# Will this be on the test?
# Investigating Signaling to Different Knowledge Structures

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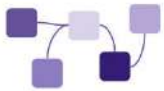
## Background

Knowledge Structures

- Refers to how ideas are organized with one another

**Lower-order Structures**
one-to-one connection between two ideas

**Higher-order Structures**
many-to-many connections; web-like network of ideas



Two Different Patterns for Learning

- **Transfer-Appropriate Processing**: studying lower- or higher-order structures of material results in understanding at that corresponding level *only*[1, 2]
- **Subsumptive Learning**: studying one level of order structures results in understanding at that level *and* the levels beneath it[3, 4]

Signaling Without Practice Testing?

- Past literature on cultivating higher-order understanding limited to practice testing[5, 6]
- Testing effects could cloud our ability to observe genuine higher-order understanding
- How else can we foster higher-order understanding?

## Research Question

How does directing learners' attention to higher- or lower-order structures of learning materials impact their understanding?

## Hypotheses

There is an **interaction** between order structure and test type, such that…

Subsumptive Learning Hypothesis:

- Higher-order condition performs well on test items that assess lower- *and* higher-order understanding.
- Lower-order condition performs well *only* on lower-order items.

Transfer-Appropriate Processing Hypothesis:

- Performance is best when test items match the order structure attended to during study

## Methods

**2x2 Mixed Subjects Factorial Design**

- Signaling condition (higher-order vs. lower-order signaling) manipulated between-subjects
- Test type (higher-order score vs. lower-order score) manipulated within-subjects
- Measured understanding of lower- and higher-order structures with a final test
  - 20-item test: 10 lower-order questions, 10 higher-order questions

**Experiment 1**

- Study phase: Participants read a text about confounds and controls, then reviewed it with highlighted sentences signaling attention towards either lower- or higher-order structures

**Lower-order Signaling Text**

"We can control environmental confounds by keeping environmental variables the same across conditions. Holding constant means minimizing differences in the experimental setting, like using the same room, time, and equipment. But holding constant isn't the only strategy we can use. Randomizing, or random assignment, is a control method where participants are placed into groups by chance."

**Higher-order Signaling Text**

"We can control environmental confounds by keeping environmental variables the same across conditions. Holding constant means minimizing differences in the experimental setting, like using the same room, time, and equipment. But holding constant isn't the only strategy we can use. Randomizing, or random assignment, is a control method where participants are placed into groups by chance."

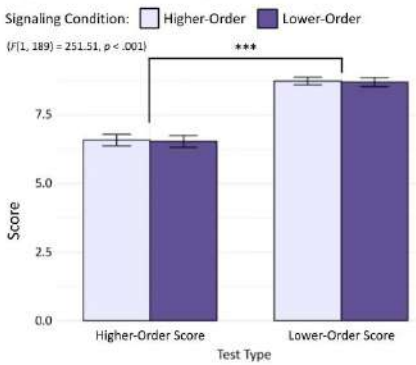
- Final test: 10 MC questions assessed higher-order understanding; 10 for lower-order
  - L-order: "What type of confound occurs when _____?"
  - H-order: Given this confounded experiment scenario, "What is the best way to control for this confound?"

**Experiment 2 - Double Exposure**

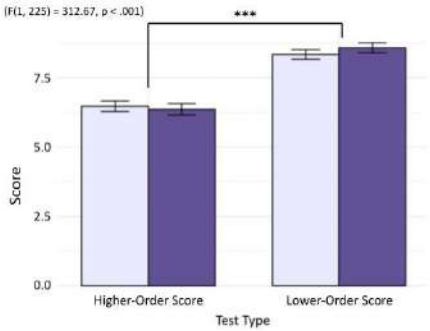
- Similar procedure; participants read their assigned highlighted text twice rather than first reading the text unmarked

## Results

**Experiment 1** (N = 191)




**Experiment 2** (N = 227)




In both experiments, a linear mixed models ANOVA revealed a significant main effect of test type. No other significant effects were found.

## Conclusions

Results from both experiments demonstrated a main effect of test type, but **did not** support our main hypotheses of a significant interaction.

**Main Effect of Test Type**

- Participants' performance was greater for lower-order test items than higher-order test items
- Higher-order understanding is more challenging and effortful to achieve than lower-order understanding

Why no interaction or main effect of condition?

**Strength of Manipulation**

- Signaling alone may not be enough to influence how participants learn about confounds
- Most participants were somewhat familiar with the content → pre existing knowledge structures resistant to the manipulation
- Stronger signaling methods should be explored with samples more unfamiliar with the material

**Specificity of Material**

- Confounds and controls could be too difficult to be reorganized in learners' minds solely on signaling cues
- Signaling effects may be observed with other content

**Immediate Testing and Short Exposure**

- Effects of signaling may appear after a longer delay
- Highlighting may be more helpful after more time with the content to organize idea structures

**Unique to Practice Testing?**

- Patterns observed in the literature may be an exclusive effect of practice testing

## References

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