

can be performed at will, the stage of inspiration is less controlled and is not necessarily subject to the problem solver's conscious desires. Sleep implies abandoning this conscious effort to solve problems: Dreams can impart clues, novel approaches, or even solutions that may elude us in the daytime. History is filled with anecdotes of creative works conceived and scientific problems solved through dreaming.

Dreams have often been the source of artistic creations, producing themes and plots as well as actual finished works. Giuseppe Tartini dreamed that he sold his soul to the devil, who then played an incredibly beautiful piece of music. When he awoke, he immediately took up his violin and attempted to reproduce the music from his dream. Although Tartini felt his own piece was much inferior to the devil's, the "Trillo del Diavolo" or "Devil's Trill Sonata" is now one of his most famous works. Beethoven, Mozart, and Wagner also credited dreams with inspiring many of their compositions.

Many authors have acknowledged dreaming as a source of literary inspiration. The poet A. C. Benson composed "The Phoenix" entirely during sleep, but did not claim to understand his dream creation. Robert Louis Stevenson reported that literary ideas came to him during sleep, most notably the plot for *Dr. Jekyll and Mr. Hyde*. Perhaps the most famous example is that of Samuel Taylor Coleridge, who fell asleep one afternoon in 1797 after reading about Kubla Khan's palace in *Purchas' Pilgrimage* and dreamed over 200 lines of a new poem; on awakening, he began at once to write it down, but unfortunately was interrupted by a visitor before reaching the end. Although "Kubla Khan" remains one of Coleridge's finest and most respected works, it is unfinished because, after the visitor's departure, Coleridge could not remember the last lines he had composed during his sleep. The genesis of this poem in normal dreaming sleep is somewhat suspect, however, because Coleridge had ingested an opium-based substance shortly before falling asleep. Thus, "Kubla Khan" was perhaps induced as much by drugs as it was by dreams. Nevertheless, studies of drug-induced sleep in habituated users (which Coleridge certainly was) have shown that many aspects of sleep remain substantially the same as in normal sleep (Dement, 1972). In any case, Coleridge also published poems he created during sleep that was not drug induced.

## CREATIVITY IN DREAMS

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Scientists often characterize creativity and problem solving by four distinct stages (LaBerge, 1985, p 188). First is preparation, during which data and background information are gathered; next is a passive stage that involves abandoning any active attempt to solve the problem; then with inspiration, a novel method of solving the problem presents itself; finally, the fourth stage involves verifying that the creative solution indeed works. Although most stages of this process

## Problem Solving in Dreams

Scientists and inventors have benefited similarly from the thoughtful interpretation of a creative dream, often after a long and fruitless search for the solution to a problem. One of the most revolutionary findings in organic chemistry was reportedly made during sleep by Friedrich Kekule, who had worked for years to discover the atomic structure of the benzene molecule ( $C_6H_6$ ). One night he dreamt of many snakes flitting about together, which finally coalesced into a ring of six snakes chasing each others' tails, whirling around in a circle. When he awoke, he correctly interpreted the snake hexagon as the elusive structure of the benzene ring.

Elias Howe had been trying for years to invent an automated sewing machine that could revolutionize the sewing industry. Exhausted by his work, he fell asleep one night and dreamed he had been captured by a tribe of savages who demanded that he produce a working sewing machine. He failed, of course, so they determined to cut off his head. When he managed to escape, the natives pursued him, lobbing spears as they ran: Howe noticed that the spears each contained a hole in the spearhead. On awakening, Howe realized that the hole should not be in the dull end of the needle (as for sewing by hand), but in the sharp end. Before long, he developed a working model of a sewing machine.

A famous archaeological riddle was solved one night in 1893 by Hermann Hilprecht, who was attempting to classify and date two stone fragments with an Assyrian inscription. After making his best guess, Hilprecht fell asleep. He dreamt that an Assyrian high priest approached him in his sleep and told him that he had classified the fragments incorrectly, that they belonged together as part of a dedication to the god Ninib, and that a third fragment completing the dedication would never be found. When Hilprecht awoke and reexamined the fragments, he found that the dream was accurate in every detail for which verification was possible. The third fragment has never been found.

The creative solutions that dreams hold are not always so obvious as in Hilprecht's case, nor are they often interpreted so ingeniously as Howe's dream. Perhaps many such dreams are wasted when people who are not attuned to their dreams ignore the suggestions they offer. If James Watt

had dreamt of a molten lead shower only once and not three times, he might never have invented the shot tower (see PROBLEM SOLVING AND DREAMING).

## Dreams in Everyday Life

Although historical examples abound of dreams revolutionizing a field or producing a great work of art, these reports probably underestimate the frequency of creative dreaming. Although most lives do not become part of the historical record, they can still benefit considerably from creative dreaming. For example, Faraday (1972) writes of a gynecologist who reported learning a new surgical technique in a dream. Dement (1972) asked 200 college students, "During sleep have you ever pursued a logically connected train of thought upon some topic or problem in which you have reached some conclusion, and the steps and conclusion of which you remembered upon awakening?" A full third of the students answered that they had. This suggests that the creative solutions that dreams may contain are available to many people, not just to a limited set of brilliant minds.

Unfortunately, the power of creative dreaming, like creativity itself, is somewhat unpredictable. Nevertheless, certain factors are common to all the cases of creative dreaming cited above. The dreamers were all well prepared with background knowledge about the issue, devoted extensive daytime activity attempting to solve the problem, and through all their work became emotionally involved in the problem. Although such factors cannot guarantee that a solution will be offered through a creative dream, they certainly seem to increase the likelihood. In addition certain researchers claim that a technique to affect consciousness during REM sleep offers a way to harness the creative power inherent in dreams (LaBerge, 1985) (see LUCID DREAMING).

The mechanism by which dreams offer creative solutions to problems is unknown, but it may be that the looser cognitive associations that occur during sleep lead to the exploration of alternate possibilities not examined in the daytime (Borebly, 1984). Intense conscious efforts made along paths doomed to failure can be unshackled and released to pursue new possibilities. When the dreamer awakens, old information may have

been processed in new ways, and alternate solutions may be available. Possibly the old adage concerning a problem that cannot be solved—"sleep on it"—is correct.

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