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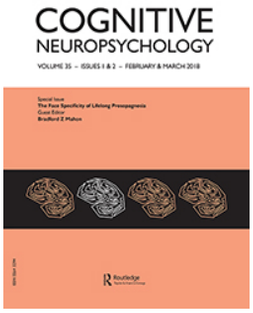

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INTRODUCTION



# The face specificity of lifelong prosopagnosia

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Humans are really good at recognizing objects by sight. How does this happen in the brain? Is the brain composed of a single, general-purpose recognition system that handles all kinds of objects regardless of type, or is it composed of multiple recognition systems, each dedicated to analysing particular categories, like faces, words, and common objects? This central issue of visual recognition research has motivated a long-running debate on the nature of prosopagnosia or face blindness. Prosopagnosia is the inability to recognize faces, and can occur following brain damage (Bodamer, 1947; Wigan, 1844), or be lifelong as a result of maldevelopment of face recognition skills (Bornstein, 1963; McConachie, 1976). The key question is whether recognition deficits in prosopagnosia are specific to faces or extend to other objects.

This question has broad implications beyond advancing theories of prosopagnosia and informing models of face recognition. Insights into the nature of deficits in prosopagnosia will guide and facilitate neural studies of the disorder (and genetic studies in the case of lifelong prosopagnosia), and they will be important for developing effective rehabilitation strategies. The face specificity of prosopagnosia will also shed light on the basic architecture of human visual recognition. Impairments restricted to faces would support a modular design, in which faces and objects are processed by distinct systems. Broader impairments that affect faces and objects would be consistent with a distributed design, in which common systems contribute to the recognition of multiple categories.

This special issue of Cognitive Neuropsychology brings together leading researchers who collectively debate and discuss the face specificity of prosopagnosia, focusing on the lifelong form (*congenital* or *developmental prosopagnosia*). Taking the lead are **Geskin and Behrmann (2018)**, who reviewed >100 papers from 1976 to 2016 and tallied the number of prosopagnosia cases that are and are not impaired with objects. With their classification, roughly 80% of >200 relevant cases showed deficits with objects. They also found that face and object deficits tend to associate in severity. They conclude that the overall pattern of impairment in prosopagnosia supports a distributed model of visual recognition, in which face and object recognition are supported by common systems running multi-purpose mechanisms.

Geskin and Behrmann's review generated a series of commentaries that move in different directions and bring up a broad range of issues. **Garrido, DeGutis, and Duchaine (2018)** argue that Geskin and Behrmann's statistical criteria for identifying object deficits are too liberal, because exactly the same criteria would have diagnosed many control participants as having object agnosia. They also argue that Geskin and Behrmann's theoretical conclusion is inconsistent with cases of face-specific prosopagnosia and note that associated face and object deficits may result from maldevelopment of distinct systems with common developmental resources. **Gray and Cook (2018)** offer a similar argument, reasoning that associated face and object deficits in prosopagnosia may not reflect common deficits, but rather separate deficits that often co-occur due to genetic and environmental factors. They make their case by pointing to the existence of pure or face-specific cases, the dissociation between different object deficits in prosopagnosia, and the elevated rates of prosopagnosia in autism despite the double dissociation between the two disorders.

By contrast, **Campbell and Tanaka (2018)** question the quality of Geskin and Behrmann's evidence for dissociations between faces and objects. They highlight the lack of attention paid to perceptual

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similarity between faces and objects, given that faces are often more similar to each other than are objects. They claim that almost 90% of the face-specific cases identified by Geskin and Berhmann may be confounded by this stimulus issue, and they encourage future researchers to devote greater care to stimulus choice and development. More generally, **Gerlach, Lissau, and Hildebrandt (2018)** contend that Geskin and Behrmann's criteria for dissociation are suspect because they infer dissociation whenever face recognition falls in the impaired range and object recognition falls in the normal range, not when face recognition is disproportionately poorer than object recognition. They also argue that a dissociation between face and object recognition may be statistically expected if the face and object tests show little or no correlation in the general population.

