Benefits and Costs of Uniqueness in Multiple Object Tracking: The Role of Object Complexity

The multiple-object tracking (MOT) paradigm has been widely used as a tool for studying attention and visual cognition. Although typical MOT tasks have employed identical objects as tacking stimuli, people usually track unique objects in real-world situations, like basketball point guard being aware of where every teammate and opponent is. Then, how do unique objects affect multiple-object tracking? Recent research has catalogued seemingly contradictory findings, varying from enhanced to impaired tracking performance. In order to understand the underlying mechanisms behind this broad range of phenomena, FU Xiaolan's group from CAS Institute of Psychology explored the role of object complexity and found out that the costs and benefits of unique object tracking depend on object complexity.

In a series of three experiments, numbers of variable digit lengths and frequently used Chinese characters with different complexity were used as tracking stimuli. Observers had to track multiple objects and to pick up all the targets when the motion stopped. Results consistently showed that tracking capacity for identical objects doesn't vary with complexity, while tracking capacity for unique objects declines when stimuli becomes more complex. Besides, unique objects are tracked better than identical objects when they are in low complexity (one-digit numbers or simple characters); while the results are reversed when object complexity is high (four-digit numbers or complex characters). When objects were in medium complexity (two-digit or three-digit numbers), uniqueness produced no difference in tracking performance.

The study also suggests that identity processing in MOT is to some degree involuntary because observers can't suppress the process even under the circumstances where identity processing is harmful for tracking. When too many resources are used for identity processing of complex objects, tracking performance suffers due to insufficient resources for tracking. So, the key effects of uniqueness in object tracking are results of a tradeoff between tracking operation and processing of object identity information within the capacity limit of working memory.

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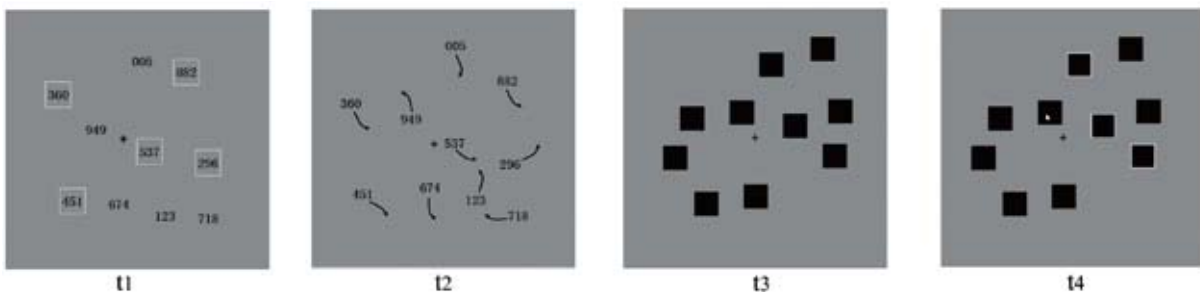

Figure 1: Illustration of the trial procedure used in an experiment. The example in this figure shows a 3-digit unique trial. Targets are marked at t1. Tracking starts at t2. When the movement stops at t3, all objects are occluded by homogeneous black squares. The task at t4 is to pick out the five targets by clicking them with a mouse.