

Abstract

The spatial focus of attention has traditionally been envisioned as a simple spatial gradient of enhanced activity, monotonically falling off with increasing distance. Using magnetoencephalographic recordings in humans, the studies reported here demonstrate that the focus of attention is not a simple monotonic gradient but contains an excitatory peak surrounded by a narrow inhibitory region. A visual search paradigm was used throughout all reported experiments which required subjects to focus attention onto a color pop-out target among eight distractor items arranged as a quarter-circular search array in the lower right visual field. The target position randomly varied relative to the position of a task-irrelevant probe-stimulus whose electromagnetic field response was analyzed. This response was enhanced when the probe appeared at the target's location, was suppressed in a narrow zone surrounding it, and recovered at more distant locations, thus, giving rise to an activity pattern that resembles the shape of a Mexican hat. Withdrawing attention from the pop-out target by engaging observers in a demanding foveal task eliminated the Mexican hat profile, which confirms a truly attention-driven effect. The profile turned out to be very similar across different target-defining features, different levels of task-difficulty, and did not depend on whether distractors were present or not. This is taken to suggest that the Mexican hat profile represents a more elementary routine-like attentional operation, that is less dependent on direct volitional aspects of attentional focusing. Source localization results revealed that the enhancement in the center of the attentional focus and the surrounding inhibition are generated within early-to-intermediate visual cortex. With a peak maximum around 250 ms, the Mexican hat profile evolved comparably late after search frame onset, consistent with feedback processing as underlying activity, and roughly in line with psychophysical estimates of the time it takes to focus attention. Finally it should be noted, that the methodological approach followed in the present thesis rules out a number of important confounds that hampered previous research. It thus provides the first convincing functional neuroimaging evidence for such a profile in humans.