How Does Attentional State Influence Temporal Organization of Memory?

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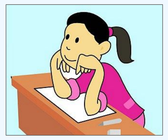
Background



"in the zone"

Attentional fluctuations are natural. They can occur during longer time frames (e.g., length of full day) or shorter time frames (e.g., during class period). [1-4]

"out of the zone"

Whether "in-" or "out-of-the-zone", attention can be subdivided into:

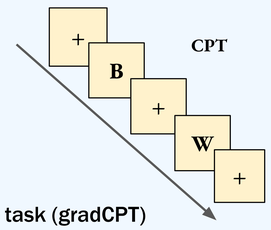
External attention: sensory info (e.g., seeing diagram on whiteboard) [5]

Internal attention: working memory, long-term memory (e.g., remembering name) [5]

Typically, attention is studied through manipulations in lab settings, where the focus is on one attention subdivision or the other.

Intrinsic Fluctuations in Attention

- Sustained attention – actively engaging with task over long time [6]
- **Sustained Attention to Response Task (SART)** – Respond to "frequently presented non-targets"; withhold response to "occasional targets" [7]
- **Continuous performance tasks (CPTs)** constantly presented with short-interval stimuli (<1 s); respond to rare targets [8]



- **gradual-onset continuous performance task (gradCPT)** gradual transitions between images; withhold response to rare images [4,8]
  - More lapses & omission errors when in worse attentional state

gradCPT with distractor present (withhold response for female faces); faces transition each 1,200 ms (Adapted from Rosenberg et al. 2013)

RT variability assessed using within-subject variance time course (VTC) analysis [1,8]

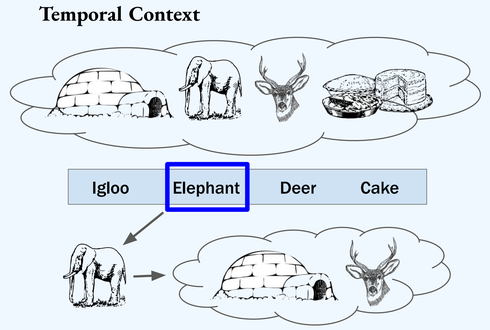
- "In the zone" – less variability (close to the mean RT)
- "Out of the zone" – more variability (very slow/fast RT)

Attention and Memory Interactions

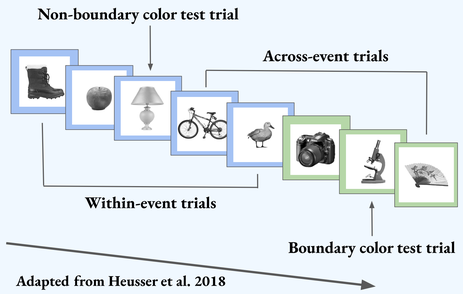
- Attention and memory are closely related where attention influences mnemonic processes and memory also guides attention [9]
- Episodic memory can guide attentional allocation in visual search [12,13]
  - Faster target detection for repeated/familiar over novel objects
- Attentional state during an experience affects memory of that experience
  - Memory is better for experiences that we attend to [5,10]
- Divided attention at encoding associated with large "hippocampally-mediated" memory impairments [11]

Temporal Organization of Memory

- Temporal context model (TCM) states that memory is organized temporally [14-18]
  - Items that are encoded together are likely to be remembered together [16]
  - This temporal clustering is typically seen in free-recall studies [14]



Adapted from Polyn and Kahan 2007



Adapted from Heusser et al. 2018

Event boundaries

- Context shifts, or "boundaries," are breaks in a continuous experience
- Event boundaries influence the organization of memory
- Temporal memory is better for within events than across boundaries [19]

Hypothesis

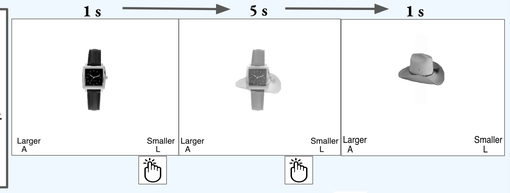
We hypothesize that attentional fluctuations will create event boundaries, and therefore influence the temporal organization of memory.

Study Design

Phase 1: Study Block 30 objects per block transition from one into another.

Study Block
You will see a series of objects. For each object, answer the question:
'Is this object smaller or larger than a shoebox?'
Use 'A' to indicate larger, and 'L' to indicate smaller.
You can respond anytime you like when the object is on the screen.
Press any key to continue.

1 s → 5 s → 1 s



Practice round followed by 5 repetitions

Phase 2: Math Block

Math Block
You will see a series of additions and subtractions.
Use 'A' if the answer is correct or 'L' if the answer is incorrect.
Press any key to continue.

78
- 14
= 54
Correct A
Incorrect L

Phase 3: Recall Block

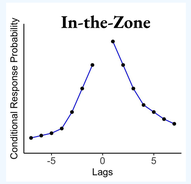
Recall Block
Verbally recall as many objects as you can from the Study Block.
You can recall them in any order, but try to recall as many as possible.
You have 2.5 minutes - use as long as you need.
Press any key to continue.

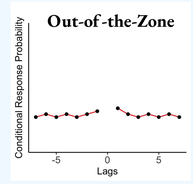
Recording starts now! You have 2.5 minutes.
148

E.g., "ornament, watch, …"

Predictions

Better Temporal Clustering

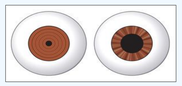




Worse Temporal Clustering

"In-the-zone" attentional state will be associated with better temporal organization of recall compared to the "out-of-the-zone" attentional state (illustrated by lag-CRP curves). [16]

Future Directions and Implications



Eye tracking/pupillometry – smaller pupil diameter associated with attentional lapses; slower, more variable RT [20]

Attention-deficit/hyperactivity disorder (ADHD) – children show increases in RT moment-to-moment variability (could be switching between "in-the-zone" and "out-of-the-zone" more frequently) [21]

Traumatic brain injury (TBI) – patients show increased RT variability on SART (indicating an increase in attentional fluctuations) [22]

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