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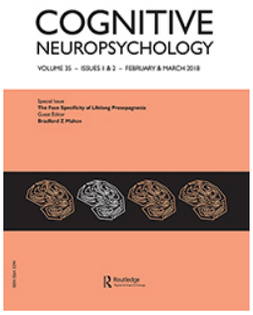

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COMMENTARY

On the use of cognitive neuropsychological methods in developmental disorders

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Geskin and Behrmann (2018) provide a thorough overview of the many studies that speak to the question of whether face and object recognition can be dissociated in congenital prosopagnosia (CP). They also raise a number of important issues regarding the theoretical and methodological foundations of cognitive neuropsychology in general, and regarding specific aspects of these in relation to CP. Such a comprehensive review of course raises a host of issues that can potentially be discussed, of which the authors have understandably selected just a few to be treated in depth. We raise here some additional issues that we think deserve further discussion.

What is the key question?

The main aim of Geskin and Behrmann's (2018) review is to "elucidate the nature of the relationship between impairments in face and nonface object recognition, and, in so doing, to characterize the functional architecture of visual recognition" (p. 4–54). They take the old question of modular versus distributed representations as their starting point and represent the distributed view as one where "object discrimination depends on dispersed regions spread across visual cortex, some of which may support the recognition of more than one stimulus class". This is not a very strong claim, and it is hard to imagine any researcher that would disagree with the proposition that object and face recognition rely on some cortical regions that support both. As also pointed out by Geskin and Behrmann, low-level aspects of vision like acuity, contrast sensitivity, and more intermediate-level visual segregation and integration processes are important for both processes. The key question, then, is: Are there processes (or regions) necessary for face recognition that are not necessary for object recognition? If this is the key question, then associations between deficits become less interesting than suggested by Geskin and Behrmann, as associations only speak to regions or processes important for both face and object recognition.

The cognitive neuropsychology of developmental disorders

The aim "to characterize the functional architecture of visual recognition" is typical of cognitive neuropsychological studies, where the relationship between impaired and preserved performance across tasks is used to create or revise models of normal cognitive function. Most commonly, this is based on studies of cognitive impairment resulting from brain injury, as seen in the study of acquired prosopagnosia. CP has by now also been extensively studied using this approach. However, classical cognitive neuropsychology might be less suitable when studying developmental disorders. There is the possibility that exactly because CP reflects a developmental deficit, it does not have implications for models of normal cognition or normal cerebral organization (Bishop, 1997; D'Souza & Karmiloff-Smith, 2011). As a disorder of development, CP may affect cognitive and perceptual processes in ways that do not readily lend themselves to the logic of cognitive neuropsychology, as the system under investigation (in all likelihood) has been abnormal from the start and has developed abnormally. Even if a dissociation between face and object recognition cannot be shown in CP, there is still the possibility that there are module-like perceptual systems for face processing in typically developed adult subjects. As pointed out by D'Souza and Karmiloff-Smith (2011), modularity might be the end state of development, but it is not its starting point.

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Conversely, if a dissociation can be shown in CP, this might not reflect the cognitive or cerebral organization of the normal adult brain.

This issue is not specific to CP or the object–face dissociation, and tackling it will possibly require extensive methodological and theoretical work, before consensus can be reached on how patterns of performance in developmental disorders might relate to theories of normal cognitive and brain function.

That said, it is of course important in itself to try to understand and characterize CP, with the long-term aim of aiding rehabilitation or compensation in individuals with this disorder. Characterizing the "clinical profile" of CP, and working towards a standard for the definition or diagnosis of CP, as suggested by Geskin and Behrmann, seems imperative. In the remainder of this commentary, we thus comment on issues we believe bear on the question of how CP may be best characterized, even if these issues might not have consequences for theories of normal visual recognition.

