Conclusions

It has been proposed that unexpected events are advantageous for learning (e.g., Schultz, 2006; Will et al., 2006). To investigate this possibility, we intentionally disrupted subjects’ expectations about the sequence of visual motions that they were trying to imitate.

Subjects learned to reproduce sequences of movements (Agam et al., 2010). We occasionally injected a novel direction of motion into a well-learned sequence, disrupting subjects’ expectations of what motion would be seen.

To gauge the impact of disrupted expectations, we measured (i) eye movements made while subjects observed each motion sequence, and (ii) the fidelity with which each sequence, with or without a disruption, was subsequently reproduced.

Subjects watched a small disk traverse a quasi-random path made up of six linear, directed component motions. After a retention interval, subjects used a stylus and graphics tablet to reproduce from memory the path that had just been seen.

Eye velocity at 60 ms after disk motion onset reflects anticipatory smooth pursuit for the final component.

Subjects do not anticipate the flip on presentation 4; on presentation 5 they expect the component to remain flipped.

Eye velocity traces during component 6 show anticipation of the upcoming direction, and, when an error is made, correction of that error.

Eye movements suggest that subjects (i) do not expect the decrement component, and (ii) do not expect the original sequence to be reinitiated.

Our task differs from that of Zhang & Luck (2009) in that here (i) the items in memory are directions of motion, (ii) the items are presented sequentially, rather than simultaneously, and (iii) the items comprise an organized “chain.”

Further investigation will be needed to determine whether any or all of these factors are responsible for difference between our results and those of Zhang & Luck.

Memories are degraded, but not lost

Analysis of error distributions suggest that subjects virtually never are guessing randomly. Rather, they successfully maintain at least some representation of each direction of motion that is to be imitated. Errors result from memory degradation, not complete loss. This contrasts to Zhang & Luck’s (2009) suggestion that short-term memory can undergo catastrophic “sudden death,” which is accomplished by random guessing.

Errors in memory for a sequence of motions are approximately normally distributed around zero, with a variance that decreases as the sequence grows more familiar. The distributions of errors made by subjects shows that memory may be degraded to some degree, but does not suffer all-­‐or-­‐none “sudden death.”

The flipped component (on flip and flip-­‐return trials), and the return to the original configuration (on flip-­‐return trials) are unexpected. We believe that their unexpected character contributes to the accuracy with which they are remembered and imitated.

Accurate reproduction of unexpected sequence events seems to be facilitated by a “novelty signal” that boosts attention and encoding (Kumaran & Maguire, 2008). This might explain the accuracy with which an unexpected, unfamiliar component is reproduced.

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Supporting Information


