Serial dependence in perception requires conscious awareness

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Serial dependence in perception requires conscious awareness

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Perception depends not only on the currently viewed stimulus, but also on expectations built from previous perceptual history, often termed perceptual priors. Perhaps the clearest example is ‘serial dependence’, where perceptual judgments — in orientation, numerosity, and so on — are robustly biased towards recent experience [1–3]. Here we ask whether stimuli need to be consciously perceived in order to influence perception, by measuring serial dependence following binocular rivalry between orthogonal gratings. We find that only the perceptually dominant rivalrous stimulus biased perceived orientation of subsequent stimuli, suggesting that the construction of perceptual priors requires conscious awareness of stimulus history.

Sixteen participants viewed trial sequences that alternated between a rivalrous display of orthogonal gratings presented separately to each eye, and a monocentric test grating (Figure 1A). After each stimulus presentation, whether rivalrous or monocentric, participants reproduced the orientation of the perceived stimulus by matching it with a rotatable line. On test trials, a grating was presented by matching it with a rotatable line. The results show that, for stimuli to act as a perceptual prior, they need to be consciously perceived. This is interesting in light of conflict in the literature over the role of attention, with one report [1] suggesting serial dependence requires attention (which squares with our finding) while another [4] that it occurs automatically, so that one object feature will yield a positive serial effect even when a different feature was attended to on the previous trial. With attentional manipulations there is always a query over how effective the manipulation was and whether observers followed instructions. Our use of binocular rivalry has the benefit that conscious awareness of the stimulus can be manipulated with a greater certainty.

FURTHER READING


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unknown, and questions remain as to the molecular details of the induced conformational changes that these proteins experience. Furthermore, the effects of cofactors and substrates during their functional cycle needs to be further investigated. In the coming years, one can expect that functional and structural studies will answer these and other questions arising along the way.

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example and back propagated by feedback (for that priors are generated at higher levels models of predictive coding assume constructed at a low level. Indeed, many mean that the of sensory processing, this does not expectancies may act at low levels circuits [5, much evidence shows that serial dependence acts directly on sensory circuits [1–3,6], probably at low levels of processing [7]. But while perceptual expectancies may act at low levels of sensory processing, this does not mean that the priors are themselves constructed at a low level. Indeed, many models of predictive coding assume that priors are generated at higher levels and back propagated by feedback (for example [8]). Our new results show that simply presenting a stimulus is not sufficient to bias subsequent perception: it needs to be perceived to exert a serial influence. If suppressed during binocular rivalry, a grating has no effect at all, either positive or negative, on subsequent perception. As rivalry suppression occurs early in visual processing in primary visual cortex, and suppression-related activity is not seen outside areas V1 or V2 [9], it seems unlikely that the prior is generated at an early stage. This is interesting, as visual adaptation, a form of negative serial dependence, does occur for suppressed stimuli [10], showing that stimuli that are suppressed from consciousness can in principle affect subsequent perception. Our finding that serial dependence occurs only for consciously perceived stimuli suggests that construction of priors is an active process occurring later in perceptual processing. Once constructed, however, the priors may act at early sensory levels [1–3,6,7], consistent with a back-propagation framework.

**SUPPLEMENTAL INFORMATION**

Supplemental information includes methods, analysis, results and two figures and can be found with this article online at https://doi.org/10.1016/j.cub.2020.02.008.

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**REFERENCES**


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