense, yet nonpainful, somatosensory sensations produced by the BP cuff. Mild discomfort or constant pressure could have constituted the raw material from which imaginary pain was subsequently constructed. This possibility is rendered less likely by the fact that at the moment of awakening from pain dreams, objective pain was often reported for the stimulated leg. Nev-

TABLE 2. Edited transcripts of dreams with references to pain

1. **Subject A, Night 2, Awakening 5, 7 min to 180 mm Hg, Left leg**
 Dreamed I had some difficulty waking up. When I finally woke up and removed the cuff my leg was full of cramps and I couldn't straighten it properly. I walked around a little on the leg and realized that there was an injury. I was walking around and feeling my leg with my hand. I was angry and upset. I said to myself "that's the last time that the cuff goes on that leg". I was angry that my right knee was *hurting*.
2. **Subject B, Night 4, Awakening 4, 7 min to 140 mm Hg, Left leg**
 I was walking through snow in a field. A woman is pushing a baby in a stroller. I offer to help and am laboring through the deep snow. I get across the field and the snow is gone. My leg felt really *achy* due to running through the snow. I was offered a ride and took it. I felt ill and vomited out food. A black lady said "What the heck is that?". I tried wiping my face. I got out of the cab, barely able to walk. I stumbled into a house full of people. There was a big set of stairs. I said "I can't do it any more, I gotta take it off". I dropped down flat on my back and tried to take the cuff off; the *pain* was still there. I was writhing around trying to get it off. When I finally did, the pressure was still there. I felt the leg once and said "shoot, there's another layer". My leg was sort of floating above the ground and kept changing so that it was out of reach. I felt twisted. I touched the skin to check. It was still throbbing, up in the air, floating.
3. **Subject B, Night 3, Awakening 2, 7 min to 80 mm Hg, Right leg**
 You came in and woke me up. I had the cuff on. It was so real. I wasn't sure if I was awake or asleep. We got up and were walking outside. I had these electrodes all over my face and the cuff on my leg. We were walking through a wooded area with a path. We went up a steep hill and had to come back down. I had the cuff on and my leg was *hurting*. I had told you that I was awake already and I didn't understand why you kept the cuff on. You slid down in a squat position to keep your balance. I was at the top and thought "I had better take this cuff off if I am going to maneuver this hill properly". I said that; you said that was fine.
4. **Subject B, Night 3, Awakening 5, 8 min to 120 mm Hg, Right leg**
 JT was there sitting in the corner and he shouted "Well I had 40 pounds this morning crossing the border" and people didn't believe him and he said "Ya, well I woke up the customs guy at 4:30 in the morning and got him to let me across the border". There was a lot of derision. I saw that he had really bad teeth, they looked as though they were rotting out. I was sitting on a bench near him and looked at him as he was speaking. He laughed and he had just this mouthful of blackness and it was really awful. Then there was something about going up some stairs. It was really hard to go up the stairs. I was going up the stairs. I could barely make it up the stairs and I think I was dragging my leg . . . because it was *hurting*. I would reach down and grab my leg and pull it along with me. It felt really heavy, like it was a wooden leg.
5. **Subject B, Night 5, Awakening 2, 6 min to 120 mm Hg, Right leg**
