# Blocked vs. Interleaved Study Sequences Differentially Impact the Retention of Generalized Knowledge and Specificity

Sharon M. Noh & Alison R. Preston
The University of Texas at Austin

## BACKGROUND

Learning conditions that are difficult can yield greater long-term learning benefits (i.e., "**desirable difficulties**")[1-3].

Optimal training conditions may differ based on the goals of learning, whether it be improving **general knowledge** vs. **specificity** (e.g., detailed memory).

**Memory studies** have shown that although massed practice can lead to better immediate performance, **spaced practice is optimal** for long-term retention[4].

**Studies on category learning** have found that the order in which information is encoded (**blocked vs. interleaved**) can lead to vastly different behavioral outcomes[5-7], but no studies to date have assessed these **differences after a delay**.

## RESEARCH QUESTION

To what degree is generalized knowledge and detailed memory preserved as a function of time (immediate vs. 1-week delay) and study schedule (blocked vs. interleaved training)?

## TRAINING METHODS

### STUDY SCHEDULES

**Blocked** (B): Sequential presentation of exemplars, blocked by category.
**Interleaved** (I): Random presentation of all exemplars across categories.

**Blocked:** $A_1$ $A_2$ $A_3$ $A_4$ $B_1$ $B_2$ $B_3$ $B_4$ $C_1$ $C_2$ $C_3$ $C_4$ $D_1$ $D_2$ $D_3$ $D_4$

**Interleaved:** $A_1$ $B_1$ $C_1$ $D_1$ $B_2$ $D_2$ $A_2$ $C_2$ $D_3$ $C_3$ $B_3$ $A_3$ $B_4$ $D_4$ $C_4$ $A_4$

### CATEGORY LEARNING

**Study Phase (Day 1 only):**

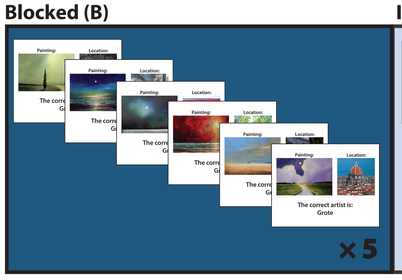
12 categories (artists) × 6 exemplars (paintings) per category = 72 paintings
Each painting is paired with a unique location (72 total locations)

**Presentation Order (counterbalanced):**

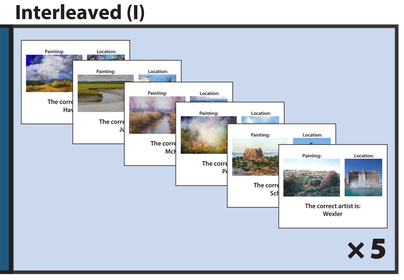
B I I B B I I B B I I B

I B B I I B B I I B B I

**Blocked (B)**




**Interleaved (I)**




## PROCEDURE

### Immediate (Day 1) Measures:

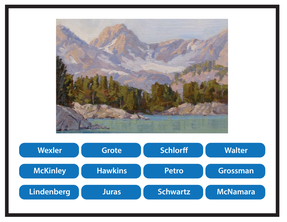
**Training Phase:** Study 72 painting+location pairs to learn artist styles
**Generalization Test:** Categorize 6 new paintings per artist (72 trials)
**Detailed Recognition Test:** For half of studied paintings, identify location
**Memory Test:** For half of studied locations, identify artist paired w/ that location

### Delayed (Day 7) Measures:

**Generalization Test:** Categorize 6 new paintings per artist
**Detailed Recognition Test:** Identify location for remaining paintings
**Memory Test:** Identify artist for remaining locations

