Memory is Better for Dynamic than Static Scenes in Immersive Virtual Reality

ME LAB

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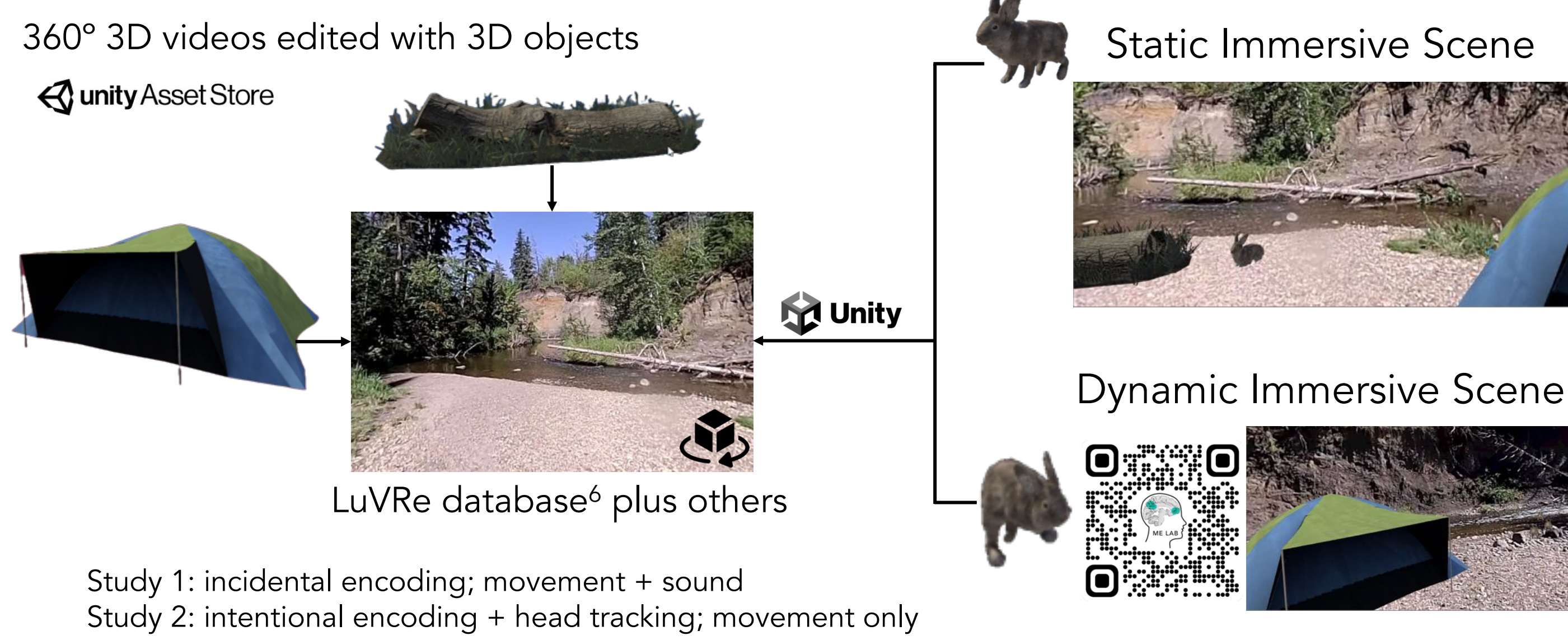UNIVERSITY OF ALBERTA
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INTRODUCTION

- Dynamic films are recognized better than static images[1-2]

- Videos with dynamic objects resemble more real-life events

- Event memory retrieval relies more on scene construction than object specific details[3]

- A scene is the spatial organization of objects and actions of an event as retrieved from an egocentric perspective[4]