 I was shouting at you: "It's not going down!". You couldn't hear me because there were 3 other beds in the chamber, another woman sleeping in here and this guy monitoring her. This guy had red hair and was a real jerk. They were doing this dream study. You inflated the cuff on my right leg and I woke up and tried to call you. It was really really intense the cuff was. I was writhing around on the bed in *agony*, tossing and turning kind of; flipping from side to side. You came in and I said "let it down, let it down". You saw these people and were really upset. You started yelling at them, asking them what they were doing there. I am going "Let it down!" really impatiently and I'm really *hurting*. So you came over to the bed, took one of those pumpers right here and turned the little knob so it would release. But the bed fell down 3 or 4 inches like an inflated mattress, and not my leg. I was lying on just a wooden thing. I waited but nothing happened to my leg so I felt it and it was still really tense. You were talking to these people. I said "It hasn't gone down" and you came over and smacked my leg right on the cuff just to see. It *hurt* like crazy. I kept saying "take it down". So you go out. Then the others put the girl back to sleep. The chamber was really big. I am wondering "how the heck did they ever get in here without me waking up?".
6. **Subject B, Night 5, Awakening 4, 7 min to 110 mm Hg, Right leg**
 You and I and my sister were sitting on a grassy hill on a farm. At the bottom in a field a young man was trying to rope a cow, tie its legs like in a rodeo, and wrestle it to the ground. Then I heard a commotion behind me, turned and saw this really old man. He is trying to wrestle an old beat-up horse to the ground. It was almost exactly the same movements as between the man and the cow, except that the man with the cow seemed more in control. It was weird for the farmer to be on the ground because he is trying to put a saddle on the horse. He was really struggling. At one point the horse was rolling right across his body. I heard this unnnff! sound as if it *hurt* him when it rolled across his legs. The unnnff! sound of him struggling and grunting in *pain* alerted your attention. You were going to go help, but he decided to give up. He got up and turned his back on the horse. The horse stood up too. He put the horse's right hind foot in this suitcase-like thing with a metal box so he wouldn't stray. At first I thought it was some kind of bear trap, but I looked again and saw it was not *hurting* the horse, just trapping his foot. The horse tried to pull his foot out and follow the farmer, but he couldn't. He just stopped, was passive; he knew what the box meant.
7. **Subject B, Night 7, Awakening 3, 8 min to 60 mm Hg, Right leg**
 I was at a dance party in a barn. Everybody was getting drunk. People were dancing. I was worried about one guy; I didn't know how he was going to act. I was dancing with someone too, awkwardly, my right leg was *hurting* and I wanted to stop. I was making small, sharp jumpy movements, not very rhythmically. It was like the floor was vibrating, I could feel it going up my leg, jarring me. My partner was leaning on me at one point. Then this guy stumbled into me, hit me from the right side. It was a really jarring sensation through my whole body. He made me angry, though I had been ticked off during the whole dream.
8. **Subject B, Night 8, Awakening 1, 9 min to 60 mm Hg, Right leg**
 A girl is sitting at the end of the bed. I tell her that we have to go back to sleep and to dream. I'm semi-sitting on the bed. My right leg was *hurting*. I tell her that I'm having troubles with my leg and that she has to lie down on it to see if that will help ease the *pain*. She looked really surprised and says "what do you mean?". But we couldn't maneuver it to get her to lie down because of the spacing in the bedroom. So I showed her how to lie on my other leg and she agreed although she said she felt stupid doing it.
9. **Subject C, Night 1, Awakening 3, 6 min to 90 mm Hg, Left leg**
 I am lying down, reclining on my arms. My right leg is bent at the knee, but my left leg is out of control. Very rapidly it lifts up and twists with both the knee and ankle bending. Several times it goes higher than my head, as if it was going to fly off. The only control I had over it was to bring it back down again whenever it did that, and that took a lot of effort. My leg was like a deflating balloon

