Title
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Limitations on a Theory of the Biological Origins of Compositionality

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Abstract

Cohen and Eichenbaum (C&E, 1993) proposed that the hippocampus supports compositionality and inherently, flexible relational transfer of learning. Based on this proposal, rats were tested for symmetrical transfer of learning after training on relations between locations. Since a rats hippocampus supports its spatial abilities, and since a relational test was being conducted, it was predicted that a strong degree of transfer would be obtained. The finding, however, was a general lack of relational transfer of learning. These results appear to limit the generality of C&E's theory and also seem to constrain the theory that the hippocampus is the biological seat of compositionality.

Cohen and Eichenbaum (C&E, 1993) proposed that the hippocampus supports declarative memory. They consider declarative memory to have the property of compositionality (e.g., Fodor & Pylyshyn, 1988), to be "fundamentally *relational*" (C&E, p. 62), and to, as a result, support flexible transfer of learning.

The hippocampus is known to support spatial abilities in animals such as rats (O'Keefe & Nadel, 1978). Based on C&E's theory, I predicted that if rats learned relations on mazes, and were then tested for transfer of learning of these relations, they would show a high degree of transfer.

A Test of the Spatial Domain Theory of the Origins of Compositionality

I adapted the test of emergent symmetry (Sidman & Tailby, 1982) to use on mazes, both because it requires relational transfer of learning and because nonhuman animals have general difficulty with this test. According to C&E, rats should show strong relational transfer of learning in tasks supported by their hippocampus. I predicted therefore, that rats should show emergent symmetry in their conditional relation learning on mazes.

Two separate groups of 12 male rats (*Rattus norvegicus*) were trained in two initial experiments on pairs of conditional relations between locations using four arms of a radial maze (see Table 1).

Table 1: Training on forward relations (example)

If food located NORTH, *then* food next EAST
If food located WEST, *then* food next SOUTH

If rats are capable of strong relational transfer of learning in the spatial domain, then *if-then* relations learned between locations should be symmetrically reversible for the rat. For example, given that the NORTH and EAST locations contained food at the same time (Experiments 2 & 3; see following), it should not matter that the rat always ran from NORTH to EAST. When started EAST in the testing trials (see Table 2) the rat should immediately proceed from EAST to NORTH to obtain the second food reward.

Table 2: Testing on backward relations (example)

If food located EAST, *then* food next NORTH
If food located SOUTH, *then* food next WEST

A third experiment was conducted, with a third group of 12 male rats, using a modified maze. This maze was more ecologically sound than the radial maze, having both proximal and distal stimuli available for the rats. Radial mazes are typified by their lack of proximal stimuli.

Results & Discussion

In these three experiments the rats displayed a general lack of transfer of learning from conditional relation training to symmetrical testing. One interpretation of this lack of transfer is that C&E's theory is less general than portrayed. A rats hippocampus may not always provide relational transfer of learning. Consequently, according to C&E's theory, the hippocampus supported spatial abilities of rats may be limited in their properties of compositionality.

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