A Connectionist Explanation of Dreams

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Abstract

A new explanation is offered for the phenomenon of dreaming, based on the findings about brain activity during sleep reported in McClelland, McNaughton, and O'Reilly (1995). Many of the phenomena that make dreams seem so strange to us are explained as a byproduct of the process of storing temporary memories into permanent memory during sleep, as it occurs in the connectionist networks of the brain. This explanation provides physiological support for for Malcolm's (1962) criticism of Dement and Kleitman's (1957) interpretations of their findings about the correlation between REM sleep and dreaming, suggesting that the sense of having had a dream is an artifact of being awakened during the process of memory storage.

It's obvious that dreams are strange, but what is really strange about them? From the dream interpreters of old to the psychoanalysts of today, people have offered interpretations of the content of dreams, as if that were the strange thing about them. But the content of dreams is almost always very ordinary. If we are or have been students, we may dream about taking exams for which we are unprepared. If we need to get to some appointment on time the following day, we often dream that we have missed the appointment. If we are deprived, even temporarily, of food or water or sex, we may well dream about what we lack.

The Midrash -- the Jewish hermeneutical commentary on the Bible - -recognized that much of the content of our dreams is based on what we experienced or thought about the previous day, and Freud too was aware of this fact. The interpreters of content believed, however, that this is the unimportant part of our dreams. I propose that, on the contrary, the fact that much of our dreaming reflects the previous day's occupations is a key to explaining our dreams.

My primary observation is that what is strange about our dreams is not their content but their structure. This structure is very different from the structure of our waking experiences, and this is what makes them so hard to describe. Anyone who has ever tried to report a dream to someone else upon awakening, or write it down for later analysis, is aware of how hard it is to put the dream in narrative form. We often cannot remember what happened before and what happened afterwards. We start describing one incident in the dream and then we say, "No, actually before I went outside I put my sweater on." We aren't sure of who people are in our dreams. We say, "I saw Uncle Joe in my dream--well, I somehow knew he was Uncle Joe, but actually he looked like my high-school teacher Mr. Rogers." We often have no idea how we got from one place to another in the dream.

All these strange aspects of dreams involve their structure rather than their content. What makes dreams so weird is generally not what we dream about, but the strange way the various elements in our dreams are juxtaposed, our inability to describe exactly what happened, our sense that all sorts of impossible combinations occur in them. It's not the elements that are impossible--they are generally quite ordinary. It's the juxtaposition of the elements that defies our ordinary logic--seeing someone who looks like one person but has someone else's name, getting from A to B without going through the space that separates A from B, being our much younger self in our present surroundings, or being our present age in the house we lived in as a child.

Some Connectionist Background

The explanation I propose for all these strange aspects of dream structure is a connectionist one. It is based on a theory about the interconnections between short-term and long-term memory put forward by McClelland, McNaughton, and O'Reilly in their 1995 paper, "Why there are complementary learning systems in the hippocampus and neocortex." The paper offers evidence for the existence of short-term memory stores in the hippocampus and long-term stores in various parts of the cortex. It describes the way short-term memories become incorporated into our long-term memory stores through mutual activation. Each short-term memory automatically activates the long-term memories that are similar to it in various ways, thus strengthening these memories. Reciprocally, the long-term memories influence the short-term ones that activated them, changing them slightly to conform with the long-term structures, so that we remember often-repeated incidents as more similar to the usual situation than they may actually have been.

One of the interesting new findings reported by McClelland et al. is that much of this activity of incorporating short-term memories into long-terms ones occurs during sleep. Based on this finding, I suggest that it is the occurrence of this activity during sleep that is responsible for the entire phenomenon of dreaming, including the strange structural nature of our dreams. Moreover, it can provide some insight into the empirical findings of the scientific dream researchers and reconcile them with our ordinary, "common-sense" beliefs on the subject.

Dement's Findings

The dream research that was so popular a few decades ago, begun by Dement and Kleitman (1957), established that there are periods of REM sleep, when the sleeper's eyes are in rapid movement, and periods of non-REM sleep, when the sleeper's eyes are not moving. Sleepers who are awakened during REM periods report dreams, while those awakened during non-REM periods report vague thoughts that do not constitute a "dream." The dream researchers interpreted this finding to mean that dreams occur during REM sleep. They concluded that everyone actually dreams several times every

night, even though we only occasionally "remember" these dreams.

The idea that we are actually "conscious" during part of the time that we are sleeping--in fact, during the time when we are sleeping most deeply, since research has also established that rapid eye movements occur when we are in the deepest phase of sleep--is a very strange one, changing the meaning of the word "conscious" Let us see what we can accomplish if we try to stick to the usual meaning of the word "conscious", namely, that we are conscious only when we are awake, not while we are sleeping.

What I propose is this: We are "conscious" of our dreams only when we wake up and have a subjective awareness of the brain activity that has just been occurring while we were asleep. That is what being conscious consists of--having an experiential, subjective awareness of our brain activity, like seeing the color green when a particular combination of wavelengths induces activity in our visual cortex. According to McClelland et al.'s findings, our short-term memory store needs to be highly active while it is consolidating the experiences it has recorded during the day with our long-term memories and knowledge. If we wake up while this activity is occurring, we become "conscious" of the events that occurred during the day that were recorded in these neural nets in our short-term memory. Since the way we normally know that something has just happened to us is that it is active in our short-term memory, we have a subjective awareness of all this activity as if we have just had the experiences that are represented in the neural nets that are activated at the moment of awakening.

Thus Dement's (1974) conclusion that we actually dream many times every night seems to be an artifact of his research method. What seems to be true is merely that there is brain activity going on all the time we are sleeping. If someone wakes us up at a time when we have been in REM sleep we will report a dream, but the dream has been caused by the very fact that we have been awakened--if we had not been awakened, the brain activity would not have been experienced as a dream.