TABLE 2. *Continued*

flying all around. Because of the fast movements of my leg the rest of my body was being shaken, like with spasms, each time it contracted. I was dressed in black and I was lying on a black leather sofa. I saw the cuff on my thigh and at one point I tried to hold my leg still with both hands. I asked you if it was normal for my leg to be in this state. You said yes and helped me to straighten up. Just before waking up I felt a *pain*, like a strong *pinching* in my thigh.

10. Subject D, Night 1, Awakening 5, 10.5 min to 65 mm Hg, Right leg

I was here but it was more like a bed in a doctor's office. It was like there were two of you working in the lab; the other person is just starting and you're finishing and you are joking about having graduated from different universities. Then I was sitting in the chair. My right leg was almost like *painful*. It was very real for me, I thought I was already awake. The leg was in the normal position with the knee bent. That's when I straightened it up and lifted it slightly to bring your attention to it. But it was like my leg was being held up by itself. I'm saying "Well what are you gonna do about this?". You have this thing like an anti-pressure cuff in your hand that you're gonna use to make the pressure in the leg go down. But you're busy doing something else. I'm feeling very *uncomfortable* with the leg because it's feeling very weird. I mean besides the fact that it's floating in the air. You suggest that I look at this picture book. It wasn't working very well.

11. Subject D, Night 3, Awakening 5, 9 min to 60 mm Hg, Left leg

I'm in a small store trying on a pair of ugly shoes. I started walking. Then I staggered forward because I was waking up and not fully conscious. You were laughing at me. I said "come on, its not funny, I'm trying to wake up!". This is the second or third time I've been trying to wake up. Then I ask myself "well ok how are these shoes?". They were awfully large. I thought I had tried on the new shoe on my right foot and yet when I looked down I realized it was on my left. It had a funny way of attaching: a strap around the back that was closed in the front with a long pin and with holes in it like for a belt buckle. I tried to angle the pin comfortably, but the logic of the design escaped me. I angled it toward my heel and that *didn't feel comfortable*, and then I angled it toward my toes and that didn't help either. It was always at an angle that was pressing into my foot. It was *sharp poking*. I reasoned that the pressure of it against the foot was meant to keep it in place. I decided to take off the shoe. Even as I did that business with the pin and the shoe I became aware of the pressure in my leg and that was kind of *painful*. That sort of turned into this attached leather seam that went up the back of my leg that was tied up here. So I undid that and somehow doing that I went to this other dream where I thought I was awake where you came to the door and told me to wake up and I said "I'm waking up, I'm waking up, that's all that I've been doing in this dream is waking up".

12. Subject E, Night 1, Awakening 3, 9 min to 100 mm Hg, Left leg

I'm in this warehouse with some people sitting at a little restaurant. A guy is playing with a coke bottle, shooting it, throwing it down, picking it up. He is getting the waitress really angry. My friend gets up, takes the bottle and throws it toward me to catch it. But it lands in a paper bag. This other guy looks really mad; I grab the bag and I'm running with it. I had no problem running even though I just had socks on; I was *hurting* my heels. That was quite intense. D also runs away, but is caught by this guy and 2 friends. They start playing a game of singing and guessing the next word. D doesn't know it and the guy just whacked him a solid one, poffff, and he fell. Then I was here in the bed; it was like the cuff had been blown up for a long time. I woke up and my left leg was in *pain* here. It felt very stiff so I was trying to flex it towards me and just couldn't move it. I had to remove the cuff myself because I just couldn't wait. I started to unwrap it, was able to go fffff and release the velcro part, but there was no sense of relief.

13. Subject E, Night 2, Awakening 3, 11 min to 100 mm Hg, Right leg

We are at a conference, talking, and we order some food. The people serving are in these beautiful dresses from the 1700s and they are absolutely good looking. The woman had black shoulder length hair, beautiful blue eyes, and this vivid red lipstick. She went "you're kind of nice" and I went "you too". She leaned down and I kissed her—a long French kiss. I was really excited.

There was a sleep lab at the conference; I was looking at someone who was hooked up. You asked if I felt like presenting later today about some sleep disorder. I asked how the hell I could do that. You gave me stacks of data and results and graphs and told me to read it and just wing it. You said that some famous people would be there. I started getting pretty stressed out.

Then I'm in a bike shop to buy a bicycle lock. The guy at the counter is being a jerk staying on the phone and I'm waiting for him to help me pick out the lock. I play around with these weird U-shaped ones made of aluminum like a 7-Up can. Its malleable and I could bend it. Then I see another one and I was forcing it and the whole thing just crumpled up. When the guy got off the phone he got really pissed off that I had damaged these two locks; he wanted me to buy them. We were arguing; I was angry.

