Effects of Handedness on Episodic Memory: Evidence from a Non-verbal Task

Jana Reifegerste[1], Karim Johari[2], & Michael T. Ullman[1]
[1]Georgetown University, Washington DC, USA; [2]Louisiana State University, Baton Rouge LA, USA

Introduction

Handedness and Episodic Memory

Prior studies have found effects of handedness on episodic memory:

- Advantages for non-right-handers vs. right-handers[1-3]
  - ➡ Which are often attributed to advantages for 'inconsistent-handers' vs. (either right- or left-) 'pure-handers'[3-10]

Suggested explanation for apparent advantage of inconsistent handers:

a) Apparent bi-hemispheric learning/retrieval of information[11-13]
b) Inconsistent-handers may have greater interhemispheric communication[14-15] and corpus callosal volumes[16-20] than pure-handers

- Though there are often few pure left-handers in the samples, so the comparisons may actually pit right- vs. non-right-handers

A Role for Verbal vs. Non-Verbal Study Material?

Relevant research not directly related to handedness:

- In direct comparisons of verbal(izable) vs. non-verbal(izable) items, study material can affect episodic-memory performance[28,31-37], and interact with other factors affecting performance (e.g., age, sex, education)[30]
- Bi-hemispheric involvement in episodic memory seems clearer for verbal(izable)[11-13] than non-verbal(izabl)[11-12,21-27] material

Prior studies of handedness and episodic memory:

- Most studies have tested verbal items (e.g., word lists)[1-2,4-10]
- Studies of non-verbal material (e.g., novel faces[7,28], tones[3], smells[29]) have yielded inconsistent effects of handedness

<u>Gap</u>: Most prior research has not directly examined the effect of handedness in verbalizable vs. non-verbalizable items

Research Question: *Does handedness differentially impact episodic memory for verbalizable vs. non-verbalizable material?*

If indeed:

1) Bi-hemispheric involvement in episodic memory is greater for verbal(izable) than non-verbal(izable) material
2) Inconsistent- (or non-right-) handers have greater interhemispheric communication than pure- (or right-) handers

➢ <u>Prediction:</u> Inconsistent- (or non-right-) handers' episodic memory advantage should **be greater for verbalizable than for non-verbalizable items**

The Present Study:

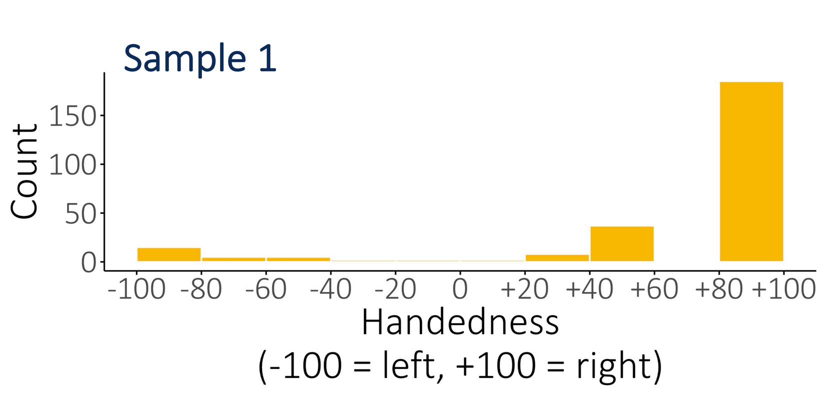
We examined episodic memory in a non-verbal recognition-memory task, with pictures of real (nameable) and novel (non-nameable) objects.

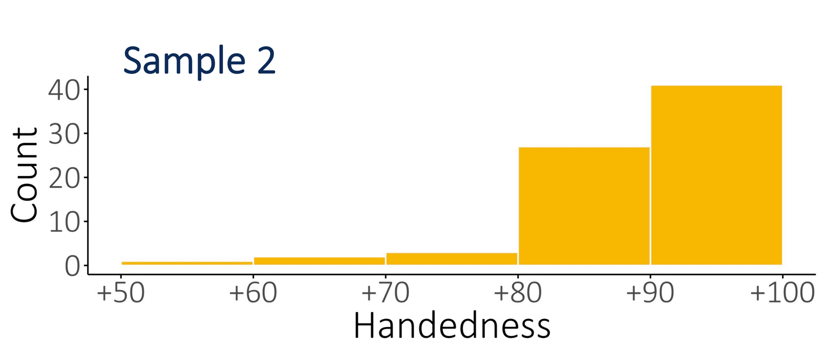
<u>Design:</u>
Handedness (continuous) X
Study Material (2 levels: real, novel)

