2

The Anti-Freud

Those dreams that on the silent night intrude,
And with false flitting shapes our minds delude,
Jove never sends us downward from the skies,
Nor do they from infernal mansions rise;
But all are mere productions of the brain.
And fools consult interpreters in vain.
—Jonathan Swift, "On Dreams"

J. ALLAN HOBSON VIVIDLY REMEMBERS sitting on the shore of a lake in Maine on a starry summer night as his teenage buddies marveled at the immensity of the universe and the mysteries that other galaxies might hold. "It seemed so silly to focus wonder exclusively on the universe when there was so much behind our eyes that we didn't understand," he recalls. "What intrigued me was how our minds had the capacity both to construct that image of the cosmos and to generate these romantic feelings about it." At the time, Hobson was a counselor at a summer camp for dyslexic students run by his mentor, an educational psychologist named Page Sharp. Sharp gave the young man from Hartford, Connecticut, advice that became the underlying theme of his career: to comprehend the mind and all its mysteries, you must study the brain.

When he arrived at Harvard in 1955 to study psychiatry and neuroscience, Hobson was a Freud devotee, having avidly devoured *The Interpretation of Dreams* and everything else Freud had written. Even his undergraduate thesis in English focused on Freud and Dostoyevsky. But by the time Hobson began his residency a few years later, he was becoming skeptical of Freud and disillusioned with psychiatry in general because neither seemed solidly grounded in anything he'd learned about how the brain worked.

"In our training as residents, we were treated as if we were psychoanalytic patients—as if any question we asked were motivated by some neurotic conflict. That was abusive to patients and abusive to us," Hobson explains on a warm autumn afternoon in the sun-drenched study of his lovely Victorian home, just a short drive away from his lab at Massachusetts Mental Health Center. As an example, he recounts an incident that occurred during a seminar for first-year residents. Jack Ewalt, then head of Harvard's psychiatric department, remarked that Hobson seemed to believe that neuroscience would actually be able to explain how consciousness was created by the brain—a prospect Ewalt considered iffy at best. When Hobson said that he didn't just believe it but knew it, Ewalt gave him a psychoanalytic response: "You're talking to me as if I were your father." The young resident's reply was classic Hobson: "No, my father would never make a stupid comment like that."

When Hobson was only one year into his residency, he left Harvard for a stint at the National Institutes of Health (NIH), where he became intrigued by sleep research upon meeting Frederick Snyder, a senior scientist and early dream researcher who was doing REM recordings at night in the neurology lab. When Snyder told Hobson he could actually tell when people were dreaming, Hobson—never one to take anything on faith—said he wouldn't believe it until he saw it for himself. "When I watched the brain waves changing in a sleeping subject, I was hooked in one night," Hobson recalls.

He was thrilled to get a year-long fellowship in Lyon in 1963 with Michel Jouvet, whose work on the sleep cycle of cats seemed just the sort of hard scientific exploration he was craving. Jouvet referred to

REM as paradoxical sleep, and dreaming as "a third state of the brain, which was as different from sleep as sleep is from wakefulness."

Hobson was particularly interested in Jouvet's experiments with cats that still experienced REM sleep even though their forebrains had been surgically removed. Jouvet's work indicated that REM sleep itself was triggered by a knob-shaped area called the pons at the base of the brainstem, and Hobson believed that it would be possible to discover exactly how this happened by probing a cat's brainstem with microelectrodes, tiny devices that could detect the firing of individual brain cells. He says Jouvet saw no merit in his plan, so Hobson decided to return to Harvard before the year was up. He got permission to do his animal research part-time while he finished his psychiatric residency at nearby Massachusetts Mental Health Center, where he set up his neurophysiology lab in 1968.

One of his fellow psychiatric residents was Eric Kandel, who later received the Nobel Prize for research demonstrating that the neurochemical serotonin played a crucial role in learning. Kandel, who had done his experiments with snails, advised Hobson to start his research on the mechanics of REM sleep in the simplest animal possible. But REM was difficult to detect in animals other than mammals, so Hobson ultimately decided to stick with cats. He teamed up with Robert McCarley, a medical resident who was fascinated by neurobiology but was also talented in computer programming and quantitative analysis.

Hobson, a self-described carpenter-tinkerer, built his own microelectrodes to work in the brainstem, an area of the brain that had never previously been probed in a living animal. The two men combined their respective strengths and found a way to insert the microelectrodes in the brainstems of cats, identify which individual nerve cells were firing, and then send those electrical signals through an audiovisual system so they could both see and hear cells firing as the cat went through its normal sleep cycles. "McCarley and I would trade off, one manning the fort and the other running home for a while, but we often both stayed up all night recording this dramatic activity from the brainstem. We were wild, our research was on the edge, but we knew we were on the verge of finding something no one thought we'd find," says Hobson.

Among those who thought Hobson was pursuing a dead end was David Hubel, a Harvard neuroscientist, who was also using microelectrode recordings to study the visual cortex in cats to try to gain a better understanding of how the brain sees. Hubel and his collaborator Torstein Wiesel won the Nobel Prize in 1981 for that work, which explained how visual images are formed via communication between the retina and the visual cortex. "Hubel originally had worked on sleep, but he switched to studying vision because he represented the widely held view that neural activity would cease in sleep," Hobson says. "He was convinced that when we stuck a microelectrode in the brainstem we'd get nothing but silence, and of course it was the exact opposite."

