
Spatial Attention Modulates Saccadic Adaptation

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Résumé

Both eye movements and spatial attention critically participate in visual perception. As vision is most accurate at the level of the fovea, the central zone of our retina, we need to frequently move gaze toward objects of interest within our environment using rapid, saccadic eye movements. We produce voluntary saccades (VS) based on our internal goals whereas reactive saccades (RS) occur automatically in response to sudden changes in our surroundings. The accuracy of both types of saccades is maintained through sensorimotor adaptation processes relying on brain plasticity. Spatial attention also contributes to vision by enhancing sensory processing of objects falling within a restricted spatial zone. This attentional focus can be (covertly) shifted and, like saccades (overt shifts), in two different ways: following our internal goals (endogenously) or in response to an unexpected change of sensory stimulation (exogenously). The relationships between the orientation of spatial attention and eye movements have been intensely debated over the past 50 years. To date, it is well-established that these systems, though distinct, are highly interconnected. However, the relationship between spatial attention and saccadic adaptation, the mechanisms maintaining saccades precision, is still unclear.

In this study, we further investigate the hypothesis of a coupling between spatial attention and saccadic adaptation by assessing, in 2 experiments, the effect of exogenous spatial attention on RS adaptation and that of endogenous spatial attention on VS adaptation. To this aim, we used modified versions of the attention orienting paradigm (Posner 1989) combined with modified versions of the double-step paradigm (McLaughlin 1967). In experiments 1 and 2, 20 participants had to perform a series of trials in which they generated a saccade (RS or VS, respectively) toward a peripheral visual target shortly (50 ms or 350 ms) after a tactile cue stimulus prompted an (exogenous or endogenous) shift of attention toward a tactile target stimulus to be discriminated (touch-induced shifts of attention, allowing to improve the performance, are known to transfer to visuo-spatial attention). In each experiment, stepping the visual target backward during the saccade was used to elicit an amplitude reduction adaptation and participants' spatial attention was oriented, in two separate sessions, either toward or away from the location of the adapted saccade's targets.

Results of both experiments indicated that 1) the gain of saccades significantly decreased due to the repetition of stepped targets, signaling reliable RS and VS adaptation; 2) the reaction time of discrimination responses decreased for cued targets versus uncued targets, consistent with the expected shifts of attention; 3) and importantly, the amount and the speed of adaptation correlated with the amount of attention oriented toward the adapted location. These results show that in addition to the effect of saccadic adaptation on spatial attention reported in the past, there is an effect of attention on saccadic adaptation, thus reinforcing the notion that spatial attentional and saccadic 'gains' entertain reciprocal relationships.

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Mots-Clés: saccadic adaptation, spatial attention, cross modal link