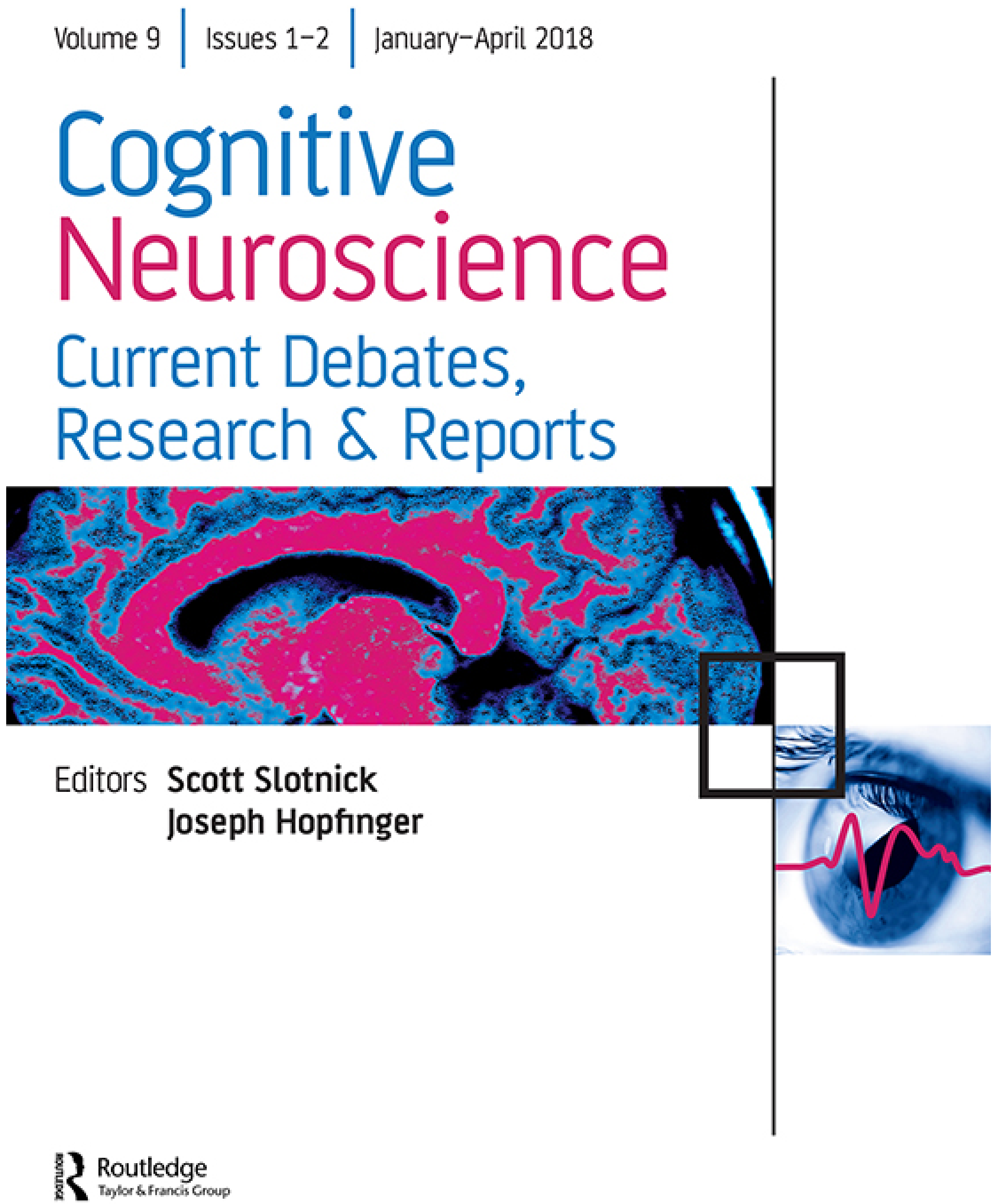

Relational properties as a source of variation for object representation in OTC

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Relational properties as a source of variation for object representation in OTC

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Abstract

The category selectivity model has shaped our understanding of the organization of object-related information in the occipitotemporal visual cortex (OTC). Ritchie *et al.* propose that OTC represents objects depending on the properties that are behaviorally relevant in a specific task/context, rather than by encoding the invariant visual properties to determine category membership. We consider this proposal in the context of recent developments that have extended the function of vision (and OTC) beyond object recognition, to include a representation of how objects relate to each other, a key piece of information for planning and acting toward behavioral goals.

