Controlling interstimulus perceptual variance does not abolish N170 face sensitivity

To the editor:

Numerous studies report a negative event-related potential at occipito-temporal scalp sites between 130 and 200 ms (N170) that is larger when elicited by faces than by other object categories[1,2]. Thierry and colleagues[3] argued that this effect reflects an artifact of uncontrolled interstimulus perceptual (physical) variance (ISPV), which when controlled eliminates the difference between faces and nonfaces. Here we demonstrate that ISPV was actually controlled in many studies, yet the N170 effect remained conspicuous (**Fig. 1** and **Supplementary Figures 1–3** online). Evidently, Thierry and colleagues' claim is wrong and misleading.

In addition to their factual error, they failed to note the striking contradiction between their hypothesis and the existing literature. Most notable are the larger N170 for inverted than for upright faces[2,4], the larger N170 for upright than for inverted Mooney faces, which when inverted are perceived as meaningless objects[5], the large modulations of N170 amplitude to faces induced by increasing visual expertise with nonface objects[6], and the emergence of N170 after conceptual priming of participants' awareness to the physiognomic value of stimuli, which were identical before and after priming[7]. All these modulations of N170 are robust despite identical stimuli in different conditions, hence identical ISPV.

These authors' position also suffers from conceptual weaknesses. It is not clear why categorical selectivity, but not ISPV-induced jitter, would be seen at an early P1 component, whereas the N170, which manifests higher-level visual processes, would be modulated only by ISPV. Nor do they offer any theoretical account of the larger N170 amplitude for low ISPV than for high ISPV. A larger jitter between trials evoked by high-ISPV stimuli should cause smearing of the component for this condition; thus causing not only a lower, but also a wider, component, which was not found in their study. In fact, the larger N170 to faces is due to an increase of power at a fixed latency rather than a larger phase-resetting of EEG waveforms for faces as compared with objects[8], an observation incompatible with Thierry *et al.*'s[3] speculations.

It is not our task to explain the null results of Thierry *et al.*'s[3] study. However, inappropriate measurement of the N170 and inconsistencies across their results should be considered. The N170 effect is circumscribed around occipito-temporal sites, falling off very rapidly with more medial and superior locations, and is much smaller (occasionally absent) at the medial occipital sites O1 and O2 than at more lateral posterior-temporal sites. Thierry *et al.*[3] averaged data across ten sites over each hemisphere, six of which were located close to midline, which explains their extremely small N170 to faces. This peculiarity is even more striking in Figure 6c of Thierry *et al.*[3], where positive amplitudes were observed for the N170. Further, if early P1 differences are found, N170 amplitude should be measured and analyzed with respect to the preceding peak to take into account baseline differences between conditions.

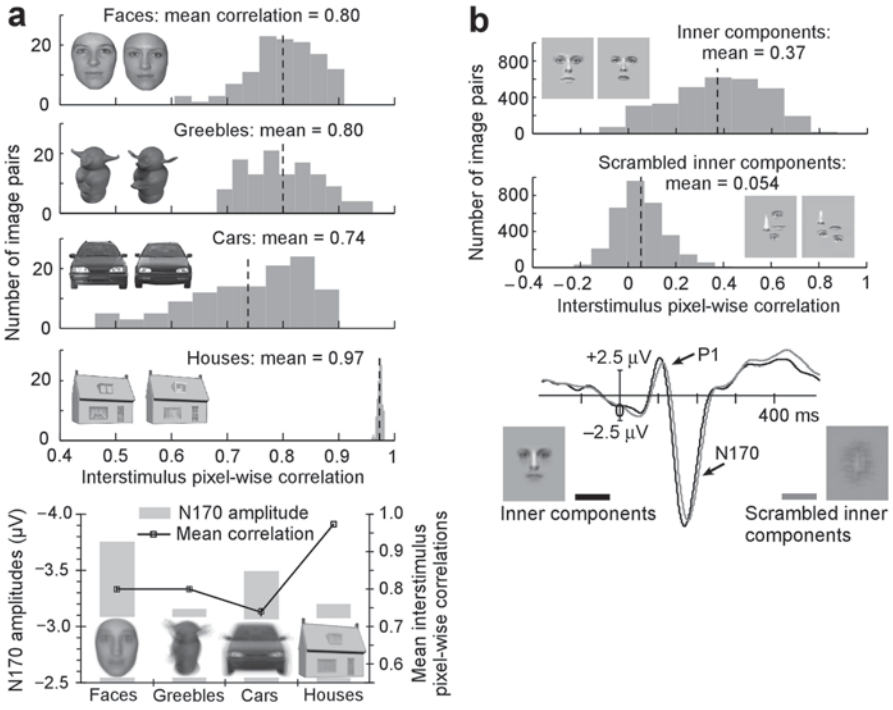

Figure 1 ISPV does not account for N170 face sensitivity. (**a**) Top, pixel-wise correlations (ISPV) for four categories of stimuli[2]. Interpixel correlation was highest for houses ($P < 0.001$), equal between faces and greebles ($P = 0.80$) and lowest for cars ($P < 0.001$). For faces and objects, correlation values were higher than those reported by Thierry *et al.*[3], indicating a better control of ISPV. Bottom, the N170 amplitudes, mean pixel-wise correlation and spatially averaged stimuli for the four categories. (**b**) Top, pixel-wise correlation for faces and scrambled face stimuli used in a previous study[11], showing higher correlation for faces than for scrambled faces. Bottom, despite the ISPV difference (see averaged stimuli), N170 was of equal amplitude for the two conditions.

