

How We Learn Versus How We Think We Learn

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The problem:

- Conditions of instruction that make performance improve rapidly often fail to support long-term retention and transfer,
...whereas
- Conditions of instruction that appear to create difficulties for the learner, slowing the rate of *apparent* learning, often optimize long-term retention and transfer

Learning versus performance

- Empirical evidence:
 - Old evidence: Learning without performance:
 - “Latent learning” studies;
 - Motor skills studies
 - Newer evidence: Performance with little or no learning;
 - The bottom line:
 - What we can observe is performance;
 - What we must infer is learning;
 - ...and the former is an unreliable guide to the latter.

Corresponding conceptual distinctions:

- Hull (1943):
 - *Momentary reaction potential versus*
 - *Habit strength*
- Estes (1955):
 - *Response strength versus*
 - *Habit strength*
- Bjork & Bjork (1992):
 - *Retrieval strength versus*
 - *Storage strength*

Examples of manipulations that introduce “desirable difficulties” (Bjork, 1994) for the learner

- Varying the conditions of learning
- Distributing or spacing study or practice sessions
- Providing “contextual interference” during learning (e.g., *interleaving* rather than *blocking* practice)
- Using tests (rather than presentations) as learning events

The word *desirable* is important ...

- Many difficulties are *undesirable* during learning, after learning, and forever after
- Desirable difficulties are desirable because responding to them (successfully) engages processes that support learning, comprehension, and remembering
 - They become undesirable difficulties if the learner is not equipped to respond to them successfully.
 - Generation effects as an example.

Tests versus presentations as learning events

- Testing as pedagogy versus testing as assessment
- Example: Roediger and Karpicke (2006)
 - To-be-learned text passage on the sun or on sea otters (about 30 idea units per passage)
 - Three conditions
 - SSSS: four consecutive 5-min study periods
 - SSST: three study period plus a test of recall for the passage
 - STTT: one study period plus four consecutive tests of recall for the passage

Roediger & Karpicke (2004)

(Passage on the sun or on sea otters; about 30 idea units in each passage)

Table 3

Mean number of times subjects were able to read the entire passage during 5-minute study periods in Experiment 2

Condition	Study Period				Sum
	1	2	3	4	
SSSS	3.4	3.5	3.6	3.7	14.2
SSST	3.2	3.5	3.6		10.3
STTT	3.4				3.4

Roediger & Karpicke (2004)

Table 5

Mean proportion of idea units recalled on the retention tests and forgetting scores in Experiment 2

Condition	Retention Interval		Forgetting
	5 min	1 week	
SSSS	.83		
SSST	.78		
STTT	.71		

Roediger & Karpicke (2004)

Table 5

Mean proportion of idea units recalled on the retention tests and forgetting scores in Experiment 2

Condition	Retention Interval		Forgetting
	5 min	1 week	
SSSS	.83	.40	
SSST	.78	.56	
STTT	.71	.61	

Roediger & Karpicke (2004)

Table 5

Mean proportion of idea units recalled on the retention tests and forgetting scores in Experiment 2