A note on assessment

Geskin and Behrmann (2018) discuss the struggle to find tasks that are well matched across categories (face and nonface category) and raise the problem of test sensitivity. A central issue they raise is the type of dependent measure used: accuracy or reaction times (RTs), and they use this in their classification of studies into the different evidence categories. Studies reporting normal object recognition in CP (a potential dissociation) based only on accuracy are considered less reliable evidence than studies using RT measures. While typical clinical tests measuring only accuracy are commonly not very sensitive, some tests may be sensitive even if they do not or base scores on RTs. For example, the Cambridge Face Memory Test (CFMT; (Duchaine & Nakayama, 2006), which has become a key tool for assessing face recognition in prosopagnosia, is quite sensitive although the main measure is accuracy. A study addressing the possible dissociation between objects and faces might have included the CFMT and the object parallel of this task, the Cambridge Car Memory Test. If data from individuals or groups with CP were found to reliably dissociate (assessed with statistical methods for dissociations, see below) on these tests compared to controls, this is potentially informative regarding the core deficit in CP. Conversely, a test is not necessarily sensitive solely because it measures RT. What the test measures and its level of difficulty remain more important for sensitivity than the type of output (accuracy or RT). Geskin and Behrmann also suggest using inverse efficiency scores to capture speed–accuracy trade-offs in performance, as they have done in recent studies (e.g., Collins, Dundas, Gabay, Plaut, & Behrmann, 2017). This measure should, however, be used with utmost caution, particularly when accuracy is low (<90%, Bruyer & Brysbaert, 2013). In addition, inverse efficiency should only be used when effects in accuracy and RTs are in the same direction—that is, not when there is a speed–accuracy trade off (see Vandierendonck, 2017).

Geskin and Behrmann (2018) also address questions of experimental control, and claim that "The validity of reaching conclusions about associations or dissociations rests on data from assessments of face and non-face recognition that ought to be matched in complexity and processing demands" (p. 4–54). This is an important issue, which has been somewhat neglected in previous literature (see Robotham & Starrfelt, 2017). It would have been interesting if Geskin and Behrmann had considered this aspect in more detail when weighing the evidence in the studies included in their review.

On associations and dissociations

One reason that dissociations are considered better evidence than associations in cognitive neuropsychology is that there may be many reasons for performance on two tasks to be associated (cf. Geskin & Behrmann (2018)), while the preferred explanation for a dissociation is that two independent systems are operating. To the issue "What will constitute trenchant evidence in the future" raised by Geskin and Behrmann, we would add that the key source of evidence for a dissociation is a statistical analysis of dissociation. There are now statistical methods for this both on the single case level (Crawford, Garthwaite, & Gray, 2003) and for group data (Crawford, Blackmore, Lamb, & Simpson, 2000).

It is by now evident that CP is not a rare disorder. It is also clear that it is surprisingly selective as developmental deficits go, and affects face processing

disproportionally compared to other visual stimuli. Interestingly, as Geskin and Behrmann (2018) also highlight, another visual task has been found to be unaffected in all the CP (~40) studies thus far, namely reading/word recognition (Burns et al., 2017; Gabay, Dundas, Plaut, & Behrmann, 2017; Rubino, Corrow, Corrow, Duchaine, & Barton, 2016; Starrfelt, Klargaard, Petersen, & Gerlach, in press). Thus, there is a clear dissociation between impaired face recognition and preserved reading in this group (which is even demonstrated statistically in some of these studies). This finding severely constrains the possible hypotheses regarding the core deficit in CP, in that it rules out at least some forms of low-level visual deficits. It also rules out a general deficit in acquiring visual expertise in CP, as fluent reading is perhaps the most impressive example of acquired visual expertise.

In the future, and perhaps based on the studies collected by Geskin and Behrmann (2018), it will be interesting to look at patterns of associations and dissociations across subjects with CP, to see whether this can help shed light on the core mechanism likely to be affected. This is important to understand CP and how it comes about, even if it may not have consequences for models of normal high-level vision. As an example, in a group of 10 subjects with developmental prosopagnosia (DPs) that we have studied, we find normal reading and a statistically significant dissociation between word and face recognition (Starrfelt et al., in press). In the same subjects, we find impaired object recognition, no significant dissociation between object and face recognition in any individual subject, and, importantly, a significant correlation between object and face recognition performance in the CP group (Gerlach, Klargaard, & Starrfelt, 2016). This indicates that a process common to face and object recognition, which is not involved in word recognition, is impaired in CP, echoing Farah's (1990) original review of acquired agnosias. To paraphrase Geskin and Behrmann's (2018) conclusion, these findings favour an interpretation of *a deficit in* a single mechanism that might support the recognition of more than one but not all visual classes *in congenital prosopagnosia*.

Disclosure statement

No potential conflict of interest was reported by the authors.

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