Are There Nociceptive-Specific Brain Potentials?

Ulf Baumgaertner and Rolf-Detlef Treede
Chair of Neurophysiology, Center for Biomedicine and Medical Technology Mannheim (CBTM), Medical Faculty Mannheim, Heidelberg University, Mannheim, Germany

TO THE EDITOR: In their study on factor analysis of brain responses to different stimulus modalities, Mouraux and Iannetti (2009) claimed that laser-evoked brain potentials do not reflect nociceptive-specific neural activity, although laser radiant heat pulses provide a purely nociceptive input. We appreciate this reanalysis of visual, auditory, and somatosensory vertex potentials using modern signal analysis techniques, although—in our opinion—the assertion that there is no nociceptive-specific brain response is not supported by their data.

First of all, the authors focused on late evoked potential components that are known to reflect mostly nonspecific multimodal processing steps, whereas modality-specific activity is reflected in early components (Niedermeyer and Lopes DaSilva 2004). Thus it is little surprise that they found 55–76% of the variance explained by multimodal components that consisted of a negative–positive wave maximal at the vertex (cf. Davis et al. 1972). Nevertheless, Davis et al. (1972) already demonstrated that cross-modal tactile–electrical inhibition on vertex potentials is less than unimodal tactile–tactile inhibition, suggesting that electrical stimuli recruit more than just tactile afferents.

The scalp topography of the vertex potential has been found to differ between visual and auditory stimulation (Simson et al. 1977) and even between laser and electrical stimulation (Treede et al. 1988). Mouraux and Iannetti (2009) were able to reproduce the differences between somatosensory, and other modalities by their blind source separation method, but not between two types of somatosensory stimulation (laser and electrical).

We propose that this lack of sensitivity of their source separation method is due to their choice of what they called “nonnociceptive” stimulus. Instead of applying tactile mechanical stimuli, Mouraux and Iannetti used electrical pulses applied to the superficial radial nerve at the wrist. Tactile Aβ-fibers have a lower threshold to electrical nerve stimuli than that of nociceptive Aδ-fibers, although threshold distributions significantly overlap (Treede et al. 1998). Since thin nerve fibers have a longer chronaxia than that of large nerve fibers (Geddes and Bourland 1985), the recommended stimulus duration for Aβ-fiber activation is only 0.1–0.2 ms (International Federation of Clinical Neurophysiology guidelines; Cruccu et al. 2008). With that stimulus duration, Aβ-evoked potentials to radial nerve stimulation saturate at about fourfold the detection threshold corresponding to 5.2 mA (Treede and Kunde 1995) and eightfold threshold already activates half of the nociceptor population (Treede et al. 1998). Mouraux and Iannetti used a much longer duration (1 ms) than recommended. This pulse duration is typically used when researchers intend to activate small Aδ- or even C-fibers (Inui et al. 2002; Kaube et al. 2000; Klein et al. 2004). The stimulus intensity of 10 ± 2 mA was probably above tenfold the threshold (thresholds were not reported, but in our hands was 1.3 mA at 0.2 ms and thus lower at 1 ms); thus those electrical stimuli most likely recruited both nonnociceptive and nociceptive fibers. Thus it cannot be expected that the laser pulses elicited brain activity beyond that elicited by their electrical pulses. The percept is a rather weak argument for the nature of the input since even high discharge rates in nociceptive afferents are not necessarily perceived as painful (Bromm et al. 1984); moreover, it has further been demonstrated that nociceptive laser stimuli generate similar amplitudes coming from the same brain regions if the stimulus intensity (energy) is slightly above and below the subjective pain threshold (Frot et al. 2007; Gross et al. 2007).

Furthermore, even if the authors would have used a tactile stimulus for comparison with the nociceptive laser stimulus, the question remains how sensitive the method of independent component analysis (ICA)/parallel ICA is in separating closely spaced sources. Available evidence on the location of nociceptive neurons in the brain (both nociceptive-specific and wide-dynamic range) suggests that their responses may be spatially indistinguishable from those of tactile neurons in the same regions (Kenshalo et al. 2000), which, of course, does not exclude the possibility of recording tactile and nociceptive responses from these areas. Together, these lines of evidence challenge the conclusion of this paper: that “activity of nociceptive specific cortical neurons cannot be explored using laser-evoked potentials.”

REFERENCES