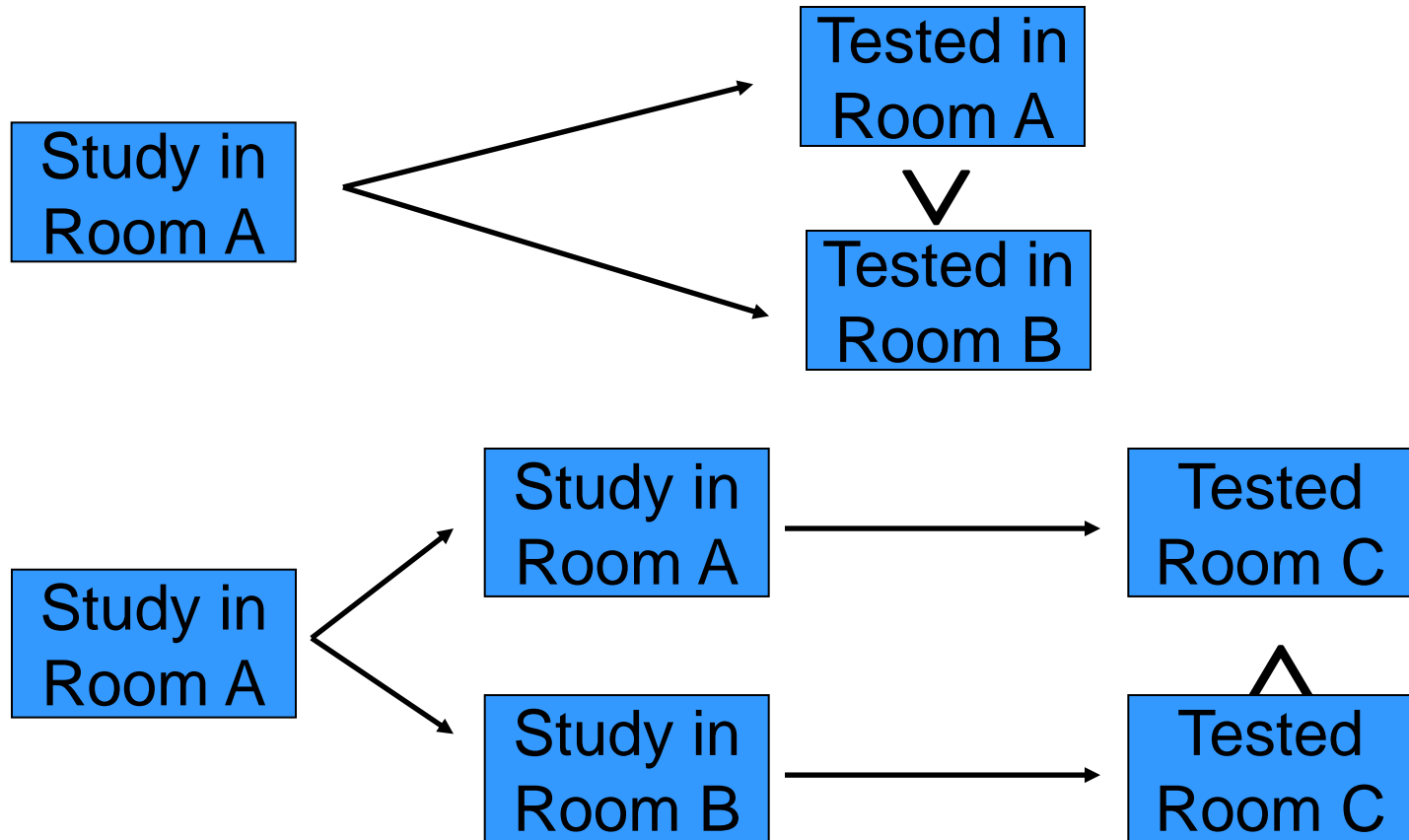
Condition	Retention Interval		Forgetting
	5 min	1 week	
SSSS	.83	.40	.43
SSST	.78	.56	.22
STTT	.71	.61	.10

Varying the conditions of learning (Example: Kerr & Booth, 1978)

Design

- Two age groups: 8-year-olds & 12-year-olds
- Task: beanbag toss to target on floor (occluded)
- Conditions of Practice:
 - Fixed: All practice at a fixed (criterion) distance;
 - Varied: Practice at criterion distance +/- one foot
(never at the criterion distance)

Varying the environmental context of learning (Smith, Glenberg, & Bjork, 1978)