What Hobson and McCarley eventually found and published in 1977 was a controversial neurophysiological explanation of dreaming that effectively kicked the legs out from under Freudian theory and most other existing psychological approaches to interpreting dream content. Based on the brain cell firing patterns they saw, Hobson and McCarley concluded that REM sleep turned on when brainstem neurons in essence flipped a switch that completely altered the brain's balance of neuromodulators—those crucial brain chemicals that act as messengers from one neuron to another and cause chemical changes inside the receiving neurons, activating or deactivating whole sections of the brain.

When we're awake, our brain is bathed in two key neuromodulators that are essential to alert, waking consciousness: norepinephrine (which helps direct and focus our attention) and serotonin. Though serotonin now is probably best known for its effect on regulating mood (Prozac and similar antidepressants work by increasing the amount of serotonin circulating in the brain), it also plays an important role in judgment, learning, and memory. After we first fall asleep, as the brain's overall level of activity falls, these two brain chemicals stop circulating and are replaced instead by another neuromodulator, called acetylcholine, that excites the visual, motor, and emotional centers of the brain and transmits signals that trigger rapid eye movements and visual imagery in dreams.

The acetylcholine-soaked brain operates under entirely different rules from its waking state: motor impulses are blocked so that we're

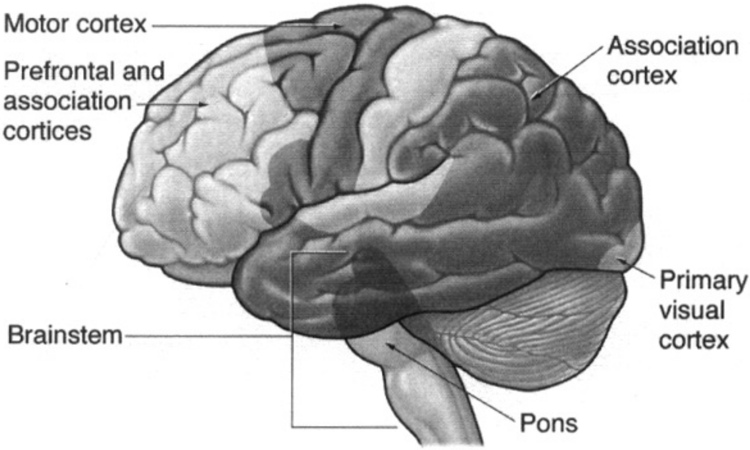

FIGURE 2.1 The pons area of the brainstem is involved in triggering the stage of sleep when vivid dreaming most often occurs. The prefrontal cortex is the seat of logical thinking; the primary visual cortex is a receiving station for signals from the retina during waking hours, and the motor cortex transforms intention into actual movements, such as running or throwing a ball. Associative cortices piece together information from the senses and memory to create the visual imagery we see whether we're awake or dreaming.

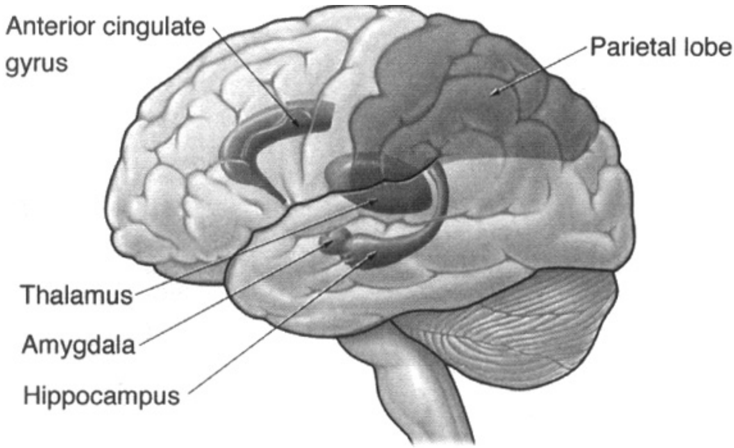

FIGURE 2.2 Brain structures or regions that play a significant role in the creation of dreams. The thalamus is a gateway for sensory information and helps direct our attention; the amygdala is at the core of our emotional system, directing the fight-or-flight response; and the hippocampus is essential in memory formation. The parietal lobe specializes in spatial orientation and forming mental imagery, while there is some evidence suggesting that the anterior cingulate gyrus may be where our sense of conscious self-awareness originates.

essentially paralyzed—in our dreams, we can't steer that speeding car down the hill or slam on the brake, no matter how hard we try. Incoming sensory information is also shut off, so the brain proceeds to interpret all of its internally generated images and sensations as if they were real. In this altered state, Hobson says, the brain does its best to spin a dream plot to match brainstem signals that may randomly stimulate an intense feeling of fear one minute or a sensation of free-falling the next. Hobson and McCarley's landmark study maintained that since the signals that initiated the creation of dream imagery came from the primitive brainstem and the more highly evolved cognitive areas of the forebrain were just passively responding to them, the dream process had "no primary ideational, volitional, or emotional content." The resulting dream was the product of the forebrain "making the best of a bad job in producing even partially coherent dream imagery" in response to chaotic signals from the brainstem.

They argued that the sense of judgment we need to recognize that we're dreaming and the ability to remember exactly what we dreamed are limited because the two neuromodulators needed for those functions are in short supply until we awaken. Therefore, we forget most of our dreams simply because we lack the neurochemicals needed to imprint them on memory, not because we have a Freudian censor in our mind furiously working to repress their taboo content.

