Abstract

Our visual world is complex and usually cluttered with a large number of objects, many of which can be simultaneously in motion. The goals of our studies were to investigate the quantity, quality, and the representational format in human visual processing and memory storage. In a first study, we analyzed the bottlenecks of information processing that constrain the capacity of visual processing and memory. We measured observers’ psychophysical performance in a direction-of-motion recalling task, and through statistical modeling, analyzed the quantity and quality of information. In contrast to the long-standing view that considers visual short-term memory as the only major bottleneck of processing, we find significant loss in both the quantity and quality of information during the initial encoding and sensory memory stages. The second study aimed to characterize the representation format for visual information in terms of different featural dimensions. Specifically, we examined the roles of three different features, viz., position, color, and direction-of-motion, in the construction and maintenance of object representations. Using a cross-cuing paradigm, we showed that features are organized in bound forms, in which any feature can serve as an effective cue to retrieve another. However, the pattern of binding strength and cuing effectiveness is asymmetric and exhibits stream-specificity (parvocellular/magnocellular) of features. This study further showed that the distribution of information loss across processing stages found in the first study for direction-of-motion holds true for all features. The third study aimed to characterize the representation format for visual information in terms of different reference frames, viz., retinotopic, non-retinotopic, or mixed. Using a motion-vector decomposition approach, we analyzed observers’ behavior and considered models with different assumptions about the contribution of each reference-frame. With some exceptions, the non-retinotopic account was found to best describe the data. Taken together, our results suggest that the visual system encodes and stores information with quantitative and qualitative loss that occurs at multiple processing stages and the magnitude of this loss varies according to stimulus characteristics and task demands.