Spacing study or practice sessions

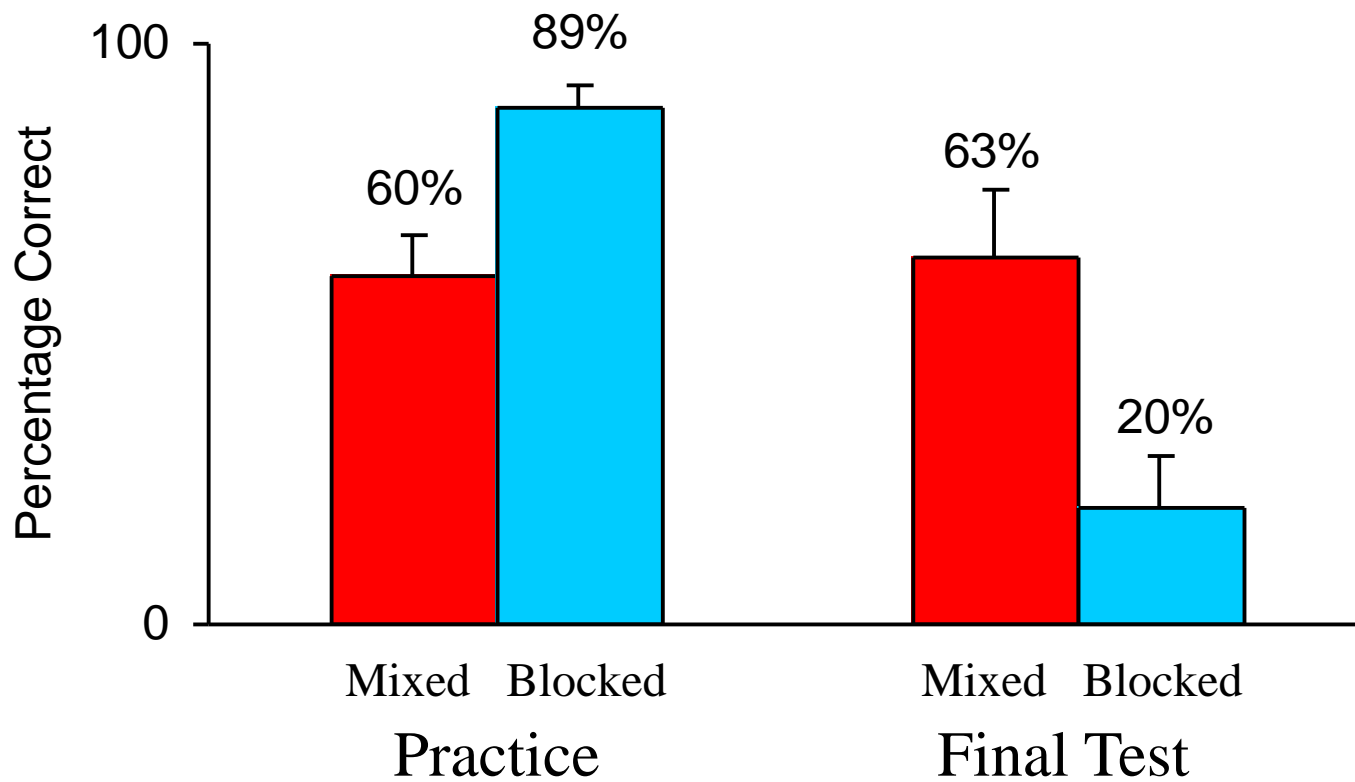
- Example: Bahrick (1979)
 - Participants learned the Spanish equivalents of 50 English words
 - Two experiments:
 - 3 or 6 sessions
 - Anticipation method
 - 0, 1, or 30 days apart

Providing “contextual interference” during learning

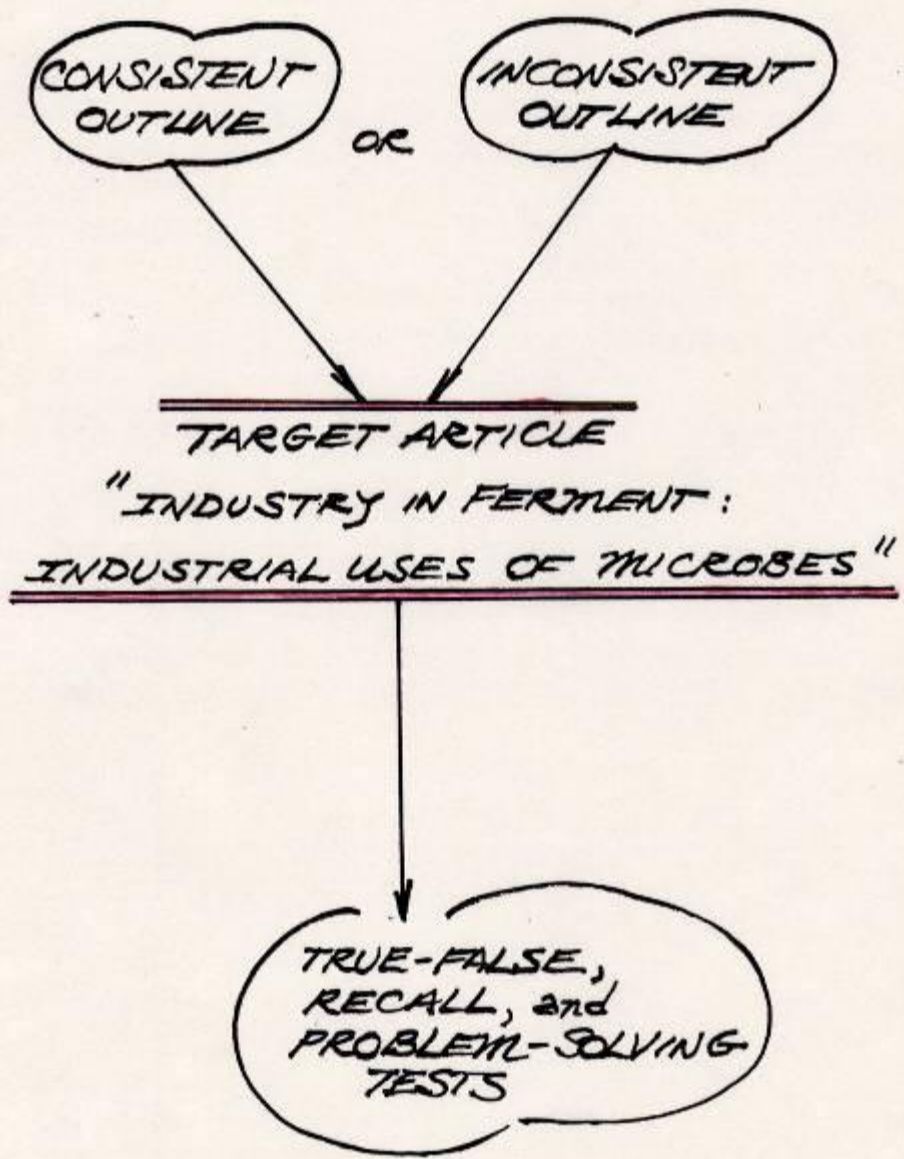
- *Interleaving* rather than *blocking* practice
 - Shea and Morgan (1979)
 - Simon and Bjork (2001)
 - Taylor, Rohrer, and Pashler (2005)
 - Ste-Marie, Clark, Findlay, & Latimer (2004)
- Consistent versus inconsistent “advanced organizer”
 - Mannes and Kintsch (1987)