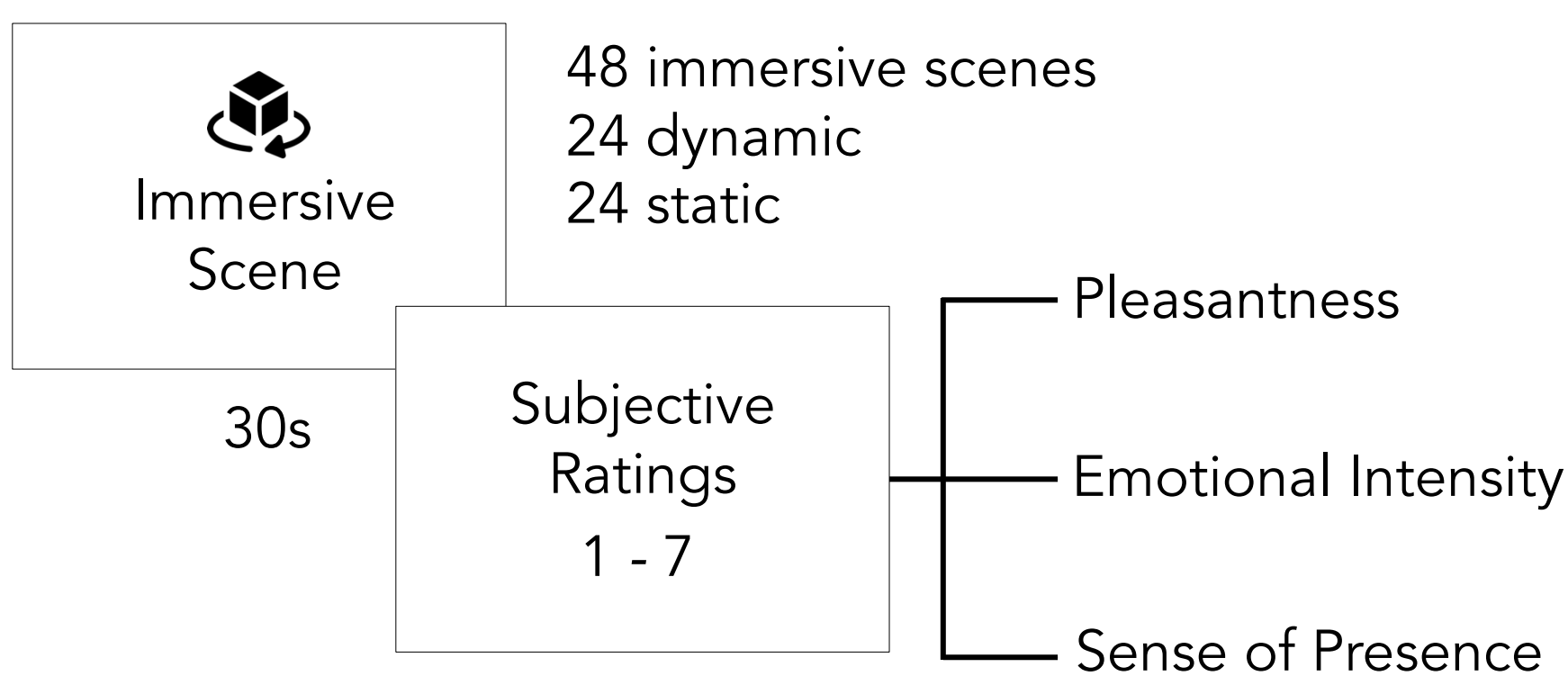- Immersive 360° virtual reality allows for controlled manipulation of dynamism and has high ecological validity[5]

Does dynamism influence scene and object memory similarly in immersive experiences?

