Evidence for Generalized Cognitive Search Processes at Multiple Levels in a Hierarchical Problem Solving Task

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Abstract

People may use similar search processes for a variety of cognitive tasks. The theoretical basis for these generalized cognitive search processes rests on molecular and psychophysical evidence for shared processes in cognitive search across domains—e.g., visual search, problem solving, spatial search, and decision making. To investigate the extent of generalized cognitive search processes in a single task, we studied how subjects' experiences in 2-D spatial search influenced their search strategies in a subsequent lexical problem-solving task (sequential SCRABBLE) involving *hierarchical levels* of decision making. These levels included when to leave a letter set (patch) and what strategies to use when looking for subsequent words *within* a letter set.

When the spatial resource discovery required search (i.e., resources were not visible until subjects moved the icon over them), subjects took longer to leave letter sets if they had previously experienced spatially-correlated (versus uncorrelated) resource distributions, replicating a previous finding. However, when resources were visible, requiring simply harvesting rather than search, lexical patch leaving times were unaffected, suggesting that generalized cognitive search processes were primed via hypothesis-driven exploration in the spatial search phase.

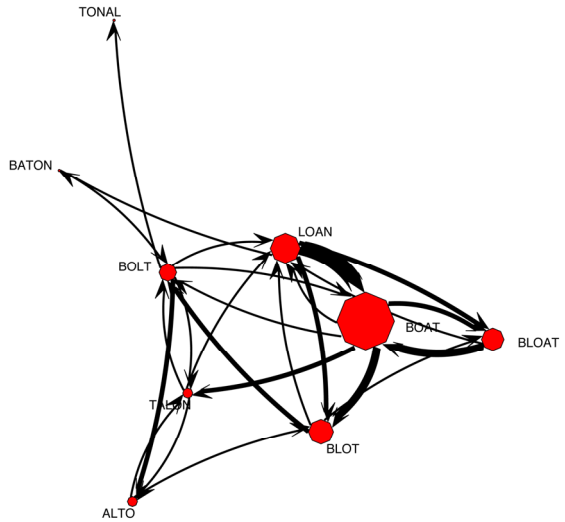

Figure 1. Observed solution transitions for subjects entering sequential solutions for the letter set BLNTAO. Arrows point to subsequent solutions; width corresponds to frequency of that transition. Dot size represents number of subjects who started with that solution.

To discover whether the effect of the spatial resource distribution prime also influenced other levels of search in the lexical task, we analyzed how sequential search decisions were made within letter sets (see Figure 1). We first modeled sequential search in a set via competing multiple cognitive hypotheses about how words were formed (e.g., edit distance) starting from the letter set or from previous solutions. We found the best fit to the data when subjects were assumed to use prior solutions as starting points for subsequent explorations.

Using this finding, we examined how the two spatial treatment conditions (correlated/clumpy or not) influenced search within the lexical problem space. Subjects who experienced spatially correlated resource distributions had *less* similarity between word solutions than subjects who experienced uncorrelated distributions. However, this was not the case when subjects only had to harvest (not search for) resources from the spatial display. We constructed a model of working memory search using a single parameter change between treatment groups to explain both letter set leaving times and inter-item similarity. The model posits that subjects can leave a letter set at any time, but also switch from the letter set to work with the previous solution at a rate related to the same parameter.

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