Like a tide ebbing, acetylcholine gradually recedes and the REM period ends, only to be unleashed again roughly ninety minutes later. Hobson and McCarley said it was this consistent chemical dance led by the brainstem that generated dreams. By insisting that dreams contain no hidden message and that the dreaming process itself is triggered by an electrochemical process as automatic and devoid of thought as a heart beating or lungs breathing, Hobson was eviscerating Freudian dream theory. As for Freud's former disciple Carl Jung, Hobson dismissed his notion of the collective unconscious and archetypal symbols as a form of religion—something for which he had no patience—but he agreed with Jung that dreaming was a creative process in the brain and any meaning that resulted was absolutely transparent.

Hobson was not arguing that dreams were meaningless; in fact, he himself considers dreaming simply another form of consciousness and records significant dreams right along with highlights of his waking experience in personal journals that's he kept since 1973, now totaling more than 120 volumes. But he insisted that every single characteristic of a dream could be traced to the underlying physiology of the brain during REM: "Dreams are bizarre because the brain has stopped secreting the chemical guidance systems we have in place when we're awake, and this is the result: you can't think your way out of a paper bag, you hallucinate, you make all these errors in judgment, emotion runs wild—with anxiety, elation, and anger predominating—and you can't remember much of it."

In his view, the settings and characters our brain dredges up from our personal memories or imagination as it scrambles to form a plot to respond to this chaotic electrochemical state may reflect our emotional preoccupations, and reflecting on those preoccupations can provide insight. But the plot fits the emotions, and we can easily infer meaning without having to decode symbols in dreams to find forbidden wishes or repressed memories.

Armed with his physiological evidence that Freudian theory was based on outmoded biology, Hobson delighted in Freud bashing, especially when he spoke at professional meetings filled with psychotherapists, some of whom he debated on stage. "We pulled out all the stops, we were almost gloating, and as a result we made enemies for life," says Hobson now, acknowledging that he "created heat where light may have been more useful."

He has no regrets, however, about his efforts to repackage his dream research for mass consumption through a novel science-as-art exhibit that opened in Boston the year his landmark study was published. Titled *Dreamstage: A Multi-Media Portrait of the Sleeping Brain,* the exhibit's main attraction was a volunteer who could be seen through a one-way mirror sleeping while hooked up to an EEG that monitored brain waves, eye movements, and muscle tone. Instead of the electrical signals being scratched out in ink on reams of paper as they would be in a sleep lab, every brain-wave change, every eye movement and muscle twitch was converted into waves of laser lights rippling on the walls—brain waves in green and eye movements shimmering in blue. The signals also were represented in audio form as changing musical tones beamed from a synthesizer, the brain's version of a little night music. To emphasize the feeling of going into a bedroom environment, visitors were asked to remove their shoes before entering the carpeted, darkened exhibit rooms. "The only people who objected to taking off their shoes before coming in were some psychiatrists. They accused me of having a foot fetish," Hobson says.

Crowds flocked to the exhibit, which was featured on the cover of the *New York Times Sunday Magazine*. Its popularity led to a traveling version of *Dreamstage* the next year, when the exhibit made a six-city tour across the United States, starting in San Francisco. Federico Fellini, whose films Hobson had admired for their dreamlike quality, was so taken with the concept of *Dreamstage* that he told Hobson he'd be happy to serve as the volunteer sleeping behind the mirror if the exhibit ever came to Rome. Hobson's scientific peers, however, were less enthusiastic, grumbling that the extravaganza wasn't real science but simply egotistical grandstanding intended to publicize his theories and advance his career.

"You get publicity and everyone says you're narcissistic, which is true, but your arguments get popularized and understood when you immerse people in science this way rather than just telling them about it," Hobson says. "It was the high point of my life because I'd always wanted to be in the circus. *Dreamstage* was my circus."

When *Dreamstage* ended, Hobson recycled some of the equipment from the exhibit to set up a sleep lab in the Neurophysiology Department at Massachusetts Mental Health Center, where a series of photos of a sleeping volunteer from the show still adorns the entrance to his group's offices. But Hobson also wanted to study dreams in a more natural setting, so once again, he put his tinkering talents to work and developed a device called the Nightcap that would allow dream reports to be collected while subjects slept at home. The Nightcap was simply a bandana containing sensors that recorded eye and head movements in order to detect the beginning and end of REM sleep and transferred the information to a pocket-size recorder. Recruiting sleep study subjects instantly became easier and less costly. Tie the bandanna around your head pirate style, smooth the adhesive-backed eye movement sensor onto one eyelid, and you were ready to report dreaming data from the comfort of your own bed rather than traipsing down for a night in a sleep lab. The equipment also could be set up to automatically awaken subjects to report dreams when the sensors indicated they had entered REM.

Though all of his prior work had been done with animals, collecting dream reports had become a top priority for Hobson. Convinced that he and McCarley had figured out what triggered dreaming, he wanted to identify the formal features that characterized dreams: What were the predominant emotions and types of mental activity being experienced? How did they correspond to the physical state of the brain in REM? And how did they differ from waking cognition? In his view, the hallmarks of dreaming—hallucinatory images, disjointed narratives, wild emotions, and lack of judgment or reflective self-awareness—occurred during waking only in people whose minds were deranged. Like his nemesis Freud, he hoped that understanding how dreaming worked would shed light on the mechanics of mental illness too.