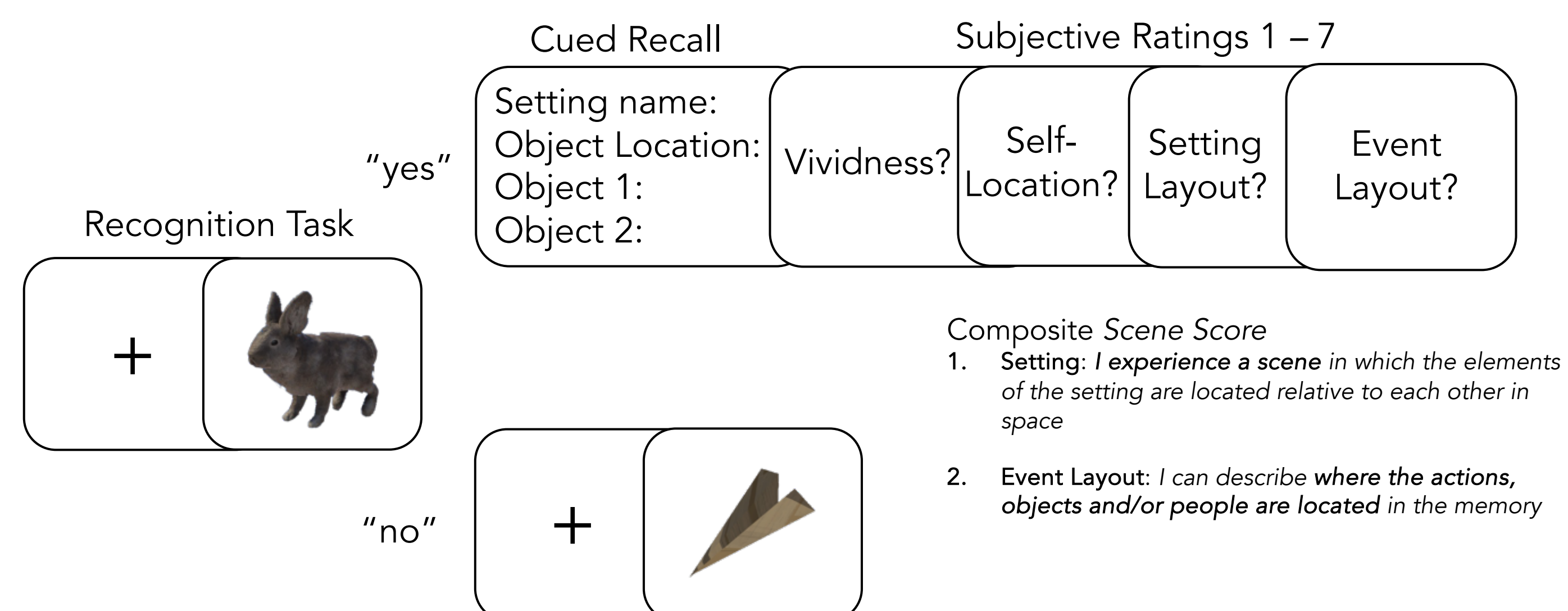## METHODS

Creating Immersive Experiences

360° 3D videos edited with 3D objects
unity Asset Store

Static Immersive Scene

Dynamic Immersive Scene

LuVRe database[6] plus others

Study 1: incidental encoding; movement + sound
Study 2: intentional encoding + head tracking; movement only

Encoding

48 immersive scenes
24 dynamic
24 static

Immersive Scene
30s

Subjective Ratings 1 - 7
- Pleasantness
- Emotional Intensity
- Sense of Presence

Retrieval

Cued Recall
"yes"
Setting name:
Object Location:
Object 1:
Object 2:

Subjective Ratings 1 – 7
Vividness? | Self-Location? | Setting Layout? | Event Layout?