**Towler and Tree (2018)** take a middle road. Integrating classic and recent findings from neuropsychology, neuroscience, individual differences, and psychometrics, they propose that face and object processing rely on separate mechanisms that are not entirely independent. They also call attention to recent studies showing weak associations between recognition of different kinds of objects, such as cars and houses, raising the intriguing possibility that there are multiple recognition systems for handling not only faces and objects, but also different types of common objects.

The neural basis of prosopagnosia is discussed by **Rosenthal and Avidan (2018)**, who highlight recent imaging studies that detect abnormal connectivity across the posterior and anterior face-selective areas in prosopagnosia. They suggest the use of network science to capture the complexity of the face processing network in prosopagnosia and to map it out at a finer scale. Along similar lines, **Nestor (2018)** notes the lack of quantitative modelling of prosopagnosia with links to mechanistic accounts of normal face processing, and he identifies several avenues for moving forward. He particularly recommends studying the phenomenology of prosopagnosia using novel imaging methods that can reconstruct subjective visual experience from brain activity.

On approaches and methodologies, **Eimer (2018)** maintains that associated face and object deficits in prosopagnosia may reflect impairment of common perceptual processes for faces and objects, or impairment in earlier sensory processes that are involved in recognizing both categories. He further argues that future research needs to go beyond behavioral data and make use of tools like eye tracking and EEG, which will allow for a more precise characterization of the processes of interest. **Ramon (2018)** raises methodological points related to Geskin and Behrmann's results, including choices of paradigm, task analyses, and replications at the level of single cases. She also encourages researchers to look at processing of familiar faces and dynamic facial expressions in prosopagnosia, arguing that this would yield original insights that could advance the field in new directions. **De Gelder and van den Stock (2018)** emphasize the importance of rigorous methodologies for identifying and characterizing prosopagnosia, such as the use of standardized face and object tasks that are matched on stimulus complexity and processing demands. They also advocate that we move beyond the issue of face specificity and make clear distinctions between different subtypes of prosopagnosia, such as those with perceptual problems versus those with memory issues.

Other commentaries provide critical perspectives. **Barton (2018)** reminds us that prosopagnosia is a heterogeneous disorder that can manifest at different levels of processing (e.g., perception vs memory), so any relation between face and object deficits is interesting only if they are found at the same level. He further reflects on whether researchers can ever agree on the "right" kinds of object to test with, how to account for prior experience and expertise, and the overall quality of current data. **Starrfelt and Robotham (2018)** note that the developmental nature of lifelong prosopagnosia does not sit well with the basic assumptions of classical neuropsychology, and as a result what we can learn about normal face processing from Geskin and Behrmann's review may be limited. They also point to recent findings of normal reading in prosopagnosia, suggesting that this rules out generic acquisition of visual expertise as a core deficit in prosopagnosia. Finally, **Rossion (2018)** draws a firm distinction between acquired and lifelong prosopagnosia. He argues that the term "prosopagnosia" should be reserved for the acquired form, following its historic use to refer to the specific neurological disorder of face identification. He worries that the liberal use of "prosopagnosia" to label all kinds of non-acquired face recognition problems is not helpful and may impede progress.

Overall, this collection of articles frames a set of important questions that can serve to organize future studies on prosopagnosia and face processing, above and beyond the face specificity issue. These articles bring together the many facets of modern prosopagnosia research, emphasizing its roots in classical neuropsychology and highlighting its interface with many disciplines, including experimental psychology and vision science, psychometrics and individual differences, and cognitive and computational neuroscience. Major issues remain open: chief among them are how to formally diagnose prosopagnosia and classify its subtypes, how to properly assess object recognition and account for prior experience, and how to synthesize association and dissociation data with other evidence in the prosopagnosia and face processing literature. All in all, the collaborative nature of this exchange provides an excellent springboard to tackle those challenges. As **Behrmann and Geskin (2018)** emphasize in their response to the commentaries, time will tell whether we will ever have a complete and coherent theory of prosopagnosia, but there is no doubt that a prosopagnosia research community is emerging, and that the next decade of prosopagnosia science will be exciting.

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## Disclosure statement

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