

The role of motion adaptation in bottom-up mechanisms of perceptual decision-making

ABSTRACT:

Background and Aims

Studying the human brain response to shifts in perception provides an insight on the neuronal processes which underlie perceptual decision. Visual ambiguous stimuli are a powerful tool to investigate such processes, since perception varies over time despite the physically unchanging properties of stimuli.

A classic example of an ambiguous visual stimulus is when two moving gratings are superimposed to form a plaid. The perception of a moving plaid switches back and forth between two interpretations: it can be perceived as a single surface with coherent motion or as two surfaces sliding one over the other (incoherent motion). It has been suggested that this phenomenon arises from competition between opposing percepts, which might be influenced by mechanisms such as neuronal adaptation, inhibition, and memory. Current perceptual stability models consider bistable perception as a result of the interaction between these mechanisms, but the relative contribution of each one is still under debate.

Method

Here, using fMRI, EEG and behavioral approaches, we explore how each of these contributes to perceptual decision during bistable visual perception of moving plaids, taking into account the possible interaction between them. We hypothesized that the crucial role of adaptation in perceptual bistability arises from its influence on other mechanisms, such as perceptual persistence (a special form of short-term visual memory) and inhibition.

Based on a set of three experiments, we first tested for distinct levels of adaptation during visual motion perceptual bistability. Then, we investigated how such adaptation competes with persistence to influence perceptual experience. Finally, we tested whether cross-inhibitory effects occur between bistable percepts of a moving plaid, elicited by adaptation.

Results

We found that adaptation can contribute to regulating percept duration during visual bistability, with distinct weights, depending on the type of percept. Our results provide further evidence for continuous competition between adaptation and persistence, the first leading to negative and the second to positive hysteresis, with a relevant role for perceptual experience. Finally, we demonstrated, both at the behavioral and neuronal level, that inhibition across neural populations plays a key role in the disambiguation of moving plaids.

Conclusions

Taken together, our findings add to the understanding of how the visual system achieves perceptual decisions based on interactions between low and high-level neuronal mechanisms, one based on adaptation and the second on short-term visual memory (persistence).

Keywords

Adaptation, Short-term memory, Ambiguous visual motion, Perceptual bistability, Perceptual decision, Visual motion integration, fMRI

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