Recognition Task
+
"no"
+

Composite *Scene Score*
1. **Setting:** *I experience a scene in which the elements of the setting are located relative to each other in space*
2. **Event Layout:** *I can describe where the actions, objects and/or people are located in the memory*
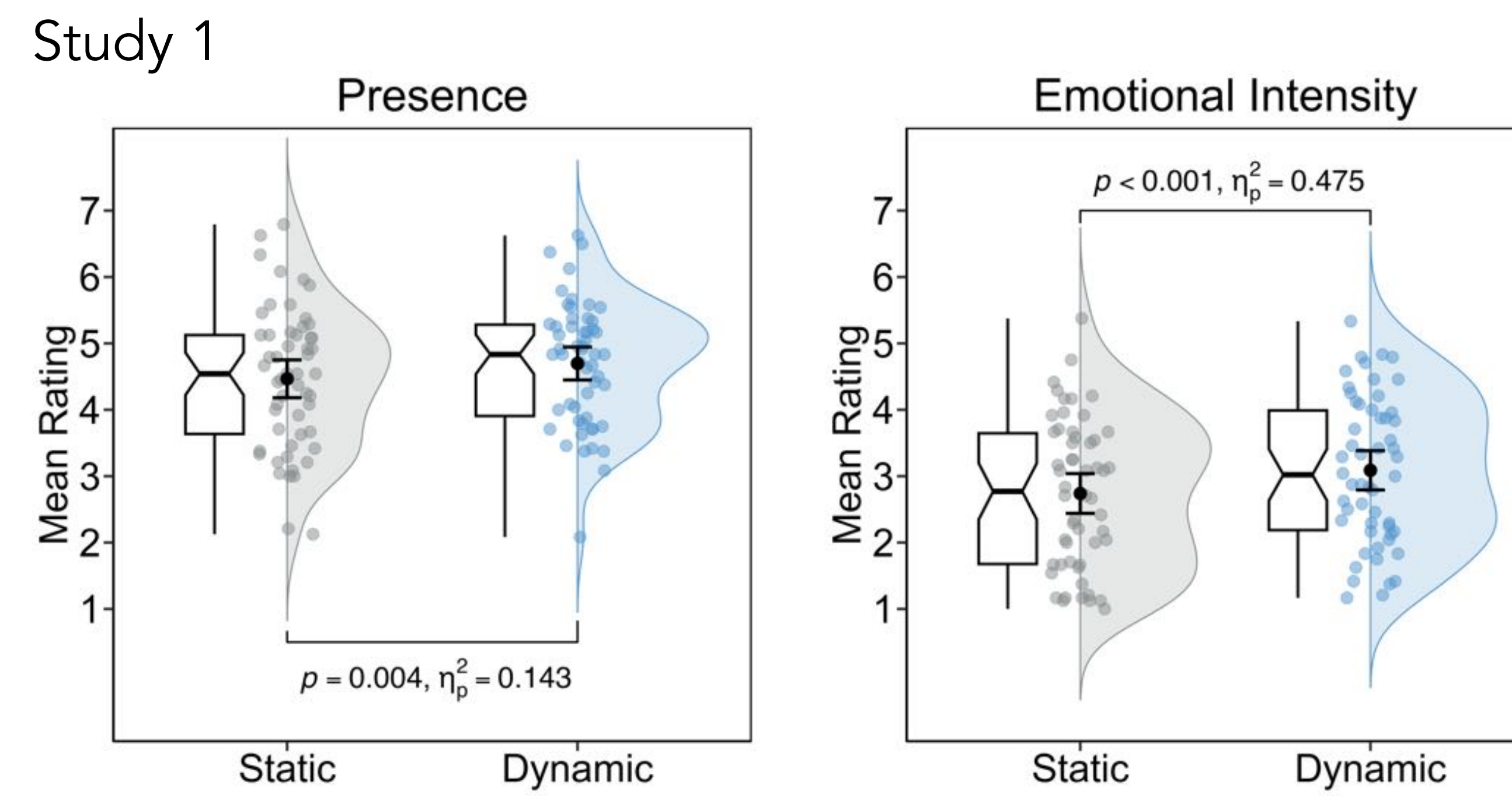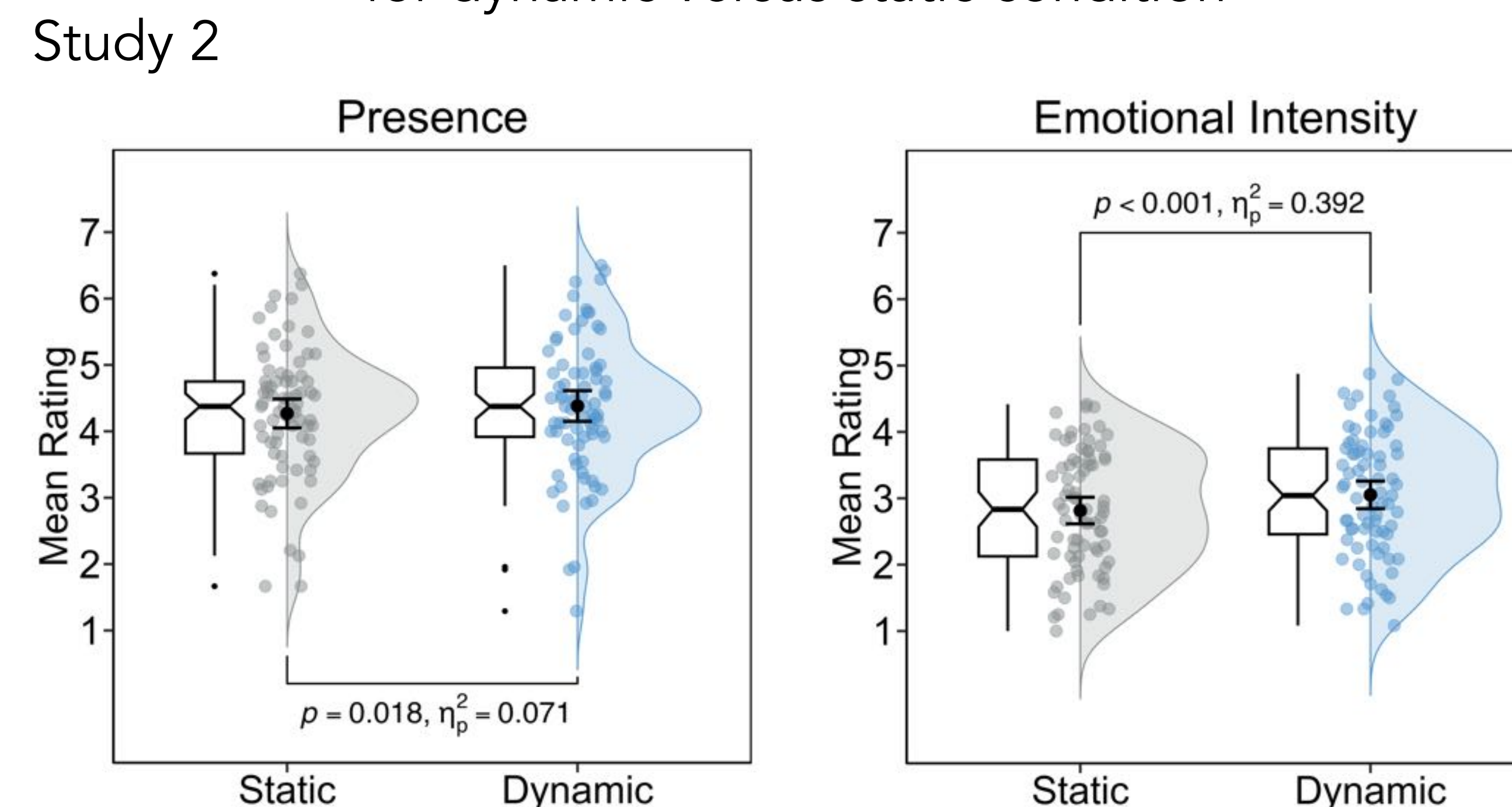
Study 1: n = 54 (34 women, 1 genderfluid, Mean Age = 19.74 yrs, SD = 1.79)
Study 2: n = 77 (40 women, 1 prefer not to say, Mean Age = 19.36 yrs, SD = 1.87)