Methods

Participants

	Sample 1 (Germany)	Sample 2 (USA)
n	265	74
Age (years)	23.7 (6.1)	53.3 (18.3)
Handedness (Edinburgh Handedness Inventory)[40]	72.2 (55.9)	93.5 (8.9)
Sex	194 F, 67 M	51 F, 23 M
Education (years)	15.5 (3.4)	17.9 (2.7)



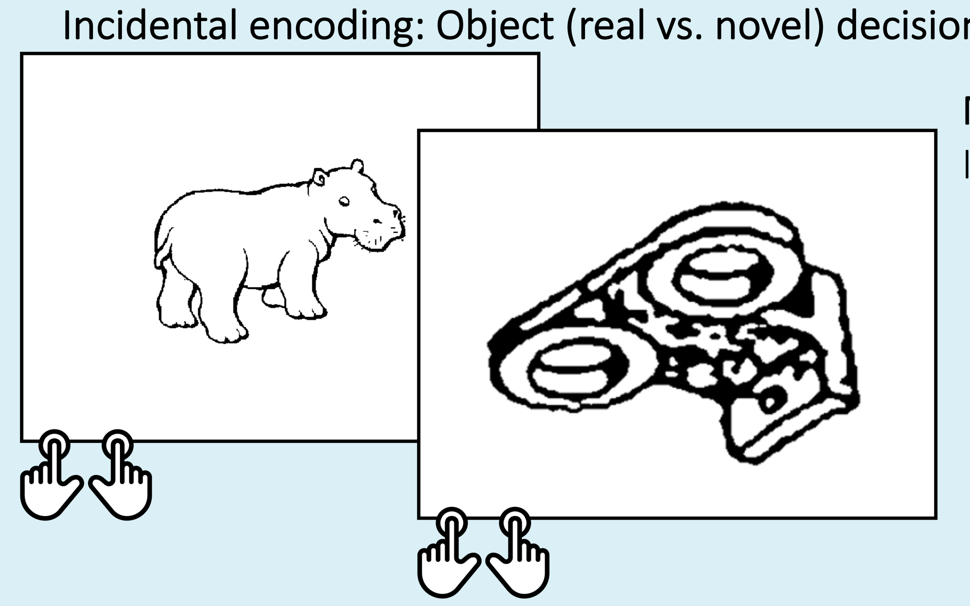


Handedness was not related to age, sex, or education in either sample.

Tasks and Materials[30,31,34]

1) Encoding phase:

Incidental encoding: Object (real vs. novel) decision

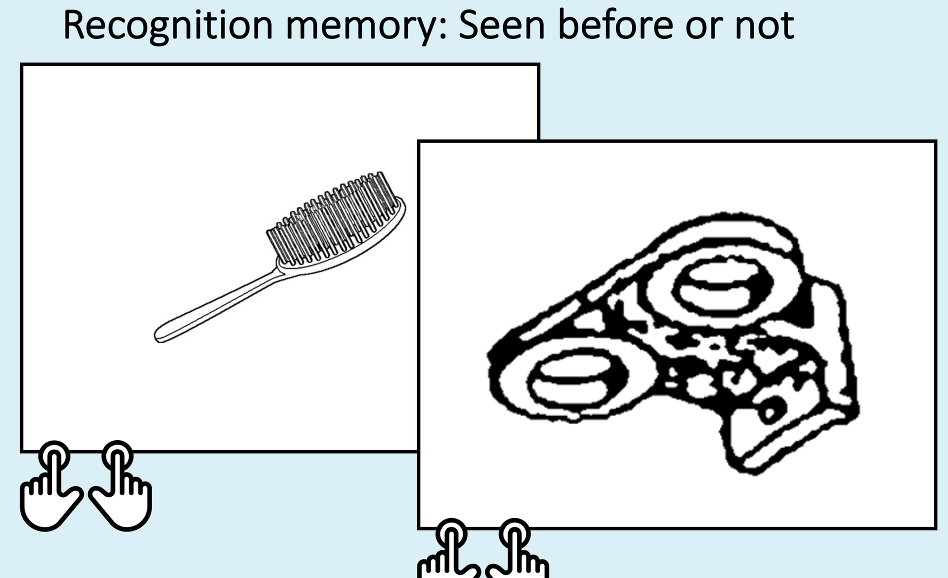


Materials:
Images of 64 objects:

- 32 real objects (nameable)
- 32 novel objects (not easily nameable)

2) Recognition phase:

Recognition memory: Seen before or not



Materials and Procedure:
Images of 128 objects:

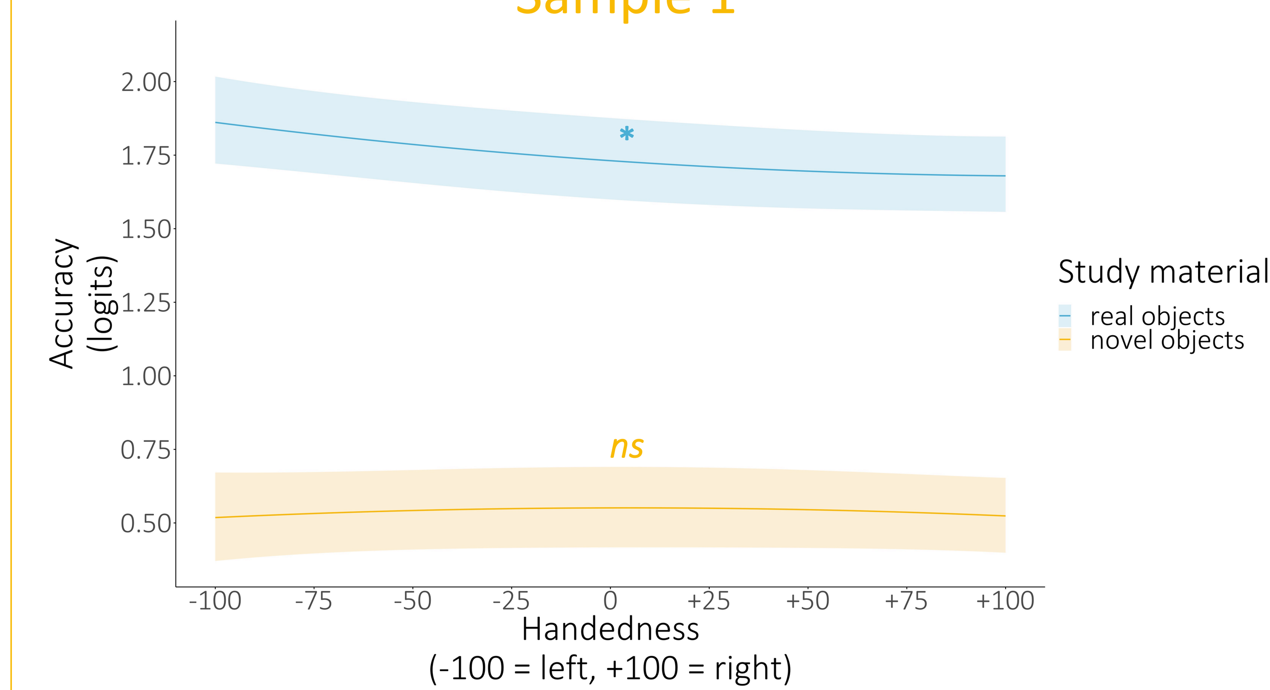
- 64 objects seen during encoding (32 real objects, 32 novel objects)
- 64 objects not seen during encoding (32 real objects, 32 novel objects)