Procedure (Rohrer & Taylor, in press)

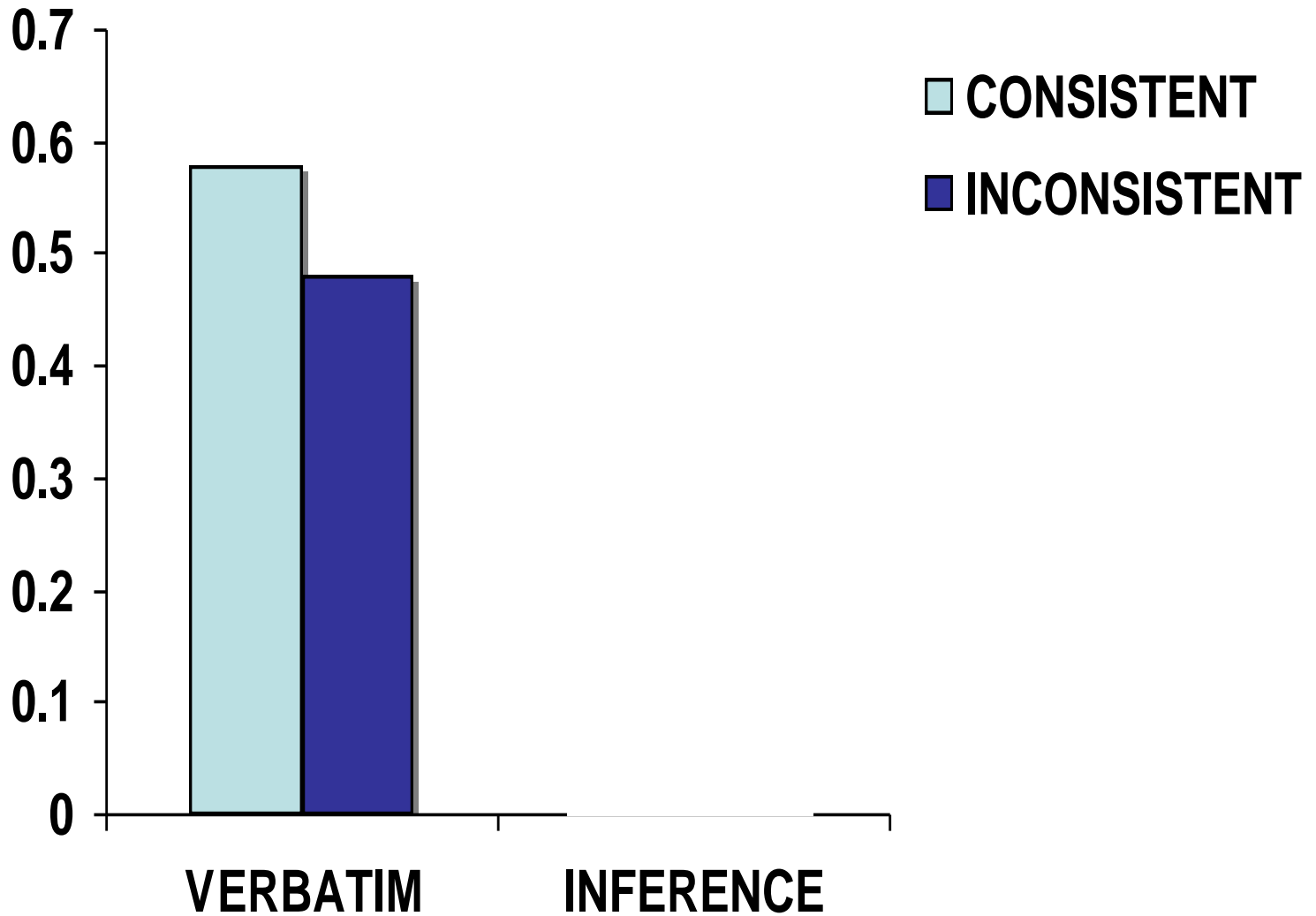
- Undergraduate participants read 4 tutorials and worked 16 problems, 4 of each type.
 - Participants had 40s to work each problem, followed by a 10-sec presentation the solution.
 - **Mixers:** Read all 4 tutorials before working 16 randomly arranged problems.
 - **Blockers:** Each tutorial was immediately followed by 4 problems of that type.
- Participants tested one week after the learning session.
 - Two problems on each type of solid intermingled.
 - None of the test items appeared during the practice phase.



