Specificity of Implicit and Explicit Memory

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Abstract

Considerable research has attempted to elucidate the relation between implicit and explicit forms of memory. This talk focuses on the *specificity* of implicit and explicit memory: the extent to which, and sense in which, memory performance reflects retention of specific features of a stimulus that was perceived during a study episode, the formation of a specific association between two previously presented stimuli, or a specific response that was made to a previously encountered stimulus. Cognitive, neuropsychological, and neuroimaging data will be considered that illuminate the nature and theoretical implications of the different kinds of memory specificity.

Keywords: implicit memory; explicit memory; priming

Introduction

For the past two decades, research concerning the relation between implicit and explicit memory has been a major focus in cognitive science and cognitive neuroscience. A particular aspect of implicit/explicit memory research that has emerged as a focal point in many recent discussions of neuropsychological and neuroimaging evidence, concerns *specificity* of implicit and explicit memory: the extent to which, and sense in which, memory performance reflects retention of specific features of a stimulus that was perceived during a study episode, the formation of a specific association between two previously presented stimuli, or a specific response that was made to a previously encountered stimulus. This issue has been explored primarily by studies concerning the phenomenon of priming, a form of implicit memory in which there is a change in the ability to identify or produce an item as a result of a prior encounter with that item or a related item.

Three types of specificity in priming and corresponding measures of explicit memory have been delineated: *stimulus, associative*, and *response* specificity (Schacter, Dobbins, & Schnyer, 2004). *Stimulus specificity* refers to the extent to which changing physical properties of a stimulus between study and test influences the magnitude of priming, including changes in perceptual modality, the identity of a stimulus (e.g., two different objects with the same name, such as two different chairs or pencils) as well as the size, orientation, and related physical features of a stimulus. *Associative specificity* occurs when priming is greater when associations between target items are maintained between study and test than when they are changed. *Response specificity* is demonstrated when priming is increased by having subjects make the same versus different responses at study and test to the same stimulus item. For each of the three types of specificity, I consider neuroimaging evidence provided by PET and fMRI studies, neuropsychological evidence provided by studies of amnesic patients with damage to the medial temporal lobe, and also relevant evidence from cognitive studies. I will argue that findings concerning the nature and extent of the three types of specificity have important implications for understanding the neural and cognitive underpinnings of implicit and explicit memory processes.

Response Specificity: Empirical and Theoretical Implications

To illustrate the nature of a cognitive neuroscience approach to memory specificity, consider recent data concerning response specificity in priming. Studies that have demonstrated response specificity in priming have been conducted with a view toward testing ideas that have been advanced to explain priming-related changes in brain activity observed in neuroimaging studies using positron emission tomography (PET) and functional magnetic resonance imaging (fMRI). In such studies, participants are scanned while they carry out a task used to assess priming, such as completing three letter word stems with the first word that comes to mind or making judgments about pictures of familiar objects. During primed scans, participants are given target items (e.g., word stems or objects) that appeared previously during the experiment; during unprimed scans, the target items did not appear previously. Virtually all studies using such procedures report *decreased* activity in several cortical regions during primed scans compared to unprimed scans, most consistently in areas within the frontal lobes and the extrastriate visual cortex. Wiggs and Martin (1998) argued that neural object representations are sharpened or "tuned" with repetition. By this view, when an object is presented repeatedly, the neurons that code features which are not essential for recognizing the object show decreased responding; in so doing, they weaken their connections with other neurons involved in coding the object. Thus, the network of neurons that codes the object becomes more selective, and this neural "tuning" or sharpening is linked with faster and more efficient responding.

Dobbins, Schnyer, Verfaellie, & Schacter (2004) attempted to directly contrast tuning and response learning accounts with an object decision priming task that had been used in previous neuroimaging research, and yielded evidence of reductions in priming-related activation in regions of prefrontal and fusiform cortex (e.g., Koutstaal et al., 2001). Dobbins et al. modified the task so that responses either remained the same or changed across repeated trials. In the first scanning phase, pictures of common objects were either shown once or repeated three times, and subjects indicated whether each stimulus was bigger than a shoebox using a "yes" or "no" response. In the next phase, the cue was inverted so that subjects were now required to indicate whether each item was "smaller than a shoebox"; they made this judgment about new items, and a subset of those that had been shown earlier. In the final scanning phase, the cue was restored to "bigger than a shoebox" and subjects were tested on new items and the remaining items from the initial phase.

If priming-related reductions in neural activity that are typically produced by this task represent facilitated size processing, attributable to "tuning" relevant aspects of neural representations, then cue reversal should have little effect on priming (though it could disrupt overall task performance by affecting both new and primed items). According to the neural tuning account, the same representations of object size should be accessed whether the question focuses on "bigger" or "smaller" than a shoebox. By contrast, if subjects come to rapidly recover prior responses, and this response learning mechanism bypasses the need to recover size representations, then the cue reversal should disrupt priming-related reductions. When the cue is changed, subjects would have to abandon learned responses and instead re-engage the target objects in a controlled manner in order to recover size information.

The fMRI data supported the latter account. During the first scanning phase, standard priming-related activation reductions were observed in both anterior and posterior regions previously linked with priming: left prefrontal, fusiform and extrastriate regions. When the cue was reversed, however, these reductions were eliminated in the left fusiform cortex and disrupted in prefrontal cortex; there was a parallel effect on behavioral response times. But when the cue was restored to the original format, priming-related reductions returned (again there was a parallel effect on behavioral response times), suggesting that the reductions depended on the ability of subjects to use prior responses during trials. The existence of response specificity poses a challenge not only for perceptual tuning accounts of priming-related decreases in fMRI signal, but also for theories that explain behavioral priming effects on object decision and related tasks in terms of changes in perceptual representation systems that underlie object representation. I will consider some of these theoretical issues, and also consider more recent findings concerning properties of response specificity in priming that help to elucidate the mechanisms underlying the effect and its relation to other forms of priming specificity.

References

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