Then I was walking around, almost limping, because my right leg had pins and needles. When my foot came down I got a *tingling, not a comfortable one*. So I was walking quickly, not letting it touch the ground very often. I was thinking that the tingling sensations were related to a knee problem I have in real life; sometimes it just snaps out and is *somewhat painful*. Then I dreamed I woke up here. You were beside me; I was telling you this dream of walking on my right leg.

14. Subject A, Night 2, Awakening 3, no stimulation

I was in a different bed telling you about a memory of another place, of some people who had a dog who had ruined a chair. I was looking at a gold caster on this chair. I asked if there was something wrong with it. It had been broken by the dog. I then looked at the chair leg. There was a big cavity where the caster should have been and it was full of broken off wood. I was remembering how unmanageable the dog was. It reminded me that I had said that I didn't like dogs. I had said "ya, that dog is a *pain*". I looked closer at the leg and realized that I couldn't fix it because I didn't have tools.

Then I was trying to get comfortable on the bed. All the electrodes but one for the EEG had fallen off; the others were dangling free. You said that this was too bad. I had tossed around in bed trying to get comfortable. It was really cold and *hurt* my backside. There was almost no mattress; I was on a board. I was saying to you that we had hit rock bottom in this bed. J came in to the room. It was now like a hospital cafeteria. She had been sleeping and was really cheerful. We were talking about making peanut butter and jam sandwiches.

ertheless, the occurrence of pain at this one point in time does not prove its existence at previous points in the dream. And the occurrence of at least one nonstimulated dream in which pain was depicted indicates that other cognitive or perceptual sources for dreamed pain (such as memories of pain) can be postulated. Resolution of these considerations will require more detailed investigations of the occurrence of spontaneous and stimulated pain in dreams.

Representation of pain in dreams

The recurrence of specific themes in the pain dreams suggests that pain sensations may have influenced dream production in several distinct ways. First, in most cases where it is mentioned the representation of pain is direct and realistic—an accurate reflection of what might be expected in the waking state. In 11 of 13 instances (84.6%), the representation of pain was direct and realistic in this sense. It was referred to as “aching”, “cramping” and “hurting” in the appropriate leg as it was in several postawakening comments. Pain was also associated in many cases with an erroneous impression of being awake or that the dreamed events were real. This may be because the stimulation activated processes normally associated with waking state perceptual activity or because it partially triggered the awakening process itself. Dream 11 is a particularly clear example of how the pressure stimulation and the inertia towards a wakeful state became intertwined in dream content. A more complete discussion of the problem of dream realism and “micro-arousals” after somatosensory stimulation can be found in Nielsen (17).

In a few instances, pain incorporations were not direct and realistic, but were transformed in significant ways. In dream 12, the subject felt pain in the heels while running, a displacement suggestive of referred pain (25,26). In dream 5, pain was incorporated directly at first, but was later exaggerated out of proportion to the sensations described in the postawakening comments. On awakening, this subject reported “tingling” and “hurting a bit” in the leg, but not “agony” or “hurting like crazy” as in the dream. Similarly, this subject did not report feeling angry or enraged upon awakening as had been the case in the dream. Finally, in dream 6 pain was reported as a feature of another character’s experience, specifically, an old farmer who grunted in pain as a horse rolled across his legs. This subject emitted a grunting sound during the REM sleep period preceding this report, further indicating that pain sensations had likely been dissociated and referred to another aspect of dream content. A similar account of pain dissociation was reported by a cardiac patient who awoke with a stabbing chest pain as he

dreamed of sticking prongs into the flank of a roast dog that his wife had served him (27). An account of dissociation of emotional responses has also been reported (28). The farmer example suggests that for dream content the referral of dreamed pain may be relatively malleable, i.e. dissociated from self-experience and attributed coherently to other elements of dream imagery. In fact, other references to dissociated leg imagery and pressure sensations are easily identified in dream 6 and the other dreams in Table 2. These images are discussed elsewhere (17) in relation to a kinesthetic fantasy model of dream formation and its reactions to somatosensory stimulation applied during sleep.