Above all, though, he hoped dream research would lead him to his Holy Grail: unraveling the secrets of consciousness, often termed the "mind-body" problem. He believes that every state of the mind—from dreaming to all forms of waking consciousness—can be explained entirely by the type of brain cell activity occurring at a given point in time. There is no "mind" over matter. Rather, mind *is* matter. Self, free will, and other such lofty concepts all boil down to a particular firing pattern among neurons. Obviously, this viewpoint disturbs anyone who believes in the concept of a soul that is separate from the body. It is hard to swallow even for the nonreligious, because it is at odds with the notion of a higher self within us that is somehow separate from the brain—the "I" who is aware of being aware.

Hobson is messianic himself in proclaiming that our emotions, memories, and thoughts are simply reflections of the Morse code of the brain's electrical and chemical activity. Nowhere is that made more clear, he argues, than in the transitions between sleep and waking, when physical changes in the brain unquestionably lead to shifts in the nature of thought and perception.

"People who object to what I say do so with that part of themselves which thinks that self is something separate and qualitatively different from the body. Yes, it's hard to imagine how consciousness arises from the brain, but it's much harder to imagine it arising without reference to anything, unless you believe in a God that controls spirits and deals them out. Accepting that the mind and brain are one severely challenges religion, but it needn't diminish the wonder of life," he says.

FORTUNATELY FOR HOBSON, such meaty questions were also of great interest to two other well-known scientists who were just forming a novel program in the 1980s to fund exactly this kind of research. The Mind-Body Network was the brainchild of Jonas Salk, famed for his polio vaccine development, and Nobel Prize–winning physicist Murray Gell-Man. Both served on the board of the MacArthur Foundation, which was in the process of providing long-term funding for cutting-edge multidisciplinary research. Hobson was one of the first three scientists chosen to participate in the group, whose members met four or five times a year to brainstorm and exchange information about their respective research projects. "I think Gell-Man and Salk felt if they had successfully tackled the problems of particle physics and infectious disease, surely our group could figure out the mind-body question," says Hobson. "I remember sitting across the table from Murray in Chicago when I explained the kind of research I wanted to do and he agreed that's exactly what they wanted, too."

For a full decade beginning in the late 1980s, the MacArthur network funded research in Hobson's lab aimed at identifying characteristics of dreaming consciousness and tracing their source to specific physiological conditions in the dreaming brain. If you dream that you're trying to run but your feet are mired in quicksand, it's simply because, according to Hobson's research, your brain's motor activity circuits have been activated by random brainstem signals. Those circuits in turn are issuing orders for your body to run, but since the brainstem is preventing those signals from reaching your leg muscles, the perception carried through into the dream is that you're trying to run but you're stuck, so you weave that into the dream's plot.

Clearly, many dreams were accompanied by strong emotions, so Hobson's group also collected data on emotions in subjects' dream reports and found that just three emotions accounted for 70 percent of the feelings dreamers said they experienced: anxiety was the most common, followed by elation and then anger. Other emotions, such as affectionate or erotic feelings, shame, and guilt, were rare in dreams, each accounting for less than 5 percent of reported emotions. This too was consistent with Hobson's theory because the chemical changes triggered by the brainstem during REM were known to stimulate the brain's emotional circuits, particularly an almond-shaped structure called the amygdala, which is the seat of the body's flight-or-fight response. If you're feeling anxious, terrified, or overcome by road rage in your waking hours, you can bet your amygdala is blasting at full volume, just as it would be when you're dreaming of being chased or of showing up totally unprepared for a final exam.

Hobson also zeroed in on what he considered another defining feature of dreams: their bizarre quality. Why does your dream start off in a hotel room in Paris, then suddenly shift to an underground cave that somehow also resembles your college dorm room? Why are you fruitlessly searching for a photo album in your bedroom and then, without any transition whatever, traveling on the space shuttle with a friend from kindergarten? According to Hobson, dreams are inherently bizarre because the portion of the brain that focuses attention, runs reality checks, and makes logical connections in waking consciousness is unhinged during dreaming. Therefore dreaming was by definition bizarre, a kind of madness.

"What we saw and looked for was shaped by what was in our minds, and we were more or less convinced that dreaming correlated with REM," Hobson says.

While REM clearly was the most favorable state for producing vivid, detailed dream narratives, other researchers had found evidence that the brain also concocts dreams in other stages of sleep. Scientists who had explored non-REM dreaming concluded that rather than dreaming only two hours out of eight per night during REM, nearly all of our sleeping hours are filled with some form of mentation, which sometimes resembles daytime thought and other times becomes more hallucinatory. Hallucinatory dreamlike thought may even briefly intrude in waking hours when our attention to external sights and sounds is relaxed. In short, they proposed that the more highly evolved, thought-producing parts of the brain were actively involved in dream creation and that the line between waking and dreaming could actually become rather fuzzy.

Hobson supported his contention that dreaming is by its very nature hallucinatory with results from his own group's experiment designed to clarify the differences between waking and dreaming mentation. They equipped test subjects with beepers so that researchers could periodically and without warning check in to sample the nature of their thinking throughout the day while they were sitting on the subway or working at their desks. At night they used the Nightcap to collect dream reports from sleep onset through non-REM and REM stages. This sampling produced eighteen hundred usable reports, which were then given to judges who scored them based on various characteristics, including degree of emotion, quality of thinking, and bizarreness. From a quiet waking state through sleep onset and on into REM, the frequency of thoughts decreased fourfold while the frequency of hallucinations rose tenfold.

