Updating visual working memory is both object-based and feature-selective

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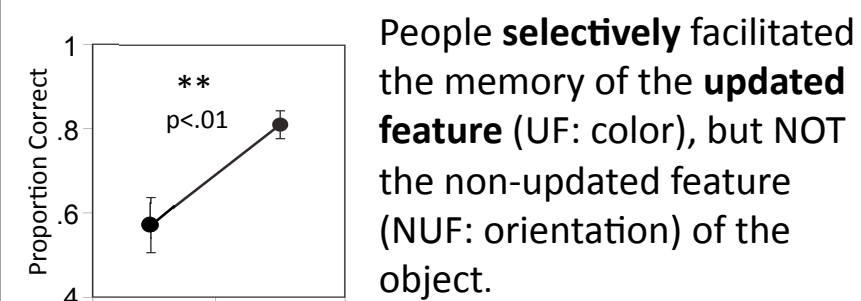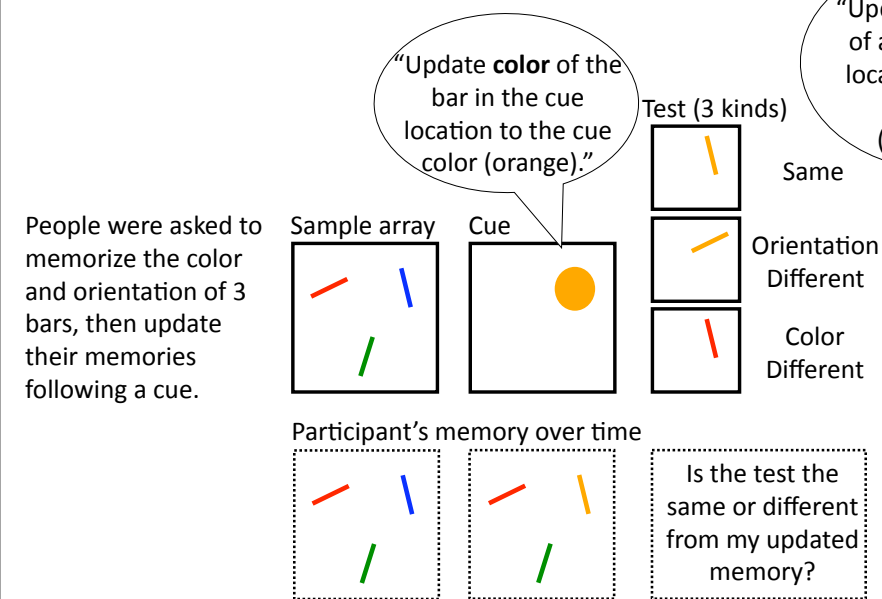
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Introduction

Stored information needs to be updated over time.

Did I put sugar in the coffee?

How do we **update** visual working memory – how do we replace old information with new information?

A previous study tested whether updating of visual working memory is object-based[3].

"Update **color** of the bar in the cue location to the cue color (orange)."

People were asked to memorize the color and orientation of 3 bars, then update their memories following a cue.

Sample array | Cue | Test (3 kinds)
Same / Orientation Different / Color Different

Participant's memory over time

Is the test the same or different from my updated memory?

People **selectively** facilitated the memory of the **updated feature** (UF: color), but NOT the non-updated feature (NUF: orientation) of the object.

** p<.01 — Proportion Correct — NUF / UF

Therefore, facilitation of the updated feature doesn't spread to the other features of an object.

Maybe this is not the whole story?
We tested to find an object-based advantage in updating memories of **multiple objects**.

E1: Same object advantage in updating

Can we find any evidence of an object-based advantage when updating more than one feature?

We asked participants to update two features of either one or two objects.

Sample array (200 ms) → **Updating 2 features** → Test — Same or Different?

One object
Cue 1 (200 ms) | Cue 2 (200 ms)
"Update **orientation** of a bar in the cue location to the cue orientation (horizontal)."
Memory over time

Two objects
Cue 1 (200 ms) | Cue 2 (200 ms)
Memory over time

N=25 — ** p<.001 — Proportion Correct — One object / Two objects

Yes! People are better at updating two features of the **same object** than two features of two different objects...

interaction p<.02 — ** p<.001 — ** p<.001 — Proportion Correct — NUF / UF — One object | NUF / UF — Two objects

while **selectively** facilitating only one feature of the object.

More accurate updating for one object than two objects suggests an **object-based** advantage. Memory facilitation only for UF showed a **feature-selective** mechanism as well.