Delay of a few minutes between the phases

Results

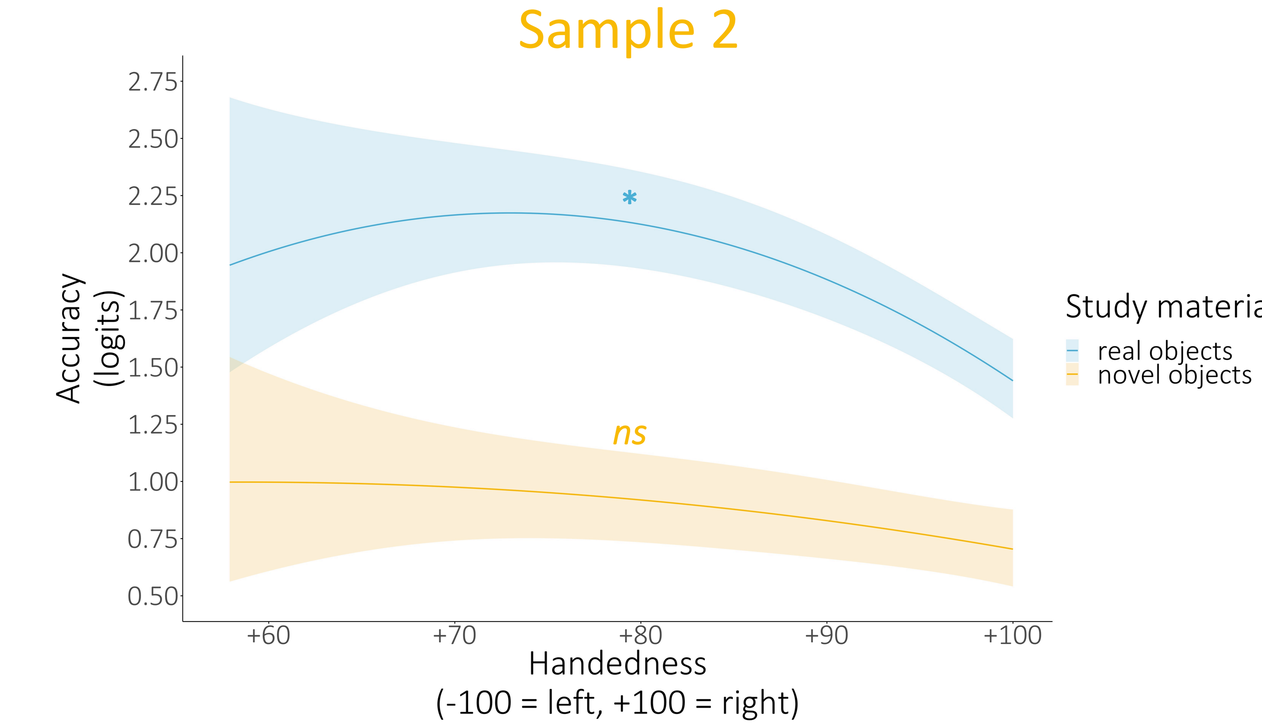
Analyses: Logistic mixed-effects regression models on accuracy during Recognition phase

Sample 1



- Handedness x Study Material: $z = 2.33$, $p = .020$
- Effect of Handedness on
  - Real objects: $z = -2.68$, $p = .007$
  - Novel objects: $z = -0.13$, *ns*

Sample 2



- Handedness x Study Material: $z = 2.01$, $p = .045$
- Effect of Handedness on
  - Real objects: $z = -3.18$, $p = .001$
  - Novel objects: $z = -1.30$, *ns*

Discussion

Summary of results:

- Handedness impacted recognition-memory performance for real (existing) objects: declining performance with increasing right-handedness.
  - Across full handedness range (Sample 1): No sign of a non-linear effect (i.e., no higher performance for inconsistent-handers than pure-handers)
- No significant effects of handedness on performance with novel objects.
- Real/novel distinction held even *within* right-handers (Sample 2)

Interpretation:

Impact of handedness on real objects could be due to their

1) "verbalness" (nameability) : see Prediction (in blue box)
   → a) greater bi-hemispheric involvement in episodic memory for verbal(izable) than non-verbal(izable) material, and
   b) greater interhemispheric communication for inconsistent- (or non-right-) handers than pure- (or right-) handers, could lead to handedness effects particularly for verbalizable study material
2) "realness" (related to existing memory traces) for real but not novel objects
   → unclear how this may explain the pattern

- Absence of a nonlinear effect (better performance for inconsistent-handers) may be due to dearth of inconsistent-handers in both samples.
  Although: the effect of handedness within right-handers (Sample 2) is in line with an inconsistent-hander advantage.

Limitations:

- Sample 1 used only a four-item version of Edinburgh Handedness Inventory
- Sample 1 included very few inconsistent-handed participants
- Sample 2 includes only (more or less) right-handed participants

Next steps:

- Data collection for both samples is ongoing
- Structural MRI data available for Sample 2
  → Mediation analyses to reveal contribution of neural substrates (e.g., corpus callosum volumes)
- Several datasets using same memory task are available
  → Replication
- "Real objects" contain both manipulable and non-manipulable objects (e.g., hairbrush vs. hippo)
  → Analyses to examine differential influence of handedness
- 1-week retention data are available for Sample 2
  → Assessment of longevity of this effect
- Reaction time analyses

Conclusion

- Handedness appears to affect recognition memory for real/existing objects, but not for novel objects
- Findings suggest that handedness effects may be explained by verbalness and/or existing representations

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References & Acknowledgements

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<u>Contact:</u> jr1754@georgetown.edu or michael@georgetown.edu