MORE THAN A DECADE before Hobson and McCarley's influential theory was published, psychologist David Foulkes also had demonstrated in studies at the University of Chicago that dreaming did indeed take place outside REM. His first study showing these results became the basis for his doctoral dissertation, which he completed in 1960. Foulkes at first accepted the widely held belief that dreaming occurred only in REM, but he wanted to find out how early in the REM cycle dreams began. To be absolutely thorough, he tried waking subjects before EEG patterns signaled the beginning of REM to ask them what, if anything, was going through their minds. To his surprise, he found that more than 50 percent of the reports subjects gave on awakening indicated that dreaming was occurring even before they entered their first REM period. In later studies the percentage of REM-like dream reports at sleep onset was shown to be as high as 70 percent. "I gave up trying to find out how and where REM dreaming began, because I could find no point at which dreaming ceased," says Foulkes.

Of course, the question of how you define "dreaming" was at the heart of objections raised by those who argued that dreams occur only during REM. Hobson's definition of a dream in the attention-getting 1977 paper outlining his new theory in the *American Journal of Psychiatry* was "a mental experience, occurring in sleep, which is characterized by hallucinoid imagery, predominantly visual and often vivid; by bizarre elements; . . . and by a delusional acceptance of these phenomena as 'real' at the time that they occur." In contrast, Foulkes included as dreaming any report of mental content, including what others might call thinking. Critics argued that non-REM dream reports were less vivid and hallucinatory than REM dreams—much more like waking thought processes—and therefore not worthy of being labeled dreams.

But additional evidence that dreaming wasn't solely a feature of REM came from John Antrobus, a cognitive psychologist at the City University of New York. He found that when people sleep later than usual in the morning, they tend to have unusually vivid, memorable dreams, the "superdreams" that they often describe to others. This is the time of day when the body's internal clock shifts as we approach waking and causes widespread brain activation. Dream reports during this time frame contained visual images that were brighter and clearer than in the typical dream, and they also were unusually detailed and long, regardless of whether they occurred during REM or non-REM sleep. "If dreams were uniquely correlated with REM sleep, this wouldn't have been the case," Antrobus says.

Certainly, the typical REM dream report tends to be longer and more detailed than the average non-REM account, as shown by the following two dream reports collected in a 1963 study by Allan Rechtschaffen and Gerald Vogel. Awakened during slow-wave, non-REM sleep, a subject gave this dream description:

> I had been dreaming about getting ready to take some kind of an exam. It had been a very short dream. That's just about all that it contained. I don't think I was worried about it.

The same sleeper was awakened during REM later in the night. Even though the subject matter of the dream described below is similar to that of the earlier one, there are obvious differences in the length and degree of detail in the reports:

> I was dreaming about exams. In the early part of the dream, I was dreaming that I had just finished taking an exam and it was a very sunny day outside. I was walking with a boy who was in some of my classes with me. There was sort of a break, and someone mentioned

> a grade they had gotten in a social science exam, and I asked them if the social science marks had come in. They said yes. I didn't get mine because I had been away for a day.

While REM dreams typically were longer as well as more emotionally charged and colorful than their non-REM counterparts, Foulkes found—as Antrobus did—that as the night progressed, dreams from non-REM sleep were often indistinguishable from REM dreams. The following dream report from a subject awakened twenty-five minutes after the last REM period of the night is a prime example:

> I was with my mother in a public library. I wanted her to steal something for me. I've got to try and remember what it was, because it was something extraordinary, something like a buffalo head that was in this museum. I had told my mother previously that I wanted this head and she said, all right, you know, we'll see what we can do about it. And she met me in the library, part of which was a museum. And I remember telling my mother to please lower her voice and she insisted on talking even more loudly. And I said, if you don't, of course, you'll never be able to take the buffalo head. Everyone will turn around and look at you. Well, when we got to the place where the buffalo head was, it was surrounded by other strange things. There was a little sort of smock that little boys used to wear at the beginning of the century. And one of the women who worked at the library came up to me and said, dear, I haven't been able to sell this smock. And I remember saying to her, well, why don't you wear it then? For some reason or other I had to leave my mother alone, and she had to continue with the buffalo head project all by herself. Then I left the library and went outside, and there were groups of people just sitting on the grass listening to music.

While a roomful of psychologists could argue endlessly about how to interpret that dream, there's no disputing that it would be hard to distinguish it from the typical REM dream. Subsequent studies have indicated that at least 5 to 10 percent of awakenings outside REM produce dream reports that are identical to those in REM, though there is no question that the majority of vivid, storylike dreams do occur when our brains are in the highly activated REM phase of sleep.

Like Hobson, Foulkes put no stock in Freudian dream analysis or other forms of dream interpretation. He believed that dreaming as we experience it is the accidental by-product of two separate evolutionary developments: the emergence of REM sleep and the development of consciousness in humans, which created the urge to make narratives out of any available data the brain receives. Whenever the story-spinning portions of the brain were activated, as they regularly were in REM, they couldn't help but churn out a dream.

The conclusions Foulkes reached about the basic nature of dreams, however, were different from Hobson's. First, he concurred with John Antrobus that dreams were not inherently bizarre. He suggested that the perception of all dreams being wild, hallucinatory sagas springs from the fact that most of the dreams we remember are so emotionally charged or odd that they wake us. We sleep through the blander, more realistic ones that fill the bulk of our hours, and thus don't recall them.