The Proposed Explanation of Dreaming

A similar artifactual effect can also explain the well-known phenomenon that patients whose psychotherapists encourage them tend to report more dreams, and that they seem to dream in accordance with their therapists' theory. The suggestion that they will remember their dreams causes them to wake up more often while they are in REM sleep, just as my setting the alarm for 7:30 often causes me to wake up at 7:25 and shut it off, since I hate being awakened by an alarm clock. This explains why such patients report more dreams. The reason they report dreams that accord with their therapists' theories is that their brain activity is influenced by the therapists' pronouncements, just as it is affected by anything significant to us that has occurred during the day.

The hypothesis that many types of brain activity are occurring in parallel while we are sleeping, and that we become aware of all of them simultaneously when we wake up, can explain many of the strange phenomena of dreaming. As Malcolm (1962) pointed out in his criticism of Dement and Kleitman's (1957) interpretation of their findings, there is no need to postulate that we are conscious while we are sleeping. We are conscious only when we are awake, but since we wake up with active memories of something just having happened to us, we believe that we have just been experiencing these events.

As little children, in fact, we believe that these are events that have actually occurred. We need to be taught by our parents that nothing actually happened in the "outside" world, that we were only "dreaming." The word "dream", then, is used to reify the memories activated during sleep that we happen to become conscious of as we wake up. We know that these events did not really happen while we were sleeping, yet we feel now that we are awake that we did just experience something, so we give it a name, "dream", to denote something that was experienced even though it didn't really happen. Malcolm (1962) insists that this is the only proper use of the word "dream", that the question of whether we really had an experience while we were sleeping is meaningless, as there is nothing that could be evidence either for or against it.

Then, as we grow up, having woken up "with a dream" many times, the phenomenon becomes commonplace, and we believe that we know what a "dream" is even if we might not understand the actual content of the dream. So we ignore the strangeness of the phenomenon itself and try to interpret the content of the dream. This has been the basis of all dream interpretation from the biblical Joseph to the quasi-scientific Freud. What I propose is that once we gain a better understanding of all the strange structural aspects of the phenomenon, we will see that there is no reason to try to interpret the content at all.

Let us consider the strange structural aspects of our dreams one by one and see how McClelland et al.'s connectionist description of what happens in our brain when we are sleeping explains each of these aspects. Consider first the fact that we often are confused about which event preceded which other event in the dream. The events themselves may be as ordinary as walking into a room and talking to some familiar person, but at one moment in the telling it seems as if we first walked into the room and then spoke to the person, yet the next moment the order seems to be the reverse.

My connectionist explanation for this is that these memories are activated in parallel in our sleeping brain, and so our dream experiences of these two events actually occur simultaneously. When describing the dream, even to ourselves, we automatically try to impose a narrative structure on it, with one event occurring after another, since that is how things happen to us in real life. But in the dream there are two events both of which seem to be at the focus of our attention, so we try to order them in a sequence, and are then baffled by our inability to do so. This inability is the necessary consequence of the fact that the two dream experiences actually occurred simultaneously, in parallel.

The frequent phenomenon of seeing a person in a dream, and somehow being certain that it is one person even though it looks like someone else, can be given a similar explanation. There is a simultaneous activation of our knowledge about one person, as some previous-day memory arouses our long-term memories of that person in the

association areas of the cortex, together with an activation of the way a different person looks, as the same or a different previous-day memory arouses the pattern associated with the appearance of the latter person in the visual areas of the cortex.

The explanation of how we can dream that we are at one place and then immediately find ourselves at some distant place without any transition just falls out of the general hypothesis. It is merely a special case of two separate memories being activated at the same time. One memory is of being at place A, while the other is of being at place B. As we awaken and experience both of these memories simultaneously, we try to make normal sense of them by experiencing ourselves as having been first in one place and then in the other, but this leaves us with the puzzle of how we got from one place to the other. Once we realize that these are just activations of two separate memories the puzzle dissolves.

The explanation of how we can be at our present age in the dream, yet be living in our childhood home, and many other strange juxtapositions we experience in our dreams, can be given along the same lines. Once the general principle is clear it seems fairly straightforward to apply it to the various strange structural aspects of our dreams. The content is then seen to be a mixture of the short-term memories that are being stored in the long-term storage areas of the cortex and the long-term memories activated by the short-term ones, due to various sorts of similarity between them.

In saying that dreams are no more than the subjective experience of a conglomeration of memories as if they were actually happening, I do not mean to imply that dreams cannot be used in therapy as a practical way of helping people come to terms with matters of importance to them. But then almost anything a person chooses to talk about in therapy can be used as a stepping-stone to reach important issues for that person. Dreams are merely bits and pieces of memories juxtaposed in a way that makes them seem unusual, and so they are accorded the awed respect we often give to unusual phenomena. But once we see that what is unusual is their structure rather than their content, and that this unusual structure has a natural explanation, we no longer need to consider the content of dreams as being in need of elaborate interpretation.

References

Dement, W.C. (1976). *Some Must Watch while Some Must Sleep*. New York: Norton.

Dement, W.C. & Kleitman, N. (1957). The relation of eye movements during sleep to dream activity: An objective method for the study of dreaming. *Journal of Experimental Psychology, 53*, 339-346.

Malcolm, N. (1962). *Dreaming*. London: Routledge & Kegan Paul.

McClelland, J., McNaughton, B., & O'Reilly, R. (1995). Why there are complementary learning systems in the hippocampus and neocortex. *Psychological Review, 102*, 419-457.