Creativity and cortical arousal

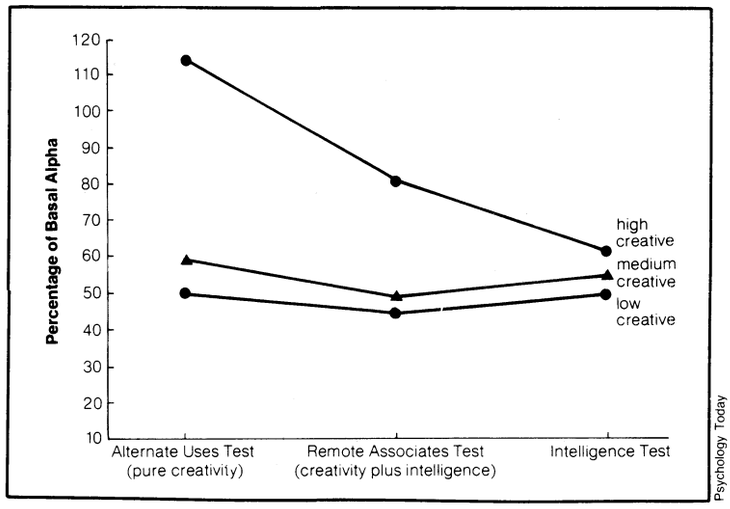
How many things can you think of to do with a brick?
Fill in the missing word: cookies, sixteen, heart, _____.

Creativity is a nebulous but obvious human quality, and serious attempts are being made to measure it and to understand it. The Alternative Uses Test, for instance, is considered to be a pure measure of creativity. It simply asks people to list as many uses as they can think of for common objects. Some people think of two or three obvious uses, while others can keep adding to the list until they are told to stop. (Bricks can be used metaphorically—"You've been a brick about this, Cynthia." Bricks can be used as bug-hiders—Set a brick on the ground, pick it up a few days later and see all the bugs hiding.)

The Remote Associates Test consists of 30 sets of three words that are related in an associative, rather than a logical, way. The testee must make the association and add a fourth word (sweet, for instance, goes with cookie, sixteen and heart). Somewhat biased, because it depends in part on intelligence, this association test is also thought to be a valid measure of creativity. Both tests have been used by Colin Martindale of the University of Maine in Portland as part of his investigation of the physiological basis of creative thought. In the July PSYCHOLOGY TODAY, he reports a link between cortical arousal and creativity.

When incoming information is on its way to the brain, the cortex is alerted. During sleep, with little input, cortical arousal is at a minimum. It increases as people go from sleep to states of reverie and daydreaming, to alert concentration and finally to emotional agitation and panic. With electroencephalograms (EEG's) the degree of cortical arousal can be measured. The slow alpha waves, for instance, are produced during periods of complete relaxation and meditation. As arousal increases, alpha decreases. And when people react to strong stimuli, for instance, alpha is blocked and replaced by faster waves.

Martindale's studies of the EEG's of high, medium and low creative people suggest that cortical arousal is directly related to creativity. Brain-wave measures were taken during a resting state. Highly creative people were found to produce alpha waves only 38 percent of the time (62 percent of the time they produced the faster waves). Medium and low creative people produce alpha up to 50 percent of the time. In other words, when tested during a resting state, creative people have higher levels of brain-wave activity than average people. Highly creative people also had higher levels of skin conductance, another measure of arousal.



Creative people produce high alpha while working on creative problems and lower alpha while concentrating on intelligence tests. Others do not vary as much in alpha production.

Martindale's findings suggest that creative people may be more sensitive to and conscious of incoming stimuli. Experiments designed to test the sensitivity of individuals to various stimuli did show that creative people tend to amplify sights, sounds and textures. Because they are oversensitive, it seems that creative people block out a great deal of alpha activity.

But creative people don't block out alpha all the time. They seem to rely on it for creativity. EEG readings were made while subjects were taking the two creativity tests and while they were taking an intelligence test. On the pure test of creativity, creative people showed greatly increased levels of alpha. Medium and low creative people produced about the same amount of alpha during all three types of tests. "In short," says Martindale, "most people produce alpha when they are relaxing, and reduce alpha when they are working on a problem. Creatives produce less alpha when they are relaxing, and increase their alpha frequency when they work on an imaginative problem." In conclusion, he says, "creative people view the world and react to it unlike most of their peers do, not because they are eccentric or strange, but because they process information differently. Creativity is not just a matter of having the proper quirks and curiosities, but of having the right brain waves." □

Gauging growth in microecosystems

Bacterial colonies have their ups and downs. If things are going well in the microenvironment, a bacterial population can double and redouble quickly. If the food supply dwindles, population growth slows. If the food supply disappears altogether or the microweather is unfortunate in the sod or marsh or mudpuddle, the colony can die out.

It often is difficult to tell what stage a microbial community is in at any particular time, even though this information could be helpful in determining the effects of, say, a pollutant on a marsh or field. Two University of Georgia microbiologists, recognizing this problem, have adapted a biochemical test that promises to be a simple and effective growth-state monitor and a useful research tool.

William J. Wiebe and Keith Bancroft report in the June PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES the use of "energy charge ratios" to determine the growth state of bacterial communities. Bacteria, like other organisms, store energy in ATP molecules. These molecules are made from the biochemical precursors ADP and AMP. The ratio of high-energy ATP molecules to lower energy ADP and AMP molecules in the cells seems to reflect the growth stage, researchers have found. Wiebe and Bancroft found that in bacterial species from various environments, natural and artificial, the ratios seem to have characteristic values—a sort of universal metabolic monitor.

The team measured the ATP-ADP-AMP ratios in bacterial samples from the open ocean, salt marsh sediments, slurries of sediment and seawater and from laboratory-grown bacterial cultures. The ratios were about the same for each of the four colonial growth phases (lag phase, boom phase, stationary phase, death phase), regardless of species or habitat.

If these ratio values can be "standardized," it may be possible to quickly measure the environmental health of bacterial colonies in the presence of perturbations such as herbicides or heavy metal pollutants. This would provide a qualitative measurement of the pollutant's effects on all the living organisms of a particular ecosystem. The system also could be used, Bancroft says, to monitor the effects of drugs on metabolism and growth phase, both in bacteria and in more complex tissues. □