In sum, some examples in the present results suggest that dreamed pain can be displaced or amplified beyond what is conveyed by the objective stimulus. Thus, pain appears to be susceptible to symbolic transformation and smooth integration into dream content. Nevertheless, the majority of examples in the present set indicate that pain in dreams typically preserves its realistic and immediate character.

A second feature of pain representation that is suggested by several reports is that pain sensations are often the primary motivating agent of the dream. In nine of the 13 dreams with pain (69.2%), subjects were preoccupied by the task of reducing pain sensations in the stimulated leg. They attempted various logical and illogical means of solving their dilemma of unwanted pressure. They queried the experimenter about their leg sensations and about real and imagined experimental procedures. Sometimes they scolded the experimenter or sought help from other dream characters. At times they even attempted to remove the BP cuff themselves. In this regard, the motivated nature of the dreams depicts attempted goal attainment, or what might be likened to a limited form of “wish-fulfillment” in the organization of the dream (6). The reports provide an opportunity for examining how dream processes respond when attainment of a highly motivated goal is thwarted. Two reports suggest that simple action repetitions are attempted. In dream 2, the subject felt the leg and removed the BP cuff only to find that the pain had not diminished. The same action was then repeated, with the discovery of “another layer” of BP cuff beneath. In dream 11, the dreamer wished to relieve painful foot sensations attributed to an ill-fitting shoe. Repeated attempts to readjust a sharp pin were made.

At least three additional reports suggest that the thwarting of goal attainment may produce metaphoric depictions of the desired goal. In dream 5, the subject’s failed admonishments of the experimenter to deflate the BP cuff produced an unexpected deflation of the bed rather than the pressure cuff as desired. In dream 6, a major theme was to help relieve the pain and

distress of the farmer under a horse. Such help would presumably take the form of removing the pressure induced by the horse rolling on his legs. In dream 11, metaphoric depictions of pain relief occurred when the dreamer attempts to remove the painful shoe, and when the dreamer "undoes" a vertical leather seam that apparently materialized directly out of pain sensations in the leg.

A third possible influence of pain on dream imagery concerns its affective tenor. In at least six of the 13 dreams with pain (46.2%), and possibly more, there is evidence of strong negative emotion preceding or accompanying the reference to pain. In five cases (38.5%), this emotion is anger. This finding is reminiscent of the results of Levitan's (13) study of migraine headache dreams in which terror was the predominant dreamed accompaniment to pain. However, in the present study anger, not terror, was the predominant affect. This finding may simply reflect idiosyncratic responses of the two subjects who reported the five anger episodes in the present study, but it is also possible that terror tends to occur when the source of the pain is unknown or out of the subject's perceived control. Anger may have been produced in the present study because the pain source was both known to and potentially controllable by subjects. One observation consistent with this notion is that in a stimulation dream that almost qualified as painful (i.e. "... harmful sensations of energy in the leg ..."), both terror and a conviction that the experiment was out of control were experienced in conjunction with the near-painful stimulation.

In sum, pain appears to be compatible with the representational processes of dreaming. It is usually incorporated in a direct, realistic fashion, but may be amplified or referred to nonself dream attributes. Its indirect effects on dream content appear to be affective/motivational, structuring imagery so as to deal both practically and symbolically with the stimulation's unwanted intrusions on sleep.

An inhibitory mechanism for pain in dreams?

Despite the significant proportion of pain references observed in the present data set, the question of the relative scarcity of dreamed pain is still pertinent. It should be emphasized that the majority of stimulated dreams (69.0%) in the present series contained no references to pain, despite similar levels and durations of stimulation. Moreover, references to pain have not been observed in the majority of the more than 25 subjects who have so far been administered pressure stimulation during REM sleep with this procedure. There is also evidence that some of the present dreams resisted incorporation of pain even though postawak-

ening comments suggested that it had been present during dreaming. These findings compel us to reconsider the possible mechanisms implicated in sensory transmission of pain during REM sleep and, in particular, the notion that the rarity of dreamed pain is related to inhibitory processes of REM sleep.

