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The face-sensitivity of the N170 component

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A commentary on

Face-sensitive processes one hundred milliseconds after picture onset
by Dering, B., Martin, C. D., Moro, S., Pegna, A. J., and Thierry, G. (2011). Front. Hum. Neurosci. 5:93. doi: 10.3389/ fnhum.2011.00093

The study of face processing and its cognitive and neural basis is an exceptionally active research field (see Calder et al., 2011, for an overview). Numerous findings from electrophysiological studies using intracranial recordings (e.g., Allison et al., 1999) or event-related brain potentials (ERPs) have suggested the existence of face-selective cortical processing mechanisms. The N170 is an early face-sensitive ERP component that was first reported in the mid-1990s (Bötzel et al., 1995; Bentin et al., 1996), and has now become the most widely used ERP marker of face perception. Many published studies have used the N170 component to gain insights into the time course and functional properties of different aspects of face processing in the human brain (see Eimer, 2011; Rossion and Jacques, 2011, for reviews).

Even though important issues about the interpretation of the N170 component and its specific links to different aspects of face perception still need to be clarified, there is a consensus that this component is a valid electrophysiological marker of face-sensitive brain processes. However, findings reported by Thierry and colleagues appear to have challenged this consensus. Previously, these authors claimed that the apparent face-sensitivity of the N170 is a methodological artifact (Thierry et al., 2007): They argued that enhanced N170 components for faces relative to non-face objects were observed in previous studies because the face images used were physically much more similar to each other than individual non-face objects. This claim has already been evaluated and refuted elsewhere (Rossion and Jacques, 2008; Eimer, 2011). In fact, there are dozens of ERP studies which demonstrate that the face-sensitivity of the N170 is not simply an artifact of uncontrolled perceptual variance.

The current article from the same group (Dering et al., 2011) raises a different issue with respect to evidence for the face-selectivity of the N170 component: The cropping of photographic stimuli can result in an enhancement of ERP amplitudes in the N170 time range, and such cropping-induced enhancement effects could in principle be misinterpreted as evidence for the face-sensitivity of the N170. Dering and colleagues do indeed demonstrate larger N170 amplitudes in response to cropped as compared to uncropped stimuli, and show that this "cropping effect" is present for faces as well as for other stimulus categories (cars, butterflies).

How surprising are these findings? It is well-known that the N170 belongs to the family of visually evoked (or "exogenous") N1 components. These ERP components are elicited over posterior visual cortical areas, and their absolute size depends strongly on low-level visual stimulus parameters such as luminance, spatial frequency, contrast, symmetry, and retinal eccentricity. But the N170 component is also face-sensitive, because it is typically much larger in response to faces than to non-face objects. It is this *amplitude difference* between faces and non-face stimuli together with its characteristic scalp topography that is thought to reflect the activation of face-selective brain areas. To interpret N170 amplitude differences between face and non-face stimuli in terms of face-selective cortical processing, low-level feature differences between stimulus categories need to be controlled. Dering et al. (2011) provide a useful demonstration that cropping photographic images may introduce unwanted low-level visual feature differences that may affect N170 amplitudes in an entirely category-unspecific fashion. As is obvious when inspecting their stimuli as shown in Figure 1 of Dering et al. (2011), cropping strongly affects the luminance, contrast, and spatial frequency profiles of photographic stimuli, even when cropped and non-cropped stimuli are size-adjusted. Because this could have a strong impact on visual ERP components such as the N1/N170, it may indeed be problematic to interpret N170 amplitude differences between cropped faces and non-cropped non-faces as evidence for face-selective processing: Low-level visual feature differences associated with cropping may be sufficient to account for such effects. The results presented by Dering et al. (2011) are a useful reminder that careful stimulus control is an important requirement for all ERP experiments, and in particular for studies that measure brain responses to real-world images such as photographs of faces and non-face objects. If stimulus control is not sufficiently rigid, systematic but unrecognized between-category differences in perceptual features could lead to mistaken claims about category-specific processing.

Poor stimulus control may have led to unwarranted conclusions about the face-sensitivity of the N170 component in a few experiments. However, in the vast majority of published ERP studies on face processing, investigators have taken great care to equate the size, location, contrast, spatial frequency, and viewpoint for images of face and non-face objects, in order to minimize any differences between object categories in terms of physical stimulus attributes. Virtually all of these experiments have found larger N170 amplitudes for faces relative to non-face stimuli, including cars and butterflies (see Rossion and Jacques, 2008, for more details). Furthermore, recent rapid adaptation studies (Jacques et al., 2007; Eimer et al., 2010) have observed N170 amplitude modulations for *physically identical* face test stimuli as a function of the category of preceding adaptors (upright or inverted faces, face parts, non-faces), thus confirming the face-sensitivity of the N170 under conditions where low-level visual confounds are plainly absent.

In addition, Dering et al. (2011) also provide evidence for category-selective modulations of P1 amplitudes. It remains unclear whether these reflect early face-selectivity

or visual differences between stimulus sets. Recent results from Rossion and Caharel (2011) provide evidence for the latter interpretation. These authors measured P1 and N170 components to intact images of faces and cars and their phase-scrambled counterparts, and found P1 amplitude differences between faces and cars for both intact and scrambled stimuli, suggesting that low-level visual cues rather than processes associated with face perception were responsible. In contrast, larger N170 amplitudes for faces versus cars were only observed when images were intact, thus underlining the face-sensitivity of the N170.

In summary, the results reported by Dering et al. (2011) illustrate that N170 amplitudes are not just determined by the category of visual objects (faces versus non-faces), but also by their elementary visual features. Careful control of these features is obviously essential in order to link the N170 to face-sensitive brain mechanisms. What remains undisputed is the fact that face-selective N170 modulations have been consistently observed in previous studies where low-level visual confounds were absent, thereby demonstrating that the N170 component is a valid electrophysiological marker of early cortical face processing.

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