Similarity-based processes in human multiple-cue judgment
Evidence from brain imaging and cognitive modelling

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Background: We often make judgments that require the consideration of several sources of information. For example, a teacher that grades a student’s exam question often integrates multiple sources of information (cues: details provided in the answer) into a single criterion dimension (the grade). This is an example of a multiple-cue judgment: a continuous estimate based on multiple cues. One common idea in the literature is that people often utilize different memory representations during this kind of judgment process. People sometimes rely on rules, where they weigh the impact of different cues together in an additive linear way. At other times, people focus on the similarity between a probe and their experience of previous similar cases. It has been proposed that similarity is an important organizing principle by which people make judgments, and that similarity always influence the judgment process to some degree. Behavioral methods with cognitive modelling (fitting cognitive models of rule-based and similarity-based processes to behavioral judgment data) have been used to test when people engage in either process, based on the classification of the better model fit. The brain networks that support human multiple-cue judgment could provide some answers to the role of similarity-based processes, but the existing knowledge on this topic is limited. Here, I combined functional magnetic resonance imaging (fMRI), cognitive modelling and experimental methods to extend previous behavioral research, and I focused on the nature of similarity in human multiple-cue judgment. I explored how the two types of memory representations are represented in the brain, if rule-based and similarity-based processes are exclusively engaged or operate as an interplay during the judgment process, and tested if similarity-based processes are the default process in rule-based judgment.

Results: Study I investigated how the relationship between rule-based and similarity-based processes should be understood. The results revealed that a similarity-based process in the precuneus is shared between the two conditions: a key brain region for similarity-based processes is thus critical for human judgment. Study II further explored the precuneus role in similarity-based judgment learning, and demonstrated that the precuneus contribute to a mnemonic process related to storing and retrieving memory representations that are used for similarity comparison. Study III tested the influence of similarity-based processes in rule-based judgment when a learned rule could not be applied, and results suggested that similarity-based processes influenced rule-based behavior.

Conclusions: These findings converge to the idea that similarity-based processes are critical for human multiple-cue judgment. Specifically, a similarity-based process in the precuneus, presumably involved in storage and retrieval of memory representations that are used for similarity comparison, stands out as a novel contribution to the neuroscience of human multiple-cue judgment.

Keywords
multiple-cue judgment, similarity-based, rule-based, exemplar-based model, fMRI, cognitive modelling