as the more complex stimulus is likely to attract more attention. In any case, the average evoked response is apparently able to reflect differences in stimuli at subliminal speeds of exposure as a result of either attentional factors or specific content differences.

If attention or complexity of stimulus determines the amplitude difference in favor of R, what would account for the later reversal in favor of D for the 0.030-second condition? Attentional processes may oscillate, first being directed at the more immediately interesting stimulus and then shifting to the less interesting one. If so, this shift toward the less interesting stimulus was strongest during the supraliminal condition, which may suggest that unconscious levels of cognition may be more closely linked to the intrinsically interesting stimulus. These are hypotheses which need further investigation.

The significant correlations between the alpha average evoked response activity and the verbal subliminal effects suggests that the subject's state at the time of stimulation already predisposes toward at least one type of subliminal effect. Shevrin and Rennick (*3*) found that average evoked response alpha was more likely to occur while subjects were free associating during somatosensory stimulation than while they were attending to the stimulus or performing arithmetic calculations. Lindsley (*14*) hypothesized that alpha waves would characterize brain activity during free associating. A high incidence of alpha may be coordinate with a state of consciousness which favors fantasy, loose thought connections, and, in general, thinking of an illogical rather than a logical type. It is interesting that average evoked response alpha correlated with the rebus and clang level subliminal effects, both of which are based on illogical phonic rather than conceptual relations, while the B-C amplitures correlated with conceptual level effects. Heightened attention to subliminal stimuli as reflected in increased B-C components may be related to realistic associations, while the shift in state of consciousness concomitant with alpha may be related to unrealistic associations. With both alpha and the B-C amplitudes, the most stable estimates of the correlation with verbal subliminal effects occurred when both R and D average evoked responses were combined, which suggest that some general factors are at work to produce the optimum level of attention and state of consciousness to enhance the later emergence of verbal subliminal effects.

The subliminal verbal effects appeared only in the first 0.001-second condition, suggesting that, beyond a certain point, multiple exposures of stimuli work against subliminal influences. Furthermore, the average evoked response effects tended to diminish in the second subliminal condition. The second subliminal series followed the supraliminal condition which might have changed the manner in which the stimulus input was processed.

Our results indicate that, in the absence of a conscious discrimination, there may nevertheless be present an electrocortical discrimination related to differences in stimulus content which are also revealed in verbal associations. The average evoked response may contain a complex coding for both conscious and unconscious psychological processes of a symbolic nature beyond those heretofore suspected.

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References and Notes

1. W. Bevan, *Psychol. Bull.* **61**, 81 (1964).
2. H. Shevrin and L. Luborsky, *J. Nerv. Mental Dis.* **133**, 479 (1961); H. Shevrin and C. Fisher, *J. Abnorm. Psychol.* **72**, 362 (1967); L. Stross and H. Shevrin, *Int. J. Clin. Exp. Hypnosis* **15**, 63 (1967); L. Stross and H. Shevrin, *J. Amer. Psychoanal. Ass.*, in press; L. Stross and H. Shevrin, *J. Nerv. Mental Dis.*, in press.
3. H. Shevrin and P. Rennick, *Psychophysiology* **3**, 381 (1967); R. M. Chapman and H. R. Bradgon, *Nature* **203**, 1155 (1964); H. Davis, *Science* **145**, 182 (1964); M. Haider, P. Spong, D. B. Lindsley, *Science* **180** (1964); J. H. Satterfield *Electroencephalogr. Clin. Neurophysiol.* **19**, 470 (1965).
4. B. Libet, W. W. Alberts, E. W. Wright, Jr., B. Feinstein, *Science* **158**, 1597 (1967).
5. M. Schwartz and C. Shagass, *ibid.* **133**, 1017. (1961).
6. K. H. Pribram, D. N. Spinelli, M. C. Kamback, *ibid.* **157**, 94 (1967).
7. The verbatim instruction for the free-association procedure was as follows. It will help you to relax if you close your eyes, so would you please close them now and let them remain closed until I tell you to open them. Fine, when I tell you to begin, I want you to say all of the different individual words that come into your mind in the space of several minutes and I'll tell you when to begin and when to stop. I want you to say all of the words—about anything at all—that come into your mind, no matter how related or unrelated, how nonsensical or even silly they may seem. It's very important that you say any and all of the different words that come to mind. You can do this best by making yourself comfortable and just letting the words come up by themselves. Are you ready? Okay, begin please.
8. H. Shevrin and L. Stross, PHS grant M-2257, Progress Report, Appendix A, Manual for Scoring (1964).
9. K. A. Kooi and B. K. Bagchi, *Ann. N.Y. Acad. Sci.* **112**, 254 (1964); L. B. Speck, B. Dim and M. Mercer, *Arch. Gen. Psychiat.* **15**, 59 (1966).
10. For the vertex-occipital recordings all measures were in the same direction as for the frontal-occipital recordings although there was much greater individual variability. The frontal-vertex recordings were highly variable, and no consistency of direction could be determined.
11. For a discussion of the relation between interactions and main effects, see A. L. Edwards, *Experimental Design in Psychological Research* (Holt, Rinehart and Winston, New York, rev. ed, 1962), p. 184.
12. H. Shevrin and L. Luborsky, *J. Abnorm. Soc. Psychol.* **56**, 285 (1958); *J. Nerv. Mental Dis.* **133**, 479 (1961); D. Spence. *J. Abnorm. Soc. Psychol.* **68**, 92 (1964); D. Spence and B. Holland, *ibid.* **64**, 163 (1962).
13. R. Spehlman, *Electroencephalogr. Clin. Neurophysiol.* **19**, 560 (1965).
14. D. B. Lindsley, in *Handbook of Physiology*, J. Field, H. W. Magoun, B. E. Hall, Eds. (American Physiological Society, Washington, D.C., 1960), p. 1553.
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Terrestrial Volcanic Belts

The article by Sagan, Levinthal, and Lederberg on Martian contamination [*Science* **159**, 1191 (1968)] points up the difficulty of certainty that the planet will not be seriously affected by unmanned exploration. One statement, however, detracts from the argument because it is simply untrue. "Terrestrial volcanic belts tend to be connected by [underground] . . . river systems. . . ." I cannot think of any volcanic belts that can be said to be connected by underground river systems. Are Japan and the Aleutians so connected? Italy and the African Rift Valley? Hawaii and New Zealand? If Mars has much liquid water, it may well have underground water movement, and the groundwater could conceivably carry biological contaminants. Such groundwater movements might be related to hydrothermal water supply, which might be related to volcanic activity in some way; there is no necessary direct connection.

"Underground rivers" are special cases of groundwater movement, and are not particularly common. The authors' statement is unfortunate in an otherwise carefully reasoned article.

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