

Strange Things, Moving Things, Wild Animals. Focus on “Neural Correlates of the Automatic and Goal-Driven Biases in Orienting Spatial Attention”

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A predator leaps out from behind a rock—that’s sure to catch your attention. The idea that certain types of stimuli have a hardwired “hotline” to attention has fascinated psychologists, philosophers, and neuroscientists for more than a century. In 1890, William James enumerated “strange things, moving things, wild animals, bright things, pretty things, metallic things, words, blows, blood” as some of the salient stimuli eliciting what he called “passive immediate sensorial attention.” Indeed, the automatic summoning of attention is important for survival even in modern life as the flash of a turn signal alerts you to the unexpected maneuvers of a sports car that is about to cut you off. However, attention is not held captive by every leaf moving in the wind—or every turn signal flashing on the road. James and his contemporaries understood that the automatic mechanisms guiding attention could be overridden, to an extent, by goal-directed volitional control of attention or “force of will.” This affords the flexibility to pull attention away from the old Cadillac whose turn signal has been blinking, incessantly, since the last Ice Age. In this issue, Fecteau et al. (p. 1728–1737) find fertile ground in exploring the interplay between automatic and goal-driven attention, examining its effects on saccadic reaction times and on visual responses in the superior colliculus (SC).

Researchers have long speculated that the spatial-attention and eye-movement systems may share common neural substrates, a view that has received some physiological support recently (e.g., Corbetta et al. 1998; Ignashchenkova et al. 2004; Kustov and Robinson 1996; Moore and Fallah 2001). In the present article, Fecteau et al. investigate the neural correlates of attention in the SC of monkeys performing a variant of Posner’s (1980) cueing paradigm. In this classic paradigm, the reaction time required to make a saccadic or manual response to a target is used as a measure of attention at the target location. When a cue is flashed at the future location of the target, attention is automatically drawn, resulting in shorter reaction times to the subsequent target at that location. The initial capture of attention is followed a short time later by a decline in attention, known as the inhibition of return (IOR) (Posner and Cohen 1984), at the cued location. During the past 20 years, these observations have inspired a large body of research examining the time course and conditions under which attentional capture and IOR operate. In recent work, the authors established the presence of a neural correlate of attentional capture and IOR in the visual responses of SC neurons. During attentional capture, target-related activity at the cued location is increased and saccades to the target are triggered earlier (Bell

et al. 2004). During IOR, this visual activity is reduced and saccades are delayed (Bell et al. 2004; Dorris et al. 2002). By varying the time between cue and target, the authors map out a detailed picture of the correlation between SC visual activity and the time course of attention as measured by saccade latency. The results would have gratified James, who speculated that “attention . . . will prepare the motor centers, and shorten the work which a stimulus has to perform on them, to produce a given effect when it comes.”

The present article examines the extent to which these behavioral and SC correlates of attentional capture and IOR are modulated by goal-driven (volitional) factors. Fecteau et al. address this question within the cueing paradigm by manipulating the informativeness of the cue. They find that the *initial* visual response to the cue does not depend on its informativeness but that cue informativeness significantly modulates the later cue- and target-related responses. These changes in SC activity correspond closely with changes in saccade latency, confirming that the monkeys are correctly interpreting the informativeness of the cue. The results clearly show that SC visual responses are influenced by both goal-driven and automatic attentional mechanisms. Interestingly, Fecteau et al.’s behavioral and neural measures suggest that goal-driven mechanisms cannot completely override the automatic time course of attention. Such a result was anticipated by early empiricists, as Helmholtz (1867) suggested, “The relation of attention to will . . . is less one of immediate than of mediate control.”

These results lead naturally to the question of whether the SC is involved in generating attentional capture and IOR or whether its role is more limited. Some studies have suggested SC involvement in the automatic capture of attention (Ignashchenkova et al. 2004; Kustov and Robinson 1996), and lesion studies in humans have indicated that the SC may also play a role in generating IOR (Posner et al. 1985; Sapir et al. 1999). On the other hand, a study in monkeys suggests that upstream structures are the source of the IOR-related reduction in SC visual activity (Dorris et al. 2002). Under this latter view, SC activity related to IOR can be regarded as a virtual readout of neural activity present across a network of areas involved in coding stimulus salience. Clearly, there is still much to learn, but renewed interest and research along these lines promises finally to answer many of the questions about attention that captivated James and his contemporaries more than a century ago.

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