E2: Does location matter?

Does an object-based advantage occur because one location is activated in one object updating but two locations need to be activated in two-object updating?

One object — To update orientation and color,
Two objects — To update color, / To update orientation,
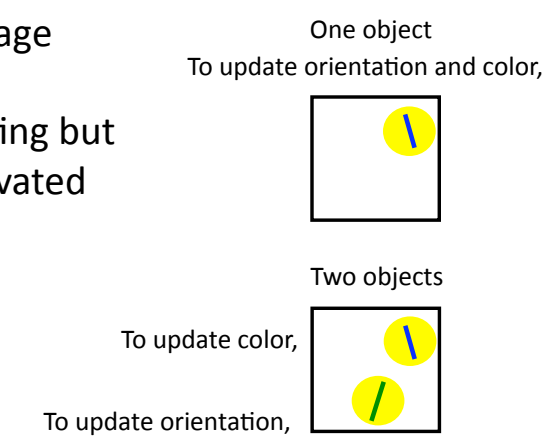
We tested this idea by having **two superimposed objects – a box and a line**[1] so that people activate only one location.

Sample array → Cue 1 (200 ms) | Cue 2 (200 ms) | Test — Same or Different?

"Update **direction** of the box gap to the cue direction (down)."
"Update **color** of the **box** to the cue color (orange)."

One location | Two locations

N=26 — Proportion Correct — One object / Two objects — One location | Two locations

Nope. People are better at updating one object than two objects (p<.001) even in the same location...

** p<.003 — Proportion Correct — NUF / UF

while **selectively** facilitating only one a feature of the object.

An object-based advantage in the one location condition suggests the same object advantage cannot be accounted for by object location.

E3: Does opening *object files*[2] matter?

An *object file* is a mental representation of an object independent of location.
An object-based advantage may occur because one object file is opened for one object updating but two object files need to be opened for two-object updating.

One object — open
Two objects — open / open
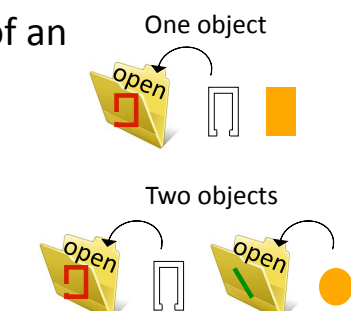
We attempted to manipulate the number of openings by adding a **sudden onset**[4] which captures attention and may demand opening a new object file.

Sample array (200 ms) → **Updating 2 features** → Test — Same or Different?

A task-irrelevant geometric shape (triangle) was used as the onset stimulus.

No onset
Cue 1 (200 ms) | Blank (1 s) | Cue 2 (200 ms)
Memory over time

Onset
Cue 1 (200 ms) | Onset (1 s) | Cue 2 (200 ms)
Memory over time

N=16 — Proportion Correct — One object / Two objects — No onset | One object / Two objects — Onset

Results did not show a significant object-based advantage nor an effect of an onset.

** p<.005 — Proportion Correct — NUF / UF

But, results showed a **feature-selective** effect in updating.

