Abstract

How does the visual system process stimuli it encounters frequently? To address this question, we investigated the attentional requirements associated with processing natural stimuli in isolation and in crowded environments. Using the dual-task paradigm, we tested observers on discriminating the gender of faces presented in isolation, in the near-absence of focal attention. We observed that performance on this task for poorly attended faces suffered only minimally. Furthermore, we also showed that finer discriminations, such as face identification (celebrities and unfamiliar faces), are unimpaired when attention is unavailable. From a computational perspective these results are surprising since observers are unable to categorize computationally simpler stimuli (e.g., a red-green color disk from its mirror image) under identical conditions. The brain mechanisms underlying the processing of face-gender were probed with fMRI. We found that the BOLD signal in the near-absence of attention was not significantly reduced, provided the faces were behaviorally relevant. This finding, that top-down expectations can be sufficient for high levels of the BOLD signal, is in contrast to current views that hold that the signal is reduced in the absence of focused attention. We took a closer look at attentional effects on neuronal activity by recording from individual neurons in the human brain while subjects performed a change detection paradigm (in which they reported whether they noticed changes made to (natural) stimuli presented in a crowded environment). Subjects were epileptic patients, implanted with depth electrodes in the medial temporal lobe (MTL) for identification of the seizure foci for potential surgical resection. We observed that neuronal responses when changes were correctly detected were significantly higher compared to incorrect trials. Under the common assumption that incorrect performance reflects the absence of attention, we

show that MTL neuronal activity is reduced when attention is unavailable. For each cell, on a trial-by-trial basis, we were able to predict the occurrence of a change (67%) and the patients' behavior (58%), significantly above chance. Our results show that the brain can process isolated natural stimuli in the near-absence of attention, while in crowded environments, attention plays a key role, as we have observed at the neuronal level.