He based his views on evidence from his own work in the sleep lab, which he considered the best setting for collecting dream reports. When researchers monitored subjects' EEG patterns in a sleep laboratory and awakened them in the midst of both REM and non-REM episodes, many of the dream reports they collected indeed lacked the bizarre flights of fancy and sudden shifts of setting we associate with dreaming. Just as a witness's report taken at the scene of a car accident would be more accurate than her recollection of details hours later, immediate reports of nighttime dream content were more reliable than accounts based on memories of dreams after awaking in the morning, Foulkes argued. A truly representative sampling of a night's worth of dream reports collected in the lab contained for the most part relatively coherent images strung together in a plausible way.

Foulkes also concluded that the creation of dreams as we know them is a high-level cognitive process that develops much later than most people assume. His conclusions emerged from meticulous, extended studies of children's dreaming, which provided fascinating insights on how human consciousness develops. As he explained in his book *Children's Dreaming and the Development of Consciousness*, "To dream, it isn't enough to be able to see. You have to be able to think in a certain way. You have to be able to simulate at first momentarily, and later in more extended episodes, a conscious reality that is not supported by current sense data and that you've never experienced before."

Foulkes's groundbreaking studies of children's dreams came about almost by accident. In a variation on the University of Chicago studies he'd done exploring whether adult subjects' dream content could be manipulated by viewing violent films at bedtime, he began an experiment to see whether children's dreams would be affected by presleep viewing of violent and nonviolent episodes of the television show *Daniel Boone.* Though he found the TV episodes had no significant impact on kids' dream content, he realized that he'd hit upon a far more interesting research angle to pursue. "I had a slowly dawning realization of what a dope I'd been in trying to see how these silly films would change dreams when in fact we didn't even understand what the baseline properties of children's dreams were—no one had done an objective study describing what they were like," says Foulkes.

When he took a research position at the University of Wyoming at Laramie, Foulkes set up a sleep lab to study a group of children he recruited through newspaper ads for what ranked as the most extensive sleep lab project ever conducted on human dreams in either adults or children. The study was launched in 1968 with fourteen children between the ages of three and four and another group of sixteen kids who were between nine and eleven years old. With the exception of four children in the older group who moved out of town, all of the children remained in the study for five years. For nine nights a year, they came into the sleep lab, where they were awakened three times nightly, primarily during REM sleep.

The sleeping rooms were made homey with toys and posters. Parents of younger children sometimes stayed to see them off to sleep, but Foulkes also frequently served as surrogate parent, reading them bedtime stories and fetching drinks of water before it was time for lights out. Though other lab personnel often were present, Foulkes was the one who consistently awakened children to ask them the crucial question: what was happening just now? Asking if they'd been dreaming might be suggesting that he expected a positive answer and also demanded a degree of introspection that could be beyond younger children's ability. He simply wanted them to report objectively, as if they were describing what they had just seen through a car window as they were traveling down a road.

Foulkes also tested the children's waking cognitive skills in daytime sessions several times a year. To gather this information for the younger children, he ran a two-week-long nursery school during the first three summers in order to closely observe children's play behavior and interaction with other people. "We wanted to include every waking observation that might have something to do with dreaming and in effect compare the daytime child with the nighttime child," he says.

His findings were startling, for they contradicted assumptions commonly held by both scientists and parents about the nature of children's dreams. Foulkes's data showed that children's dreams didn't become similar to adults' in either form or frequency until they were between nine and eleven years old. When he awakened children in the sleep lab, the rate of any dream recall at all during REM sleep was no more than 30 percent until children passed that critical ninth birthday, after which dream reporting rates reached the adult level of around 80 percent. Even more significantly, the dream content the children described differed dramatically from adults' and evolved over time in a consistent pattern among the children studied.

The dreams of children under age five consisted primarily of brief, bland, static images in which they frequently saw animals or were thinking about daytime activities such as sleeping or eating. Typical are these dream reports from one of the children in the study—a four-year-old boy named Dean:

> I was asleep and in the bathtub.
> I was sleeping at a co-co stand, where you get Coke from.

Between ages five and eight, children's dream reports became more complex, with action sequences and interactions between characters, but the child himself didn't regularly appear as an active character in the dreams until age seven or eight. When awakened at age six, for instance, Dean gave the following report, which characterizes dreaming ability at this stage of mental development:

> A cabin at Barbara Lake. It was little and I looked in it. Freddie and I were playing around, with a few toys and things.

By age eight, Dean's dreams developed longer narratives in which he was featured as a more active player:

> My family—my sisters and my mom—and I were going on a trip skiing. We were flying there. I could see the airplane and the people and things at an airport. And when I turned around, I took the wrong plane, and I went to the Olympics instead. I got worried when I went to the Olympics because I missed the plane. I could see the people at the Olympics, they had a torch, and people skiing and stuff.

A dream reported by Dean's sister Emily at age twelve reflects the further evolution that Foulkes pinpointed as occurring after children reached eleven, when their dreams, like adults', reflect personal concerns and emotional preoccupations:

> I was in a car with two friends of mine, and another girl and her mother, who was French, was driving us home. She had a French accent and was talking to us. And there was something in the street that was mine and I told them that that was my choker out there in the street. And so we stopped and one friend got out to get it. And this other guy, her father, he was in the car too, he just drove off and left her there, standing out in the middle of the street. And we were all just looking at each other in the car, wondering. At the end of the dream I was kind of excited because he left her out there in the street all alone, and kind of angry toward him.

