

neural signals must be made with care, and in this case the possibility that implicit processing was operative failed to come to light. This oversight precluded an essential category of neurocognitive mechanism that allows decisions to be influenced by information not consciously accessible to decision makers.

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## Response to Paller *et al.*: the role of familiarity in making inferences about unknown quantities

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**The recognition heuristic is a decision strategy that relies on explicit recognition memory. We argue that conceptual implicit memory cannot account for our findings (Rosburg *et al.*, 2011) and is also too limited to account for the midfrontal old/new effect (FN400), which, in our view, is a multiply determined familiarity-related brain signal.**

Heuristics are decision rules that allow fast and frugal decisions in complex environments. The recognition heuristic is a memory-based strategy stating that, whenever two objects have to be ranked according to a criterion, the recognized object has a higher value with respect to this criterion [1–3]. How can one determine whether subjects actually rely on ‘mere recognition’, however [2], and not on other kinds of information? To address this issue, we recorded event-related potentials (ERPs) while participants performed a city-size comparison task [1]. We promoted use of the recognition heuristic by always pairing a well-known with a largely unknown city name. We were able to predict participants’ decisions on the basis of a brain signal recorded between 300 and 450 ms after stimulus onset. This is a remarkable finding for the following reasons. In its topographic and temporal characteristics, this brain signal resembled the midfrontal old/new effect (FN400), an ERP effect associated with familiarity-driven

recognition. By this, our findings support the view that the recognition heuristic relies on an early explicit memory process. As the memory processes underlying the recognition heuristic have not been explicitly examined to date [2], our results add to the increasing number of studies showing that neuroimaging data can constrain and validate psychological models.

In their comment, Paller *et al.* acknowledge the merits of our approach, but criticize a familiarity interpretation of the FN400 effect, relating this component to conceptual implicit memory instead. They state that the FN400 only correlates with familiarity under restricted circumstances, when conceptual implicit memory closely co-varies with familiarity. Paller *et al.* thus propose that conceptual implicit memory rather than familiarity is reflected in the FN400 and contributes to the decisions in the city-size comparison task. We argue here that this claim is not sufficiently substantiated.

Paller and colleagues have previously maintained that familiarity and conceptual priming should be differentially affected by some but not all experimental factors [4]. This is a valuable point to reiterate, but, by this same line of reasoning, there are a number of extant data points that challenge the position that the FN400 indexes implicit conceptual priming: retrieval intention should not affect implicit conceptual priming. Yet, an FN400 effect was observed when participants had to explicitly retrieve, but not when an implicit task was performed [5]. Retrieval orientation should not affect implicit conceptual priming. Yet, the FN400 was reported to co-vary with it [6]. Perceptual

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overlap between study and test should only minimally affect conceptual priming, yet there is increasing evidence that the FN400 co-varies with the perceptual overlap between study and test, even though the conceptual overlap is preserved [7]. One would further assume that the FN400 would correlate with behavioral measures of conceptual priming if the FN400 primarily reflects priming processes. Yet, a recent study found dissociation between these two measures [8]. These findings are all in line with the interpretation of the FN400 as a reflection of familiarity-related processes, but are almost impossible to reconcile with the view that the FN400 exclusively indexes conceptual priming.

On the other hand, demonstrating that the FN400 is affected by the meaningfulness of stimuli (e.g., [9]) does not conflict with our concept of familiarity. We recently proposed [10] that familiarity is multiply determined and that a distinction can be made between an incremental (relative) familiarity mechanism (set by the repeated exposures of an event in an experimental context) and – as in our study – the pre-experimental (baseline) familiarity of an event. This multi-factor view of familiarity also implies that conceptual priming can contribute to familiarity under some circumstances.

Perhaps the most perplexing aspect of Paller and co-workers' comment is that they base their comments upon FN400 data alone and do not attempt to theoretically address how implicit conceptual priming can contribute to decisions in the city-size comparison task. Priming effects are behavioral changes observed in tests that make no reference to previous learning episodes [4]. In contrast, the recognition heuristic assumes that inferences about a to-be assessed criterion are made on the basis of explicit memory, and is particularly useful in situations in which

recognition is highly correlated with the criterion being predicted [2], as in our study. Taken together, it is warranted to conclude that the recognition heuristic relies on familiarity and not on conceptual implicit memory.

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