Finally, the off-hand dismissal of the intracranial literature is inexcusable. These studies have identified intracranial face-specific potentials whose response properties are in agreement with the face-related N170 recorded on the human scalp[9], as well as with neuroimaging and single-cell recording findings. There is no question as to the validity of those intracranial data and to suggest that they could be artifactual as a result of the population studied is inappropriate.

To conclude, it is basic psychophysics that stimulus variance must be controlled[10], and ERPs can indeed be affected by factors such as ISPV. However, control of ISPV does not abolish the N170 face effect. Moreover, several self-contradictions in the authors' data (replotted in **Supplementary Fig. 4** online) refute their own proposal. Thus, the reported results are not valid and are not evidence against the well-established and reliable effect of larger N170s to faces than to objects.

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Note: Supplementary information is available on the Nature Neuroscience website.

COMPETING INTERESTS STATEMENT
The authors declare no competing financial interests.

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Is the N170 sensitive to the human face or to several intertwined perceptual and conceptual factors?

Reply:

In our study[1], minimizing interstimulus perceptual variance (ISPV) eliminated N170 category effects, whereas ISPV differences modulated this component. Thus, previous studies on the N170 in which ISPV was not similarly controlled are hard to interpret. We do not claim that the N170 is sensitive only to ISPV; inversion[2,3], symmetry[4], interpretability[5] and expertise[6] all affect N170 amplitudes, possibly in a face-selective fashion. Although some previous studies have used low-ISPV stimuli[2,7], comparisons between conditions differing both on object category and other dimensions can be misleading.

Consistent with our results, two studies comparing frontal views of cars and faces[2,8] found no category effect in the N170 range. Notably, in Bentin *et al.*'s Figure 1a, the N170 amplitude difference between faces and cars was not significant (the remaining conditions were asymmetrical and so were the scrambled faces of Figure 1b).

We re-emphasize that we do not equate ISPV, a psychophysical concept, with interstimulus pixel-wise correlations, a physical measure. Clearly, equivalent pixel changes at different image locations will have different psychophysiological consequences. Thus, variation among visual stimuli along different dimensions will induce different (and not necessarily linearly increasing) N170 modulations. Understanding the effect of ISPV *per se* on N170 amplitude requires a fuller understanding of perceptual similarity, which is beyond the scope of our study. The point remains that even simple efforts to minimize ISPV have a dramatic effect on apparent N170 category selectivity.

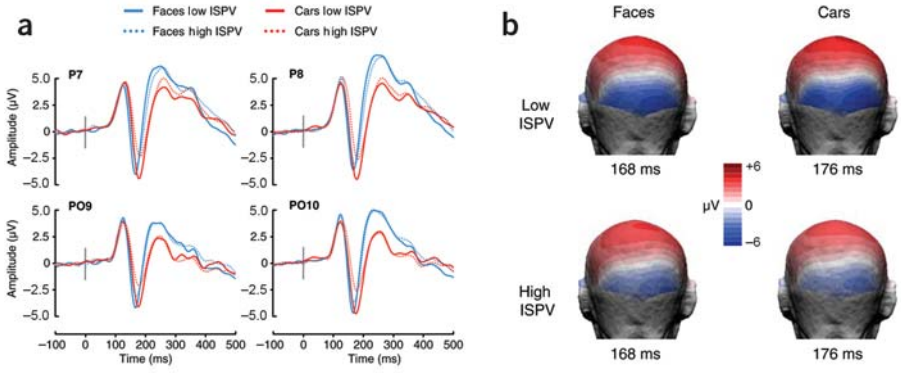

Figure 1 ERPs and N170 topographies recorded to faces and to cars in the low- and high-ISPV conditions of experiment 1 of Thierry *et al.*[1]. (**a**) ERPs at electrodes P7, P8, PO9 and PO10. In all cases, there was no effect of category (all *P*s > 0.1), a significant effect of ISPV (all *P*s < 0.001) and a significant interaction (all *P*s < 0.01), which replicates analyses conducted over ten electrodes. Notably, the N170 was not larger to faces than to cars when ISPV was controlled (low ISPV). (**b**) N170 scalp topographies in the four conditions of experiment 1. The topographies were highly similar between conditions and differed only with respect to their strength, indexed using the global field power. All electrodes included in the statistical analysis of Thierry *et al.*[1], except PO3, showed negative amplitudes in all conditions in the N170 range.