RESULTS: ENCODING

Study 1

Presence — $p = 0.004$, $\eta_p^2 = 0.143$

Emotional Intensity — $p < 0.001$, $\eta_p^2 = 0.475$

Higher sense of presence & emotional intensity for dynamic versus static condition

Study 2

Presence — $p = 0.018$, $\eta^2 = 0.071$

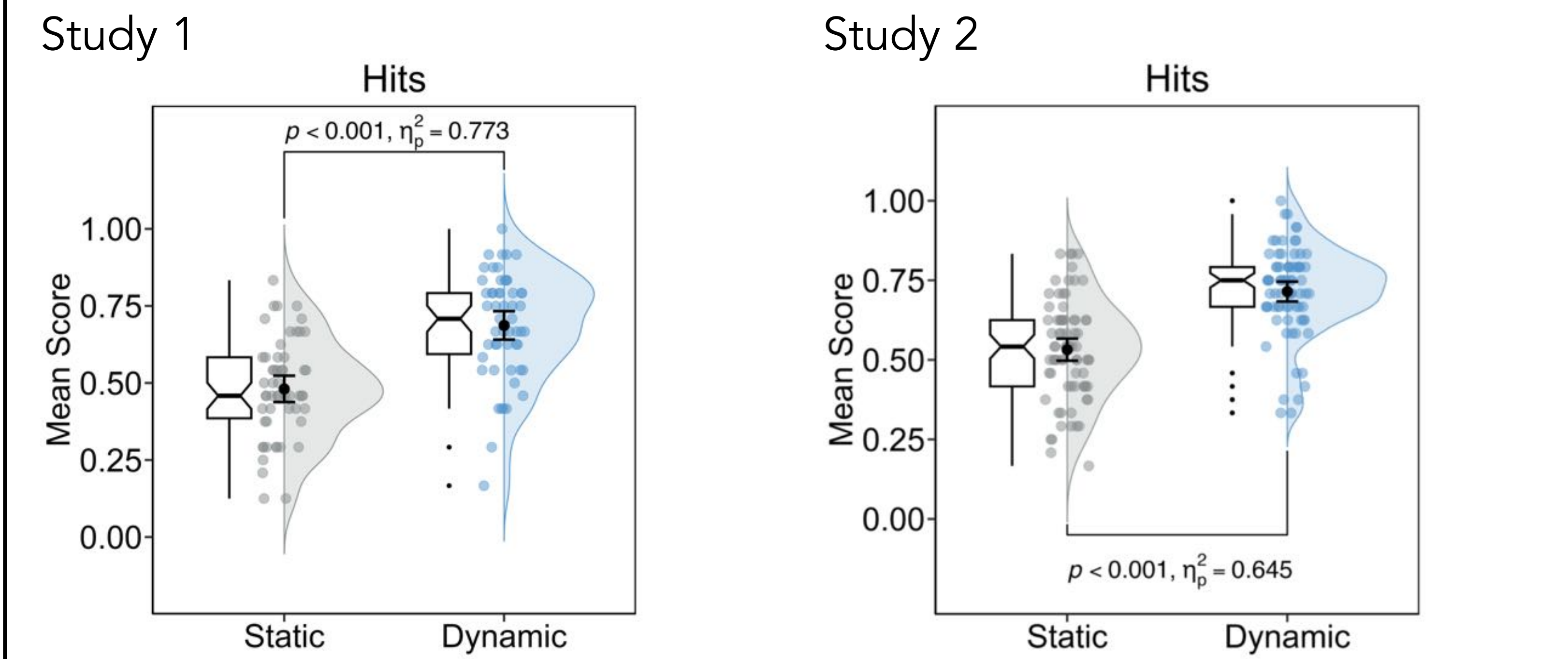Emotional Intensity — $p < 0.001$, $\eta_p^2 = 0.392$

CONCLUSIONS

- Consistent with prior research,[1-2] there is a dynamic superiority effect in recognition memory

- Dynamic events lead to a stronger sense of presence and more emotionally intense experiences than static events

- Dynamism influences scene-related aspects of memory but not object specific details

- Immersive 360° experiences allow us to leverage how key properties of the real-world influence how we form and remember events