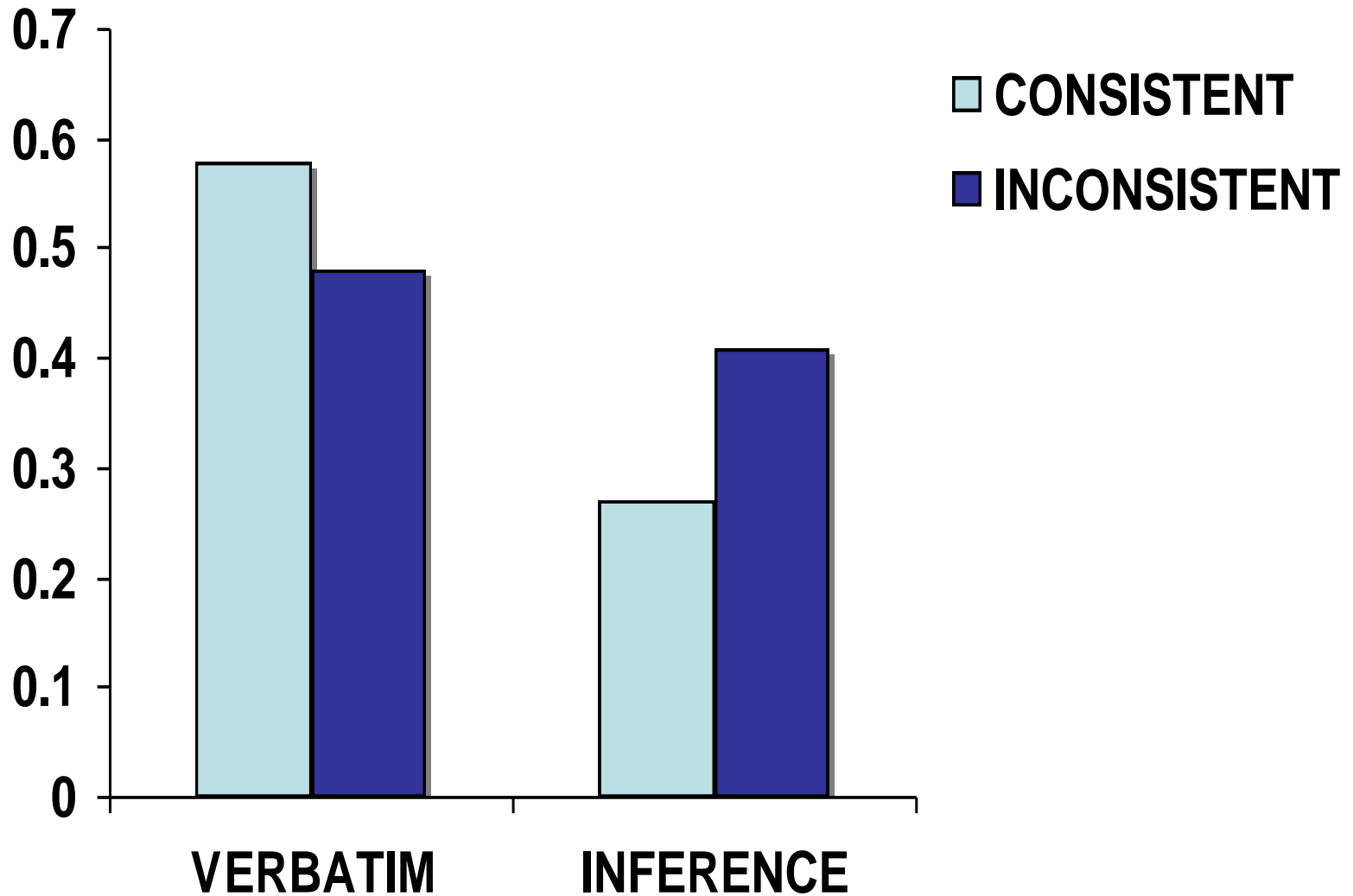
Mannes & Kintsch (1987)