Main

A vast literature in visual neuroscience has shown that OTC is the primary brain anatomy for visual object representation, with discrete areas, each selectively responding to particular stimulus categories (e.g., faces in the fusiform face area, bodies in the extrastriate body areas). Ritchie *et al.* suggest that category-selectivity is largely a byproduct of the experimenters' assumption that object recognition through categorization is the main information-processing goal of OTC. This constrains the way experiments are designed and data are analyzed –i.e., contrasting neural responses between a few *kinds* of objects, selected based on prior assumption, and presented for passive viewing. Instead, a comprehensive understanding of the OTC function would be achieved by measuring neural responses to broadly sampled objects encountered in naturalistic settings, in which the observer has a goal. This approach would reveal that the same object can be represented differently in OTC, given different goals, and that representations of objects of different categories can cluster together, if they are relevant for the same natural behavior (e.g., social interaction, navigation). In sum, OTC regions would be best understood as components of behaviorally relevant networks, rather than regions with selectivity for certain object categories.

Ritchie *et al.*'s proposal joins a broader movement that, based on new empirical findings, is redefining, and expanding, the function of visual perception, and therefore, the organization and computations in visual cortex. Moving beyond *classic* object perception experiments, with objects presented in isolation during neuroimaging, researchers have increasingly considered object perception 'in context'. The goal is to uncover visual functions that normally occur in ecological vision, where objects appear among other objects, in complex environments. This line of research has revealed mechanisms, implemented in the same ‘category-selective’ OTC areas, for precisely encoding meaningful relations between objects (Gandolfo et al., 2024; Hafri & Papeo, 2025; Kaiser et al., 2019; Papeo, 2020). For example, it has been found that the very same body in the ‘category-selective’ extrastriate body area is represented differently (as evidenced by both univariate effects and activity patterns) depending on whether it does or does not appear to interact with another body (e.g., it is spatially close and oriented toward vs. away from another; Abassi & Papeo, 2020). Similar effects in body/face representation have been reported in the ‘category-selective’ fusiform-face and fusiform-body areas (Abassi & Papeo, 2022; 2024). Likewise, the ‘object-selective’ lateral occipital cortex has been shown to respond differently to the same objects in different relations; e.g., a jug tilted toward vs. away from a glass (Roberts & Humphreys, 2010; see also Baeck et al., 2013; Kaiser & Peelen, 2018; Kim & Biederman, 2010; Walbrin et al., 2018). These kinds of effects have revealed a role of OTC in *relation perception* beyond object categorization. On this view, OTC extracts and represents relational properties of the objects –i.e., properties that specify interactions or connections between objects; e.g., mutual distance, orientation, contact–, beyond the features that specify each object’s characteristics, thus contributing to uncovering the causal and social structure of the world.

Research on *relation perception* has shown that object representation in OTC can vary depending on how, from time to time, objects relate to one another, and with respect to the observer. This research field has already let go a view of OTC as a machinery for mere object categorization, and, in this spirit, is compatible with Ritchie et al.’s proposal. Even more, *relation perception* may reveal one mechanism through which OTC contributes to achieving behavioral goals. In Ritchie’s illustration of behaviorally-relevant visual analysis of a scene, deciding to pet a dog on a woman’ leash requires the observer to process a large set of properties, many of which are relational (e.g., distance between dog and woman, their walking speed, space between them and self, dog attached to the leash). Since we now know that OTC encodes relational properties of objects, and since relations are not fixed properties of the objects, representation of relational information may help explain the variation in object representation in OTC, predicted by Ritchie et al. as an adaptation of OTC to the visual diversity of behaviorally relevant properties.

One merit of Ritchie et al.’s proposal is to illustrate, through the so-called distributed-sparse coding model, how OTC could represent objects in a way that supports various and different behavioral goals. But, just like behavioral goals can vary with respect to a given object, behavioral goals can also vary across the lifespan. Object categorization may remain a particularly important goal in the first months of life, when the behavioral repertoire is extremely limited, but learning about the physical and social world is intense and productive. Categorization is critical for generalization and abstraction. In early developmental stages, OTC may be the key substrate for supporting this goal/task, especially because vision develops earlier than other sensorimotor systems (Ayzenberg & Behrmann, 2023; Cusack et al., 2024; Kosakowski et al., 2022; Mello et al., 2025; Spriet et al., 2022; Xie, Hoehl et al., 2022). However, if OTC is initially organized by categories, we should probably recognize that this organization has more flexibility than previously appreciated.

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