- In a future fMRI study, we will investigate how dynamism supports scene memory for immersive experiences
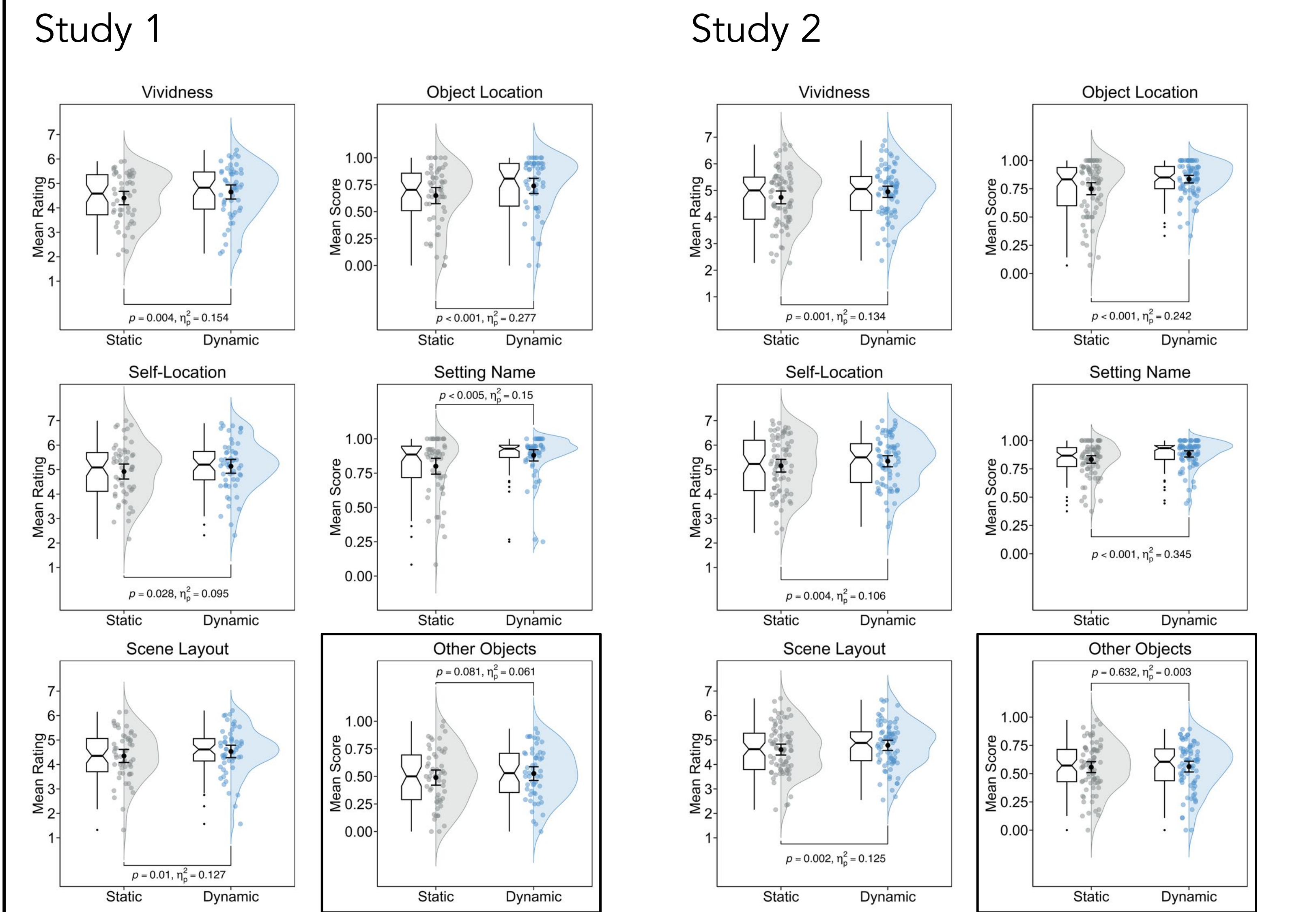
REFERENCES

1. Goldstein et al. (1982). *Bulletin of the Psychonomic Society.* 20, 37-40.
2. Matthews et al. (2007). *Psychonomic Bulletin & Review.* 14(5), 989-993.
3. Rubin & Umanath. (2015). *Psychological Review.* 122(1), 1-23.
4. Rubin, Deffler, & Umanath. (2019). *Cognition.* 183, 44-56.
5. Bohil, Alicea, & Biocca. (2011). *Nature Neuroscience Review.* 12, 752-762.
6. Schöne et al. (2021). *Current Psychology.* 42, 5366-5384.

RESULTS: RETRIEVAL

Dynamic Superiority Effect

Study 1 — Hits — $p < 0.001$, $\eta_p^2 = 0.773$

Study 2 — Hits — $p < 0.001$, $\eta_p^2 = 0.645$

Dynamism boosts scene memory

Study 1
- Vividness — $p = 0.004$, $\eta_p^2 = 0.154$
- Object Location — $p < 0.001$, $\eta_p^2 = 0.277$
- Self-Location — $p = 0.028$, $\eta_p^2 = 0.095$
- Setting Name — $p < 0.005$, $\eta_p^2 = 0.15$
- Scene Layout — $p = 0.01$, $\eta_p^2 = 0.127$
- Other Objects — $p = 0.081$, $\eta_p^2 = 0.061$

Study 2
- Vividness — $p = 0.001$, $\eta_p^2 = 0.134$
- Object Location — $p < 0.001$, $\eta_p^2 = 0.242$
- Self-Location — $p = 0.004$, $\eta_p^2 = 0.106$
- Setting Name — $p < 0.001$, $\eta_p^2 = 0.345$
- Scene Layout — $p = 0.002$, $\eta_p^2 = 0.125$
- Other Objects — $p = 0.632$, $\eta_p^2 = 0.003$