Critics who rejected Foulkes's conclusions have argued that collecting dreams in the sleep lab rather than a home setting biased the results. A team of researchers at Hobson's neurophysiology lab conducted a home-based study in which parents collected eighty-eight dream reports from fourteen children from age four to ten. Parents were told the study's purpose was to determine the nature and frequency of children's dreams and that they shouldn't pressure children into reporting dreams, though on five of the nights, children were instructed to repeat to themselves "I will remember my dreams" prior to going to sleep. Over a period of thirteen consecutive nights, parents collected dream reports using a microcassette recorder when they awakened children in the morning and sometimes also during the middle of the night. The results of the Harvard study showed children were able to give detailed reports of dreams that were similar to adults' in length, number of characters, settings, and bizarre qualities. Children as young as four and five years old reported dreams and said they themselves were active characters in most of them. The researchers concluded: "Because this wide range of dream mentation is only revealed to trusted confidants in a familiar and comfortable environment, an important implication is that the sleep laboratory may not be the best source of naturalistic dream data."

In response, Foulkes says that what the parents—mainly professional couples from the Boston–Cape Cod area—knew about the study influenced the results. "One can imagine not only the general cultural pressure that contemporary Cambridge-area doctors and lawyers would feel to see to it that their children perform 'well' in any test of imaginativeness," he argues, "but also specific pressure from an investigative team whose theory also specifies that children's dream reports must be imaginative." Foulkes had done studies himself showing that when the same method was used to collect children's dreams at home and in the lab, there was no significant difference in content or recall.

Other critics who doubted Foulkes's findings about children's dreams argued that the paucity and mundane content of dream reports in younger children was due to immature language and recall skills—in other words, an inability to accurately describe what they were dreaming. But Foulkes's daytime tests of the children's cognitive abilities actually showed that children who most often reported dreams did not have better memories, vocabularies, or descriptive skills than their counterparts who reported fewer dreams. Instead, the children with the most frequent dream reports were those who scored well on tests that measure visual-spatial skills, such as a standard test in which they are shown a picture of a colored pattern that they had to reconstruct with blocks. Foulkes concluded that visual imagination abilities develop gradually and are a crucial prerequisite for dreaming.

His point was supported by unexpected results among two children in the study. Two boys in the eleven-to-thirteen age group seldom reported dreams during REM awakenings. Though they had average memory and verbal skills and were adequate students in school, the boys scored abnormally low on the block design test, with results in the same range as five-to-seven-year-olds. "In their case, even more clearly than for the five-to-seven-year-olds, it can't be that the children are having dreams but simply not remembering or describing them very well. It seems much more likely that they were simply not having dreams or not having very memorable dreams," argues Foulkes.

Foulkes's argument that children younger than five lack some of the cognitive visuospatial skills essential for dreaming is also supported by studies of dreaming among the blind, some of which have been conducted by his wife, cognitive psychologist Nancy Kerr. Children who become blind before the age of five rarely experience visual imagery in dreams. Those who lose sight between the ages of five and seven sometimes retain visual imagery, while those blinded after age seven are able to dream much as sighted people do and to form visual imagery in waking consciousness, such as conjuring up a mental picture of people they've met since losing their sight. Since Foulkes found the span between ages five and seven to be the critical period in the development of dreaming, he contends that it is during this period that the brain becomes capable of creating visual images without relying on direct perceptual experience. "Dreaming is related not to how we see but to how we are able to think about persons, objects, and events when they are not physically there," says Foulkes.

That thought process, of course, is also what allows the blind to have visual experiences even though they no longer get input from their eyes. Raymond Rainville, a psychologist who lost his sight at the age of twenty-five and has since studied the phenomenon of dreaming among the blind, says that when he was newly blinded, the visual images in his dreams had the same clarity and quality of what he used to see before losing sight. "Being able to see in my dreams was the first step in my conscious recognition that sight and vision were different phenomena. Vision is a way of thinking from my point of view," he says.

But after more than three decades without sight, Rainville says that in the majority of his dreams now, he is a blind person, and most of the images in the dream are in the same category as the visual imagery he creates during waking hours. "I can create visual images of things or people I've never seen based on information I get from other senses. I've never seen my own children, but I'm very sure I know what they look like, and when I dream of them, I see them," he says. But when he dreams about the home where he grew up and experiences that occurred before he was blind, those visual images are qualitatively different—he sees them with the same clarity and confidence as he did when his eyes were available as tools for conveying information from the outside world. "Most of the imagery in dreams is memory dependant, and as you get older, more and more of memory stored is blind memory," he notes. These vivid dreams evoking preblind times occur for Rainville just a couple of times a year, and usually only when he's out of his normal routine or has experienced an emotionally provocative event in waking hours.

He recounts one dream in which he is a boy of eleven or twelve walking to the beach as he often did with his grandfather. He sees vivid images of the panorama of people passing by, particularly one alluring woman wearing a blue bathing suit and shiny black earrings. He and his grandfather stop for pizza, and as they're waiting for it to cool, his grandfather excitedly tells him to look up to see who's coming. "I am sure he means somebody from our place, family, but as I look up the scene turns into a still life. Then it is a postcard and then I know it is a dream," Rainville recalls. He says such preblind dream narratives are filled with happy imagery, but they always create powerful feelings of sadness upon awakening to the reality of being blind. "Nevertheless, remembering what it was to see plays a very important and stimulating role in maintaining the psychological capacity to visualize realistically. It is also reassuring to know that the neurological underpinnings are still there," he adds.

