Electrophysiological correlates of the spatial representation of relative saccade-target value in humans

Annabelle BLANGERO, Genevieve L. PRICE, Simon P. KELLY

Department of Biomedical Engineering, City College of New York
ablangero@ccny.cuny.edu, genevieveprice626@gmail.com, skelly2@ccny.cuny.edu

Many of our choices require the relative valuation of presented options before selecting an appropriate action. Previous studies in monkey electrophysiology and human neuroimaging have implicated the parietal cortex in the representation of relative value. The same region of the brain is also known to be involved in the spatial orientation of attention as well as in the planning of goal directed movements (intention).

The spatio-temporal characteristics of the relative-value representation in human subjects, however, have yet to be established.

We conducted an ERP study in 14 healthy individuals to address this. In our cued saccade task, we first presented the subjects with two colored circle targets to the left and right of central fixation. After 800ms, a gray fixation point changed color to that of one of the two targets, instructing the subject to make a fast and accurate eye movement to the corresponding target. Each of 3 possible colors was associated with a certain number of points (value; 1, 20 or 50 pts) obtained provided the saccade is made within a 350ms deadline. The color-points association was varied every 5 blocks of 126 trials. We recorded the subjects' neural activity with EEG and their eye movements with an eye tracker. Saccade reaction times were significantly faster when the eye movement was directed toward the higher value target of the pair compared to toward the lower value. We analyzed the visual evoked potential evoked by target onset to test for encoding of relative value.

We found a significant, relative positivity contralateral to the position of the higher-value target over lateral parieto-occipital scalp. Remarkably, this signal was transient, lasting only from 225ms to 400ms post-target, and its amplitude scaled with the value differential between the contralateral and ipsilateral objects. It is noteworthy that our relative value signal is opposite in polarity and thus clearly distinct from typically reported spatial attentional effects on human ERPs.

Because humans have a natural and intuitive tendency to direct attention and to act upon objects of our environment that they value most, the processes of valuation, attention and intention are intertwined both functionally and conceptually. In ongoing follow-up experiments we are attempting to disentangle these processes through comprehensive manipulation of the critical task contingencies - specifically, the value associations (linked to target location and identity) and advance information on action goals (related to location, identity and value). Experiments 1 and 2 aimed at determining whether the relative value representation is echoed on the presentation of target alternatives even when the identity and value of the target is known in advance (exp 1: color-value, color pre-cue), or alternatively, when the target location is known in advance (exp 2: color-value, spatial pre-cue). In experiments 3 and 4, we address the alternative scenario where relative value is associated with locations rather than with target identities, and employ the same color (exp 3: spatial-value, color pre-cue) and spatial pre-cues (exp 4: spatial-value, spatial pre-cue).

Despite the fact that value does not have any bearing on the performance of these imperative tasks, which simply require saccades to cued targets, preliminary results suggest that target selection activity is strongly modulated by the value of the cued target. These control experiments provide a clarification of the link between valuation and target selection mechanisms.

In conclusion, we investigated the human neural correlates of the spatial representation of relative value and identified a novel component, the CRVP (contralateral relative value positivity), which encodes the location of the higher value object of two, lawfully scaled by the difference of value between them.