Investigating the link between bodily self-consciousness (BSC) and grid cells

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Abstract

For grid cells, both environmental information (i.e. landmarks) and self-motion information (i.e. vestibular, efferent motor copy) derived from one's body are crucial to locate oneself in a given space. Beside, sensory input containing environmental cues are initially processed in the framework referenced to the self (egocentric framework), suggesting much relevance of the self to grid cells. Bodily self-consciousness (BSC) are regarded to originate from integration of multisensory bodily signals. Studies on BSC have demonstrated that it affects self-related spatial cognitive processes, such as spatial semantic distances and size perception. Hence, we hypothesized a link between grid cells and BSC. To investigate the link, we verified whether experimental modulation of BSC can affect grid cell-like representation acquired in the entorhinal cortex (EC).

27 participants performed the spatial memory task designed to measure grid cell-like activity using fMRI. To assess influence of BSC on grid cell system, two experimental conditions differing in the states of BSC were designed for the task. The BODY condition was intended to induce stronger self-identification compared to the NOBODY condition by showing a body-shaped avatar congruent to participant's posture and hand movements. The modulation of BSC by the avatar was confirmed by significant questionnaire results.

6-fold symmetric grid cell-like representation was successfully replicated. The 6-fold representation only was significantly higher than 0, while 4,5,7-fold control were not. Sequentially, to assess whether the modulated BSC influenced the grid cells, the condition-wise grid cell-like activities were compared each other. As a result, we found that the grid cell activity in BODY condition was significantly reduced and undetectable, while it was pronounced in NOBODY condition.

We further investigated whether the vanished grid code in BODY condition is by the antagonistic inhibition of the boosted egocentric process. Intraparietal sulcus(IPS) which is responsible for self-identification and self-location process in posterior parietal cortex was chosen as a region of interest(ROI). By the ROI analysis, we confirmed that BOLD activity in IPS was higher in BODY condition, strongly suggesting enhanced egocentric process and supporting the hypothesis.

In this study, we confirmed that grid cells are affected by BSC modulation. More specifically, showing self-identified avatar during a virtual navigation decreases grid cell-like activity in EC, but enhance activity in IPS which are related to egocentric representation of space. These data link BSC to the neural mechanisms of spatial navigation and suggest that BSC modulations biases navigational brain processes towards egocentric representations.

Keywords: *Bodily self-consciousness, grid cells, spatial representation, navigation, self*

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Biography

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