He says dreams also play a crucial role in his ability to navigate new surroundings and to imprint visual imagery. If he has to learn the route to his dentist's new office, he eventually has what he calls a consolidation dream, in which all of the auditory and sensory data he's absorbed on the first couple of trips is pulled together to give him a mental picture of the new place or route. Only after he's "seen" his way in the consolidation dream can he negotiate the route as if he were in his own home, where he navigates with the same confidence as a sighted person. Such dreams also help consolidate other kinds of new visual imagery. "When my daughter gets her hair cut short, I will Braille it, appreciate it, comment on it. However, the next time she crosses my path or I think about her, in my spontaneous waking image she will still be wearing long hair. Once I dream of her in her new hairdo, that is, once I have seen it, she will appear to me in it pretty much consistently from that time on." He says others who were blinded at some point after early childhood have reported similar dream experiences.

Foulkes was intrigued by the data from children's dreaming studies showing how this visualization capacity relied upon by the blind gradually and naturally emerges in children, but he was most surprised by how long it took for children's dreams to include images of themselves as active, on-the-scene actors in their own dreams. He found it particularly significant because neuropsychological evidence showed that if we couldn't generate a given category of imagery in dreaming, we couldn't do it in waking either. This suggested the startling possibility that until they are at least seven years old, children don't have a conscious self-identity. The tests psychologists use to gauge whether children have developed this sense include asking a child whether she is the same person she was when she was a baby, or whether she would be the same person if she had a different name. "In telling us about their dreams, children are telling us about operations they can and cannot perform in their mind's eye," he says. "And best of all they are telling us this without even realizing it."

In the mid-1980s, Foulkes ran another dreaming study with children between the ages of five and eight in Atlanta, where he was on the faculty at Emory University and was running a sleep lab at a state mental health institute. He wanted to see if he could replicate the first study's results on the development of conscious self-identity. He did.

Summarizing what he believes children's dreaming tells us, Foulkes says, "Consciousness is not a luxury afforded full-blown to creatures born as immature as we are and facing as much to learn as we do. Consciousness emerges slowly, and its eventual scope is not even approached until the early grade-school years. With the emergence of active self-representation, of autobiographical memory, and of a sensed self that lends continuity to experience, the human person emerges. We dream because we have achieved consciousness."

Though Foulkes intended to do further experiments using analysis of children's dreaming to identify when other key features of consciousness emerge, his hopes were dashed when his funding for dream research was eliminated in 1991 at the state facility where he operated his lab. Unable to find other backing for his research, Foulkes's career abruptly came to an end, and he retired in Oregon—a development that dream and sleep research pioneer Allan Rechtschaffen considers an unfortunate loss. "David is the most careful, considerate experimenter I've ever seen, and his work should have had more of an impact," he says. Foulkes chalks up his fate to the politics of funding meted out by government agencies. "The decision to retire was thrust upon me, and there's a sense in which I can accept responsibility because if you don't bend to the current twist of the wind in neuroscience, then you're going to drop out of favor," he says, noting that the major wind he'd resisted was the neurophysiological explanation of dreaming as the brain simply doing its best to make sense of random signals from the brainstem. "Within the field of sleep and dream research there was less and less support for basic psychology," Foulkes says.

Other researchers interested in dream content or the psychological aspect of dreams echoed Foulkes's view of how Hobson's well-publicized theories have affected the course of dream research. Observes Bill Domhoff, a dream researcher at the University of California at Santa Cruz: "Hobson comes out with his theory and becomes the anti-Freud. It vaulted him to celebrity but it was very polarizing. He becomes Mr. Science, and the other side is seen as nonscience, wiping people like Foulkes out of the picture. Hobson got the stage and the money and that shapes a field mightily."

In response to such criticisms, Hobson says being the anti-Freud certainly got him attention but he doesn't believe it helped him get funding for his work. In fact, federal funding for dream research in general began to dry up in the 1980s, with research for sleep disorders taking priority among those controlling the purse strings. "What they were really mad about is their labs got closed and they lost grants. I didn't do that. The NIH did," he says. He also denies that he dismissed the importance of psychology in the study of dreams, noting that he is in fact a great believer in psychotherapy, as long as it's the right kind—that is, in his view, not psychoanalysis. Indeed, his 1977 paper that created such a stir in the psychotherapy community clearly stated that while the primary motivating force for dreaming was physiological rather than psychological, that did not imply that dreams "are without psychological meaning or function."

Providing a broader perspective, cognitive psychologist John Antrobus says that even though Hobson and McCarley's theory still doesn't explain how a dream actually is created, he does give Hobson enormous credit for recording neuronal activity in the brainstem to confirm its role in accounting for the alternation of REM and NREM (non-REM) sleep stages, especially at a time when little attention was given to structures underlying the brain's surface. "Here was this brain that looks like it's wide awake 20 percent of the night—the EEG looks like a waking EEG," says Antrobus. "How do you account for that? We didn't know the brainstem was doing this. It was Hobson and McCarley who pointed out what was activating the brain to give it the superficial characteristics of waking. That was the big contribution of Hobson's work."

But did the brainstem really turn on dreaming? That assumption was about to be challenged by an inquisitive young man named Mark Solms, who—like Hobson—was a determined researcher with no qualms about questioning authority on a scientific point. And to make the debate even more interesting, he was a psychoanalyst and staunch defender of Freud. His findings, along with research using technology that captured the dreaming brain in action as never before, would help bridge the divide between the Freudians and the neurophysiologists and uncover further surprises about what was happening in the mind at night.