rate method for determination of $L$ and $A$ for DNA in solution, in part because the interpretive theory is simple. For example, excluded volume effects are minimal for unstretched DNA with $L \leq 100$ kb, and are further reduced by extension. The systematic underestimation of $F$ for $x > 31 \mu m$ may signal the breakdown of the conventional bending elasticity, because beyond that point the correlation length $(kT/F)^{1/2}$ becomes less than the double helix period. Further mechanical studies of DNAs that are supercoiled, single-stranded, intrinsically bent, or in contact with proteins should prove even more interesting.

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Explicit and Implicit Learning and Maps of Cortical Motor Output

Alvaro Pascual-Leone et al. (1) report that cortical motor output maps change systematically as subjects practice a reaction time task when a sequence of stimuli is patterned, but not when the sequence is random. Implicit learning, measured by comparing improvement in reaction time in patterned conditions with that in random conditions, was correlated with growth in the maps. Pascual-Leone et al. assessed explicit learning every 120 trials by asking subjects to try to describe the pattern; by their definition, explicit learning had occurred only when the subject could describe the pattern with complete accuracy. The maps returned to baseline conditions about the time explicit learning occurred. Pascual-Leone et al. suggest that the growth in the maps reflected implicit learning and that the return to baseline reflected some kind of transfer from implicit to explicit learning. This conclusion is post hoc and is inconsistent with other research on implicit learning.

Implicit and explicit learning can occur independently (2, 3), whereas Pascual-Leone et al. seem to regard the former as a precursor of the latter. In their experiment (1), subjects were asked to recall the pattern after every block of 120 trials, a procedure that is likely to have induced an explicit learning strategy. Assuming that implicit learning is automatic, both forms of learning probably occurred simultaneously under these conditions. If so, the changes observed in the maps could reflect a number of stages in implicit learning or explicit learning, or both, and not necessarily a shift from one to the other.

But the maps may not reflect implicit learning at all. Pascual-Leone et al. apparently assumed that implicit learning in the reaction time task is a motor process, but that assumption is suspect. Implicit learning is evident in this task even after the mapping of effectors to responses is changed (4) and subjects are first exposed to the repeating pattern only by watching it without making a response (5). Without a specific rationale for relating implicit learning to the cortical motor output maps, it is not clear that the growth in the maps is related to implicit learning.

It seems more likely that explicit learning caused the growth in the maps. Mean reaction time was about 200 ms five blocks before explicit learning supposedly occurred and was under 100 ms two blocks before. Such fast reaction times suggest that subjects knew in advance what stimulus to expect, which suggests explicit learning had occurred. Reaction times faster than 100 ms have previously been regarded as anticipations, and such responses are strongly correlated with, although perhaps not completely diagnostic of, explicit knowledge (3). The subjects in the study by Pascual-Leone et al. had apparently acquired explicit knowledge well before they were so classified, perhaps because the procedure induced an explicit learning strategy. Thus, the greatest growth in the maps was strongly related to explicit learning. Moreover, implicit learning has been shown to begin early in practice, in the first 100 trials (3, 6). At that stage of the experiment of Pascual-Leone et al., there was little, if any, change in the maps. Both the growth in the maps and the return to baseline were most likely caused by explicit learning. Perhaps the growth is caused by increments in explicit knowledge and the return to baseline by overlearning or automatization.

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REFERENCES AND NOTES

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