

Concept combination with logical connectives

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A defining trait of human cognition is the capacity to form compounds out of simpler concepts. This ability relies signally on the logical connectives AND, OR and IF-THEN. Simple statements, e.g., 'there is a fork on the table' (P) and 'there is a knife' (Q), can be combined in different ways using logical connectives. No evidence is available to date on how and where the human brain represents compounds based on different logical connectives, and how these are evaluated against new facts. Here, participants learned associations between graphic cues and conjunctive (P and Q), disjunctive (P or Q) or conditional (If P then Q) compounds. During fMRI scanning, a cue was shown, followed by a delay, during which participants recalled the compound associated with the cue. Finally, a visual scene was evaluated for compatibility with the compound. Two participant groups were recruited so that conditionals were interpreted in either of two ways: thus, same form, different semantics. The left inferior frontal gyrus (LIFG, BA44) was the only area encoding the surface form of compounds during maintenance. Activations sensitive to semantic differences between compounds emerged only during evaluation. Then, LIFG, ventrolateral PFC (BA47) and inferior parietal cortex (BA40) showed greater activations to OR and IF-THEN than AND, with BA40 being the only region responding to alternative interpretations of conditionals. Our results indicate that left prefrontal cortex represents the complete logical meaning of connectives, whereas parietal cortex operates on modified representations that may result in simplified, context-sensitive, interpretations of conditionals.

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