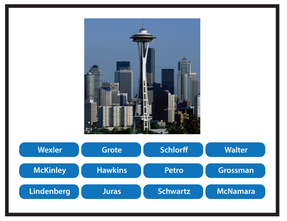
**Training Phase**


**Generalization Test**



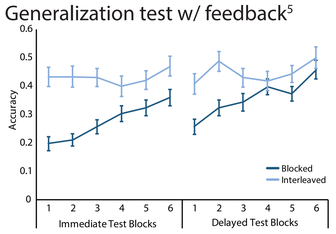

**Detailed Recognition Test**

**Memory Test**

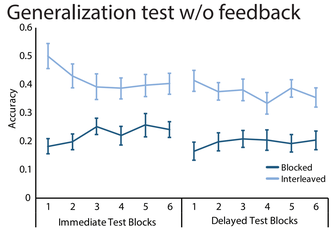


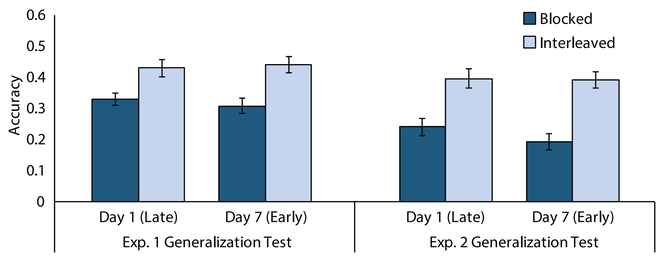

## Feedback During Generalization Test Aids Retention of General Knowledge for Blocked Categories

**Experiment 1:**
Generalization test w/ feedback[5]

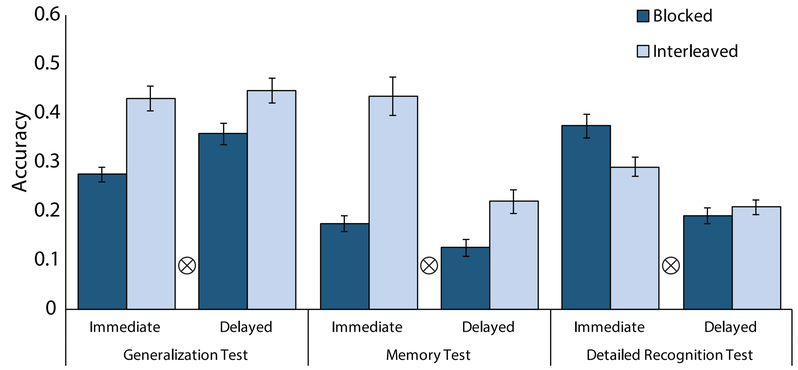



**Experiment 2:**
Generalization test w/o feedback

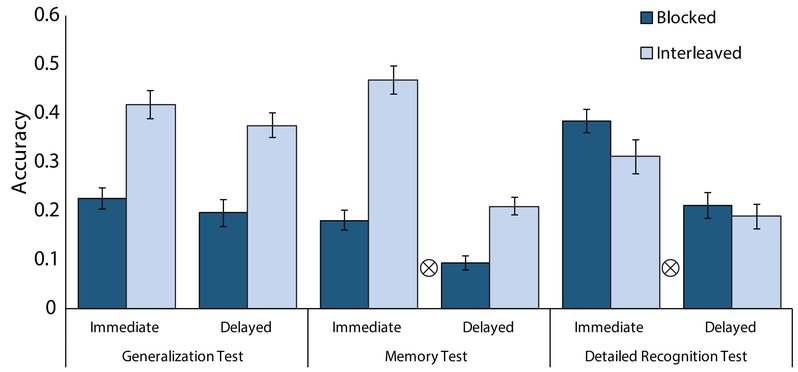



## EXPERIMENT 1




## EXPERIMENT 2




## CONCLUSIONS

1. Interleaved training is optimal for generalized knowledge and memory immediately and over time.
2. Blocked training is beneficial on immediate tests of detailed recognition requiring high specificity.
3. While memory and detailed recognition deteriorate over time, general knowledge remains relatively stable even after a delay.

## REFERENCES

1. Bjork, E. L., & Bjork, R. A. (2011). *Psychology & the real world: Essays illustrating fundamental contributions to society*.
2. Dunlosky, J., Rawson, K. A., Marsh, E. J., Nathan, M. J., & Willingham, D. T. (2013). *Psych Sci in the Public Interest, 14*(1).
3. Bjork, R. A. (1994). Memory and metamemory considerations in the training of human beings.
4. Cepeda, N. J., Pashler, H., Vul, E., Wixted, J. T., & Rohrer, D. (2006). *Psych bulletin*, 132(3).
5. Kornell, N., & Bjork, R. A. (2008). *Psychological science*, 19(6).
6. Noh, S. M., Yan, V. X., Bjork, R. A., & Maddox, W. T. (2016). *Cognition*, 155.
7. Carvalho, P. F., & Goldstone, R. L. (2015). *Psych bulletin & rev.*, 22(1).

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