Behavioral evidence of predictive coding: Contrast sensitivity enhanced for stimuli matching the prediction from the preceding information

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Predictive coding model has provided the viewpoint of studying the human brain as the organ of inference (Friston, 2018), with evidence from many findings that the top-down effect of predictive information can be reflected even in the earliest sensory neural activities (Rao & Ballard, 1999). However, it remains as a question whether those predictive effects can indeed lead to enhancement in low-level perceptual performance. Therefore, this study aimed to examine the impact of predictive information on contrast sensitivity, one of the fundamental human visual abilities. Gabor patches were selected as the visual stimuli to test contrast sensitivity and to generate prediction. The experimental task was a 2-alternative-forced choice task of reporting the tilted orientation of the target Gabor patch with keyboard press (i.e., left or right). Importantly, preceding the target, a stream of three Gabor patches were presented according to the three conditions; two prediction conditions, matching and nonmatching, and a control condition without prediction. For the prediction conditions, three Gabor patches whose orientations differed in regular steps of 30˚ were presented sequentially as preceding information, thus inducing the impression of rotation. In the matching condition, the target Gabor patch was presented in the angle matching the direction of stream rotation while the nonmatching target was in the orthogonal angle. The angles of preceding stimuli in the control condition were selected randomly and irregularly to prevent the generation of any predictive information. The contrast sensitivity of 50% threshold was measured by the adaptive 1-up-1-down staircase procedure. Threshold for each condition was measured by individual staircases. The result showed enhanced contrast sensitivity in the matching condition, compared to the nonmatching or the control conditions. Importantly, contrast sensitivity in the nonmatching condition was not lower than in the control condition—the participants made a response based on their perceptual experience, rather than passively reporting in a biased way following the preceding information. The current finding suggests that preceding predictive information can lead to enhancement in contrast sensitivity to the following target. This supports the idea that the predictive processing paradigm can also be extended to low-level visual perception, providing the the evidence for the link between the previous neural findings and behavior.