More accurate recall of scene than object memory for dynamic than static events

Movement predicts object location score

Study 1 — $\beta = 0.584$, $p = .013$

Study 2 — $\beta = .062$, $p = .001$
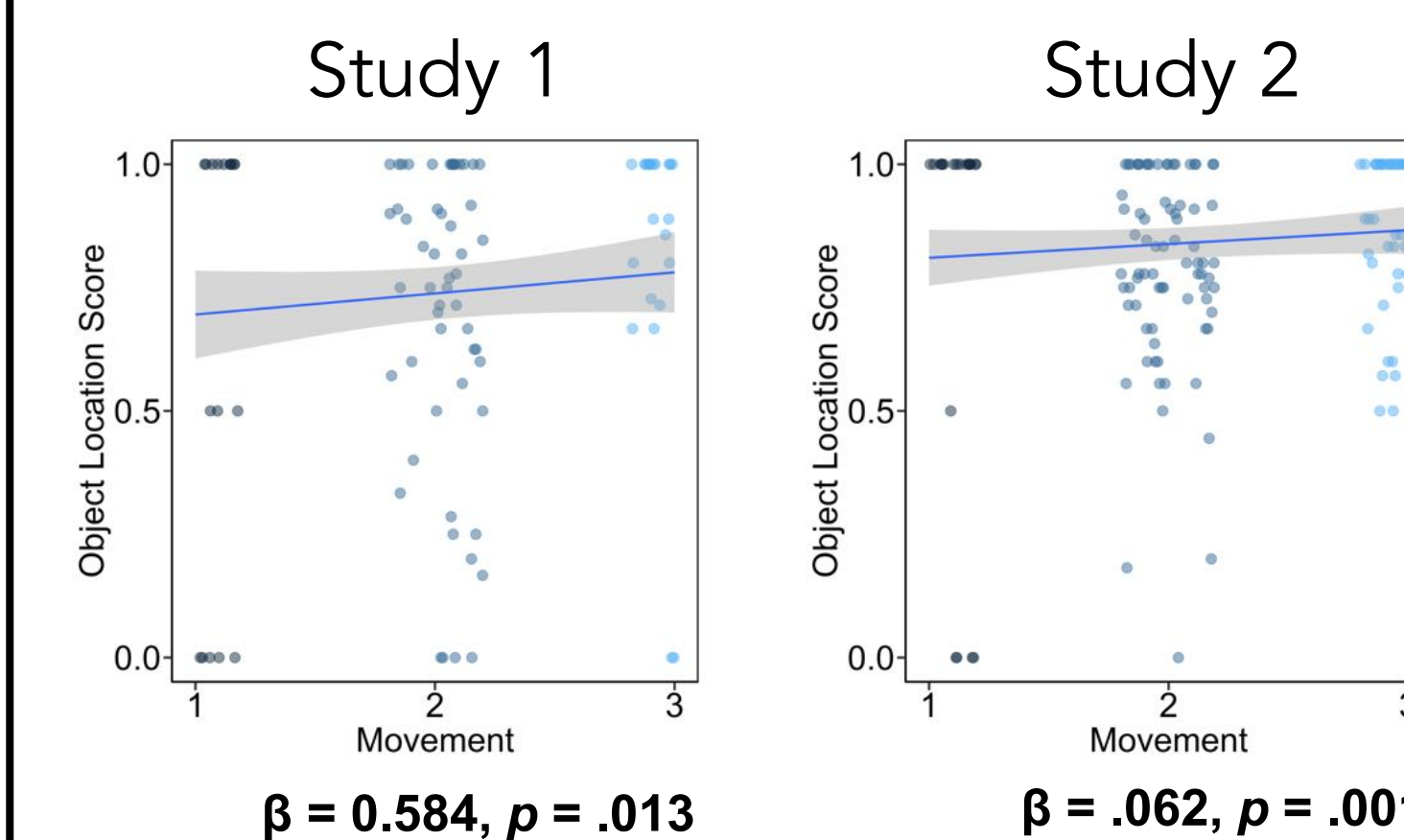
Movement Scoring:
1: object moves once
2: object repeats the same action
3: object moves across the scene

In the dynamic condition, the extent of object movement predicts object location score