The null effect of the onset suggests a future study should use a different stimulus to promote the opening of a new object file. Suggestions?
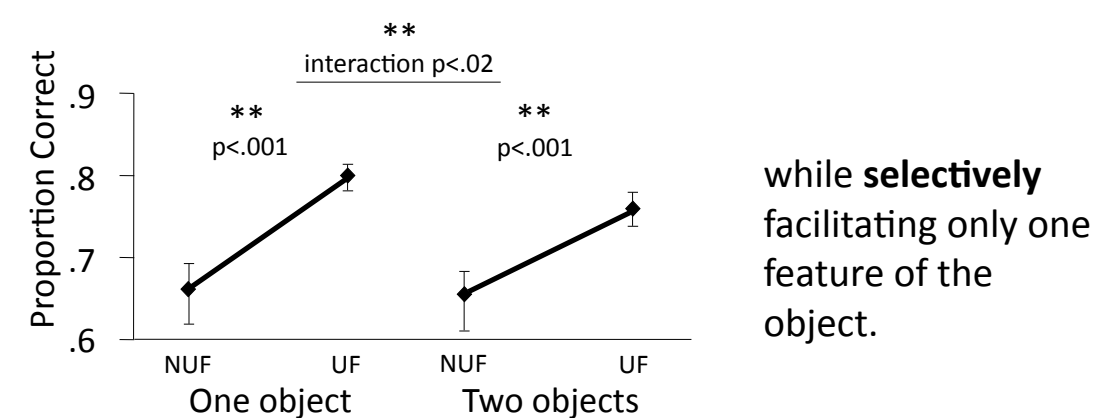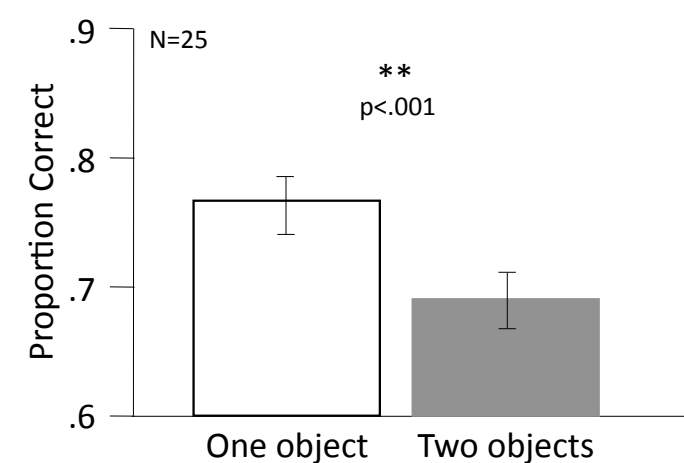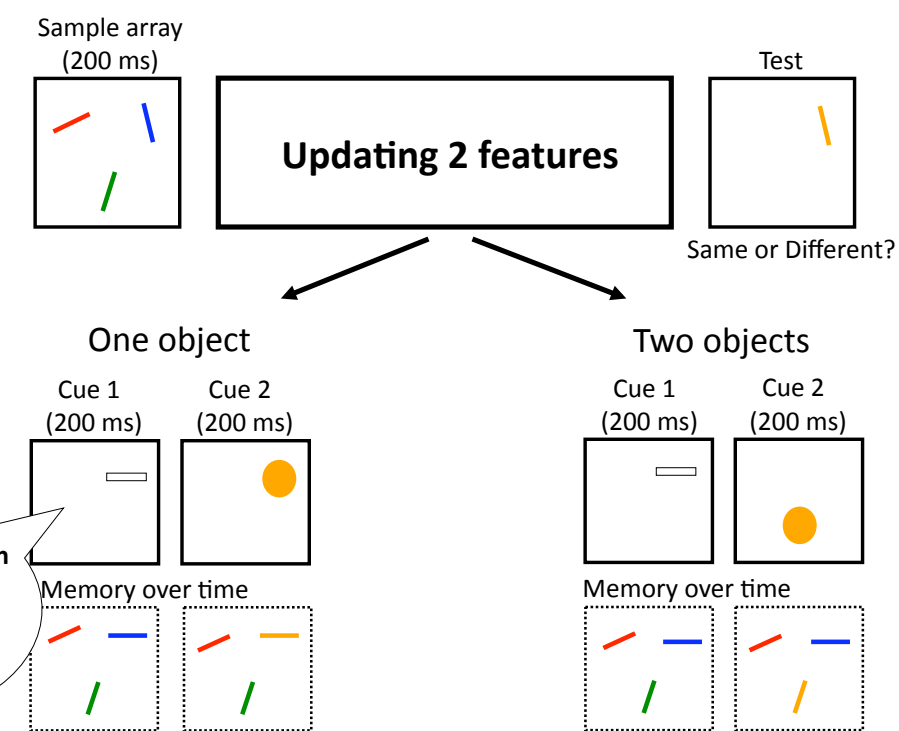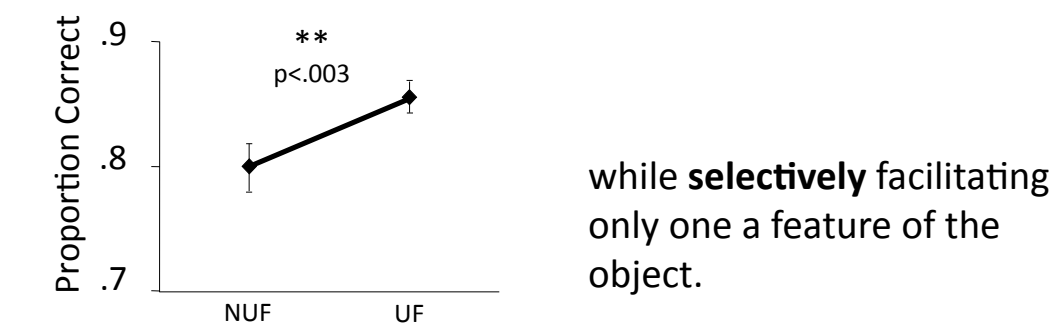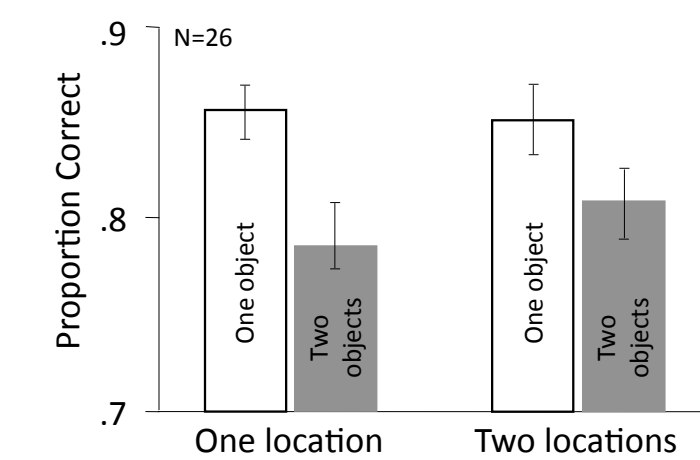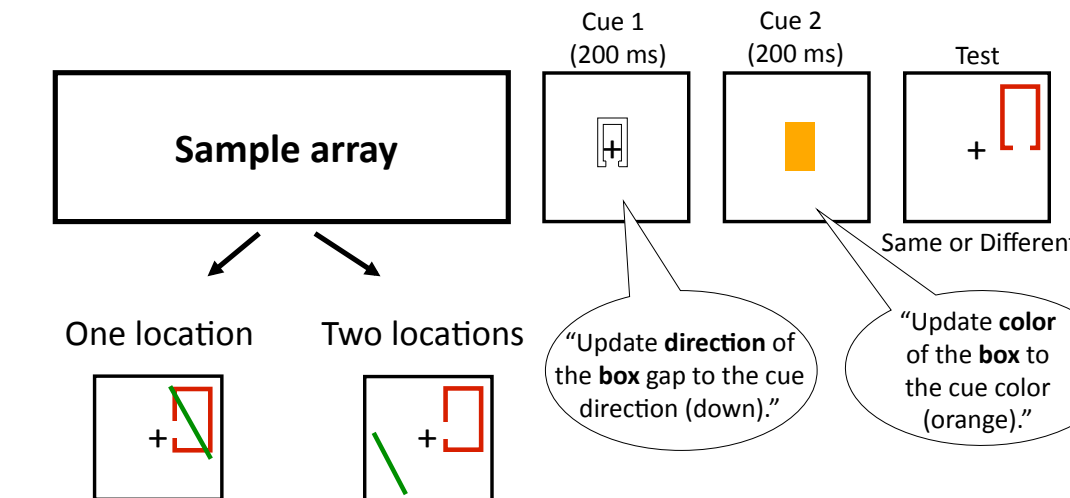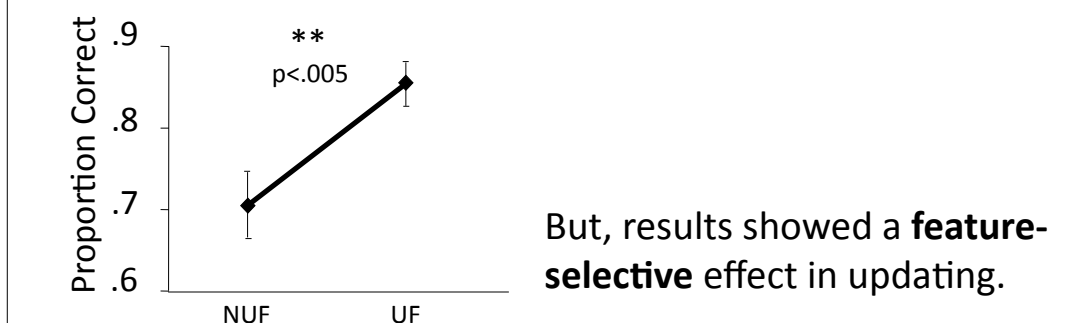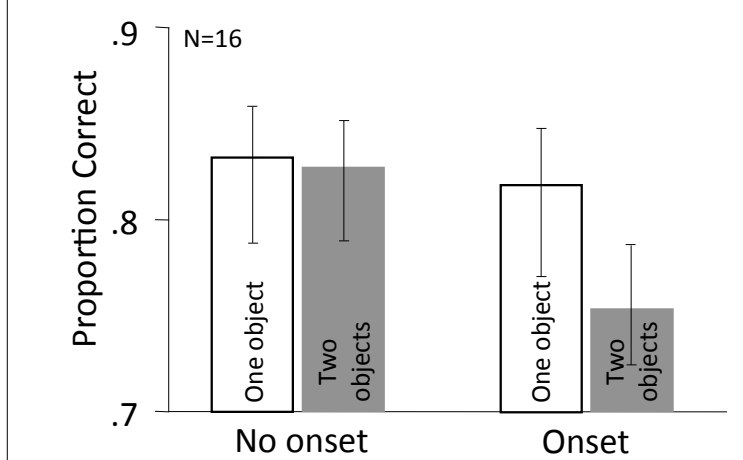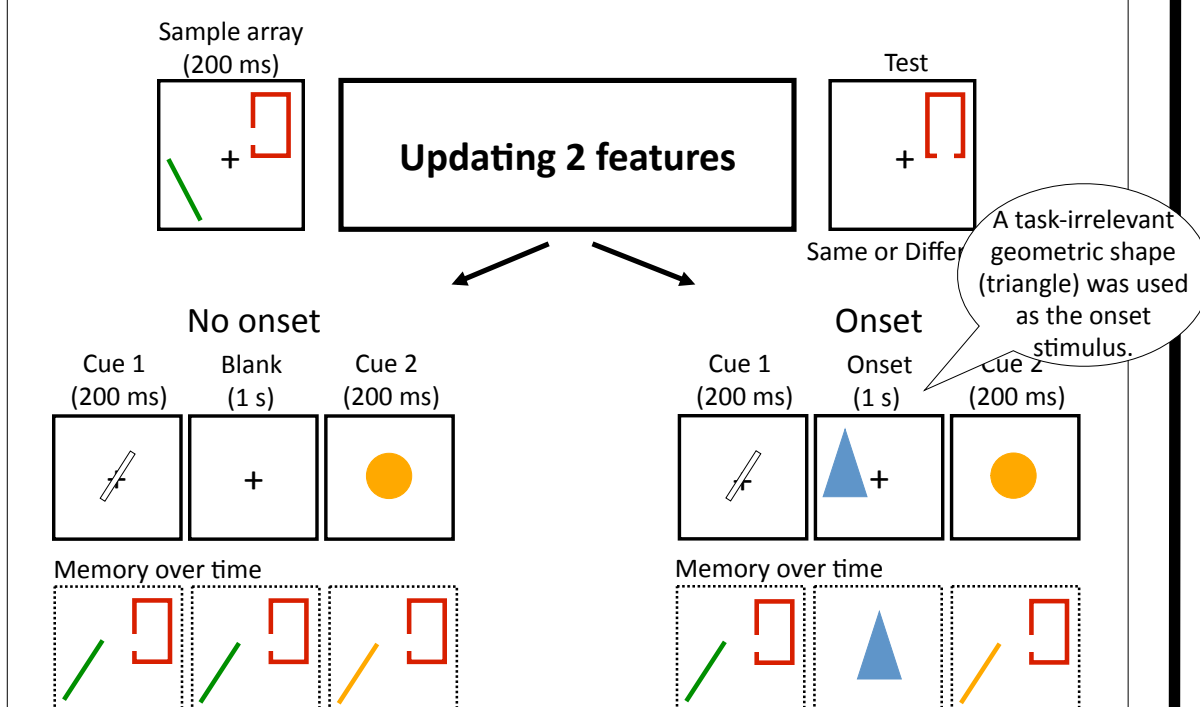
Conclusions

- Updating multiple items in visual working memory showed both an object-based advantage and a feature-selective effect.
- The object-based advantage was not due to the different number of locations.
- The object-based advantage might be due to the different number of openings of object files during updating – stronger evidence is still needed.
- We conclude that an object-based and a feature-selective mechanism coexist in the updating of visual working memory.

References:
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(2) Kahneman, D., Treisman, A., & Gibbs, B. J. (1992). The reviewing of object files: Object-specific integration of information. *Cognitive Psychology, 24,* 175-219.
(3) Ko, P. C., & Seiffert, A. E. (2009). Updating objects in visual short-term memory is feature selective. *Memory and Cognition, 37(6),* 909-923.
(4) Jonides, J., & Yantis, S. (1988). Uniqueness of abrupt visual onset in capturing attention. *Perception and Psychophysics, 43,* 346-354.

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