Statistical Learning, Implicit Memory, and Phonology

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This paper argues that (1) implicit memory is based on statistical learning; (2) phonological learning of word forms is based on implicit memory, and therefore that (3) phonological learning of word forms is statistical learning.

Implicit memory as statistical learning

A theoretical analysis of two key implicit memory phenomena, skill learning and repetition priming, shows that a number of apparent dissociations between them are misleading (Gupta & Cohen, 2002). First, it can be shown that the fact that skill learning but not repetition priming follows the power law of practice follows from the mathematical definitions of these constructs, and that this dissociation is therefore artifactual. Second, it can be shown that the presence or absence of correlations between these phenomena is also artifactual, and also follows from their definitions. Behavioral dissociations between these phenomena therefore cannot be regarded as evidence of a processing dissociation between them. Further, a statistical learning based computational model can be shown to account for specific empirical data, exhibiting a classic profile of skill learning and repetition priming, as well as a number of apparent dissociations between these phenomena (Gupta & Cohen, 2002). These theoretical and computational analyses provide complementary evidence that skill learning and repetition priming are aspects of a single underlying mechanism that supports implicit memory. The computational simulations suggest that this mechanism has the characteristics of statistical learning.

Phonological learning as implicit memory

The hypothesis that phonological learning of word forms is based on implicit memory predicts that implicit memory tasks employing nonwords (i.e., novel phonological word forms) should yield a typical profile of skill learning and repetition priming (e.g. Gupta & Dell, 1999). A typical multiple-repetition implicit memory task was devised in which participants were presented with nonwords. Some of the nonwords in each block of stimuli appeared only once during the experiment while other nonwords appeared in every block. Participants were simply required to repeat each stimulus as soon as it was presented. Performance functions were very similar to those in standard implicit memory tasks, exhibiting classic skill learning and repetition priming. These findings suggest that implicit memory plays a role in the learning of phonological forms, which in turn suggests a role for statistical mechanisms in phonological learning.

Further evidence of the role of distributional statistics in phonological learning comes from a second manipulation in the study. If distributional statistics play a role in the learning of phonological word forms, then a word form's frequency-weighted neighborhood density (N) should impact repetition priming. To test this hypothesis, half of the nonword stimuli had a high N and half a low N. Neighborhood density was found to have a significant impact on learning of the nonwords.

Phonological learning as statistical learning

The effects of neighborhood density provide new evidence that phonological learning is affected by the distributional statistics of the environment. The presence of classic skill learning and repetition priming effects in nonword repetition provides complementary evidence regarding the nature of the underlying learning, suggesting it is based on implicit memory. The theoretical and computational analyses suggest that implicit memory is based on statistical learning mechanisms. Together the present results provide new evidence that learning novel phonological forms is based on statistical mechanisms.

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