Evidence from animal studies indicates that transmission in the high-threshold afferents subserving pain sensations is blocked during REM sleep (16). Inhibitory centers in the brainstem reticular formation influence several levels of the somatosensory system, including afferent spinal neurons. They inhibit both tonic somatosensory signals concurrent with the state of REM sleep and phasic signals coupled to phasic motor activation and rapid eye movements. Thus, REM sleep mechanisms appear capable of suppressing both tonic and phasic pain stimuli. Presumably, the tonic inhibitory mechanisms may be more prone to fail—and thus to result in dreamed pain—when continuous, ramped pressure stimulation is used. Failure of inhibition may be due to any of a number of physiological reasons: incompatibility with some types of stimulus gradients, temporary fluctuations in tonic neuronal hyperpolarization, limited range for certain stimulus intensities. The mechanism may be analogous to the "central control trigger" proposed by Melzack and Wall (26,29) to regulate pain during the waking state:

... an area exists in the brainstem reticular formation that is capable of exerting a powerful inhibitory influence on transmission at all levels of the somatosensory system ... [that] acts as a central biasing mechanism ... by exerting a tonic inhibitory influence, or bias, on transmission at all synaptic levels of the somatic projection system ... (26, p. 168).

In fact, the pain-modulating substance P is co-localized with cholinergic neurons in the laterodorsal tegmentum-pedunculopontine tegmentum (LDT-PPT) region of the brainstem. These are known to be critical to the integrity of REM sleep, sending both ascending branches to basal forebrain and thalamus, which are implicated in limbic and cortical activation, and descending polysynaptic relays to the dorsal and ventral horns, which are implicated in sensory and motor paralysis. Injection of substance P into this region has been found to be antagonistic to REM sleep (30). It is thus possible that REM sleep is reciprocally antagonistic to substance P and limits supraspinal influence over pain under most conditions. Failure of this mechanism may result in direct, undisguised incorporations of pain sensations into dream content.

REM sleep influences on pain perception during dreaming may also involve higher-level limbic system activity. Melzack and Casey (31,26, pp. 163–165) proposed that a "central intensity monitor" in the limbic system summates ascending somatosensory inputs from the midbrain reticular neurons and outputs an appro-

priate affect/motivational response. Stimulus intensities up to a critical level will trigger positive affect and an approach drive. Intensities beyond this level will produce negative affect and an aversive drive. Such a mechanism may explain both why many pain dreams in the present study were associated with intense negative emotion (primarily anger) and why pain sensations seemed to motivate the production of dreams in which "escape from the stimulus" was the central motive. The mechanism may also explain why several nonpain stimulation dreams contained sensations of intense sexual arousal, i.e. because of sub-threshold activation of the limbic system. Example 13 (Table 2) demonstrates a pattern consistent with the Melzack and Casey (31) model: a sequence of positive affect (sexual arousal) is followed by increasing negative affect (stress, anger), and finally pain.

That such high-level organization may be implicated in the representation of dreamed pain is reminiscent of the claim that brain activities subserving attention, emotion and memories of prior experience can modulate pain (26, p. 160). It also parallels research which indicates that vivid waking imagery can increase tolerance to painful stimulation (32–34). However, it remains to be demonstrated that similar mechanisms mediate pain sensation during dreaming and waking imagery.

CONCLUSIONS

In conclusion, the rarity of pain in dreams may be attributed to the lack of compatibility of pain sensations with processes of REM sleep generation. However, some types of pain sensation can be incorporated into dream content, typically in an unmodified, realistic form. When they are modified, pain sensations may be amplified or referred to other body parts or attributes of the dream. Pain also has a powerful motivational/affective influence on the formation of dreams. It can shape entire sequences of "problem-solving" activities and emotional reactions. It is likely that mechanisms in both brainstem and limbic systems modulate the incorporation of pain sensations into the dream content of REM sleep.

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