



Comment

The role of alpha activity in regulating inward and outward conscious perception[☆]

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In their intriguing work, Northoff, Zilio, and Zhang [1] examine recent psychophysiological evidence on conscious perception, concluding that post-stimulus activity is related, in an interactive, non-additive way, to spontaneous pre-stimulus activity in the alpha frequency range. In this comment, we would like to bring to the Authors’ attention two additional perspectives regarding alpha activity modulation, which are related to two classes of phenomena shaping the contents of consciousness: i) the bottom-up interoceptive effects of the body, and ii) the top-down effects on alpha power related to meditative practices. A third phenomenon refers to the controversial yet intriguing possibility that individuals could anticipate stimuli before their actual presentation, a phenomenon known as “retrocausality”. Effects of this kind have been observed at the physiological level in some studies involving emotionally activating stimuli [2,3]: although we will not focus on this in this comment, future studies should aim to investigate this effect.

Let us now consider some bottom-up effects that are linked with the body. The relatively recent and rapidly growing field of research on interoception has repeatedly showed that systematically timing stimuli presentation along the cardiac cycle impacts perception. Detection of near-threshold tactile, visual, and auditory stimuli, and notably, multisensory integration [4], is higher and faster during diastole than systole, when heartbeat-related sensations are at a minimum [5]. Likewise, somatosensory evoked potentials are higher during diastole than systole and inversely related to the amplitude of the heartbeat-evoked potential (HEP) [6], an electrophysiological index of cardiac interoceptive processing. On the other hand, focusing attention on the heartbeat induces, notably, an increase in alpha power [7], a well-known marker of cortical inhibition, together with an increase in HEP amplitude [8]. Among studies on the contents of consciousness, the heartbeat could be one of the main drivers of pre-stimulus oscillations across different experimental contexts, particularly modulating perceptual abilities by reducing cortical excitability through increasing pre-stimulus alpha power on a trial-by-trial basis.

Respiratory phase-related changes in brain activity and excitability further characterize body-brain connections. The phase of spontaneous respiration drives brain activity across a wide range of areas [9]. While performing different tasks, respiratory phase-related changes are significant for tactile, auditory, and visual perception, visuo-spatial and emotion recognition, and episodic memory performance [10,11]. Additionally, unlike the heartbeat, respiration can be voluntarily modified by participants, who automatically adapt their respiratory cycle to trial onset (usually predicted by a cue), systematically leading to an alignment of respiration with the highest moment of neural excitability (which is generally found in the inhalation phase of respiration), reflected in low pre-stimulus alpha activity and enhanced perception of external stimuli. Consequently, pre-stimulus alpha activity could be linked with the respiratory phase in a number of experimental contexts, shaping conscious experience and underscoring the need to consider respiratory rhythms within models on the contents of consciousness.

[☆] Comment on “Beyond task response—Pre-stimulus activity modulates contents of consciousness” by G. Northoff, F. Zilio & J. Zhang

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As for the top-down effect, an important way humans self-induce changes in brain activity is via training attention, such as during the practice of meditation, as studied by Contemplative Neuroscience, a fascinating research field between Western science and ancient Eastern traditions, mainly Buddhism. The role of alpha activity in these practices appears crucial. Increased alpha activity is one of the most commonly observed phenomena during states of consciousness reached with concentrative or single-point meditation (*Shi-ne* or calm-abiding in the Tibetan tradition) [12]. In advanced meditators (with up to 30,000 h of practice), alpha power can increase even by a factor of 10, as we have recently observed [13]. These findings are generally interpreted as a correlate of greater attention focused on interoceptive activity and/or on a single mental object, complemented by the inhibition of other distracting stimuli from the external environment. This interpretation aligns with the perspective derived from Buddhist epistemology, which claims that there are six “doors” of access to consciousness: five of them are sensory and face towards the outer world, while the sixth faces inwards, where sensations from the body (interoception) and conceptual objects from the mind arise. According to this perspective, concentrative meditation allows the voluntary inhibition of the five sensory gates in favour of the sixth [14]. In this context, alpha oscillations could represent the crucial correlate of such a mechanism, which could also be regulated voluntarily to focus attention on interoception. It would be of great interest for future studies to assess pre- and post-stimuli activity interactions in such non-ordinary states of consciousness.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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