The Role of Working Memory in Schema Induction

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Much progress has been made in the last twenty years both in identifying the mental processes that underlie higher-level cognition and characterizing the cognitive deficits that accompany frontal-lobe damage in patients. As Dunbar and Sussman (1995) note, however, little work has been done to help understand frontal-lobe function by linking cognitive with neuropsychological research. Though our understanding of the role of working memory in cognition has greatly increased, neuropsychologists have only recently begun to discuss the cognitive deficits in frontal-lobe patients in terms of basic processes such as working memory and attention. Thus, while it has been established that patients with frontal-lobe damage often have difficulty in performing problem-solving tasks, until recently little has been known in detail about the role of the frontal lobes in cognition. Recent work, however, has begun to associate functions such as working memory and executive control with specific regions of the frontal cortex. By understanding the roles that working memory and executive control play in higher-level cognition,it should be possible to predict which cognitive deficits should result from injury to which regions. The experiment described here seeks to more precisely characterize the working-memory requirements of one aspect of higher cognitive function, namely induction, by showing the implications that impairment of one particular aspect of working memory can have at the higher cognitive level.

Evidence suggests that the amount of working memory resources devoted to a particular task greatly affects how much is learned. There is reason to believe that working memory also influences the complexity of what is learned We propose that unimpaired executive control is essential to the process of induction through mechanisms such as analogical mapping, whereas it is less vital to simpler cognitive processes such as association learning. We argue that the high working-memory load of analogical problem-solving derives from the fact that in the course of solving problems by analogy, individuals must retain the elements of the source, the elements of the target, and mappings between source and target. In the experiment described here, we used a "dual-task" paradigm (Dunbar & Sussman, 1995) to test the hypothesis that, in situations in which central executive function is impaired, the capacity to form simple associations may remain relatively intact, even when the capacity to form complex associations is severely impaired.

Fifty participants were presented with a series of eight mathematical group problems. Mathematical groups are useful for studying structure mapping because they lend themselves to representation by a relational schema (Halford & Wilson, 1980). In addition, these tasks can be successfully performed through either structure mapping or memory for associations between pairs of stimuli.

We found that, relative to those in the control group, participants who were required to solve the problems while simultaneously performing a distractor task designed to interfere with the central executive showed impairment in the ability to make inferences based on structure mapping, even when they were permitted to learn associations between stimuli to a criterion. We interpret this finding as indicating that impairments in analogical reasoning linked to working memory deficits are at least partially attributable to the fact that analogical problem-solving places more severe demands on executive function than does association learning.

References

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