Mannes & Kintsch (1987)



Mannes & Kintsch (1987)



Induction

- The ability to generalize concepts and patterns through exposure to multiple exemplars.
 - A domain in which massing/blocking, not spacing/interleaving is optimal?
 - Kornell and Bjork (2007)

“Spacing is the friend of recall but the enemy of induction.”



-Ernst Rothkopf

Induction is a critical to higher-order learning; spacing is (typically) an effective learning technique; but maybe massing--not spacing--is the friend of induction?

Desirable-difficulties findings: Implications for the design of instruction?

- Variation?
- Interleaving?
- Spacing?
- Using tests/generation as learning events?

Desirable-difficulties findings: Implications for the evaluation of instruction?

- Students' evaluation of teaching?
- Trainees completing “happy” or “smile” sheets in industry?
- Students expectations as to how courses should be taught?

Piaget (1962)

“Every beginning instructor discovers sooner or later that his first lectures were incomprehensible because he was talking to himself, so to say, mindful only of his point of view. He realizes only gradually and with difficulty that it is not easy to place one’s self in the shoes of students who do not yet know about the subject matter of the course.”

How we learn versus how we think we learn

- Misconceptions
 - We have a faulty mental model of ourselves as learners (human memory versus a videotape recorder)
 - Intuition versus research: We are not, apparently, educated by the trials and errors of everyday living and learning
- Counterproductive attitudes and assumptions
 - Performance indexes learning
 - Efficient learning is easy learning
 - Differences in the performance of individuals reflect differences in innate ability or learning style
 - Individual differences are greatly over-appreciated,
 - The power of experience, practice, and effort is underappreciated
 - Comments on the *styles-of-learning* idea

Individual differences and the *styles-of-learning* idea

- *Why is the idea attractive?*
- *Why is it counterproductive?*

Parents Of Nasal Learners Demand Odor-Based Curriculum

March 15, 2000 | [Issue 36•09](#)

COLUMBUS, OH—Backed by olfactory-education experts, parents of nasal learners are demanding that U.S. public schools provide odor-based curricula for their academically struggling children.



A nasal learner struggles with an odorless textbook.

"Despite the proliferation of countless scholastic tests intended to identify children with special needs, the challenges facing nasal learners continue to be ignored," said Delia Weber, president of Parents Of Nasal Learners, at the group's annual conference. "Every day, I witness firsthand my son Austin's struggle to succeed in a school environment that recognizes the needs of visual, auditory, tactile, and kinesthetic learners but not him." ... "My child is not stupid," Weber said. "There simply was no way for him to thrive in a school that only caters to traditional students who absorb educational concepts by hearing, reading, seeing, discussing, drawing, building, or acting out."

Individual difference *do* matter, and matter greatly

- New learning builds on--and depends on--old learning
- Personal, family, and cultural histories affect, among other things
 - Motivation to learn;
 - The degree to which learning is valued;
 - Aspirations and expectations with respect to learning;
 - The knowledge and assumptions brought to new learning
- Example: Lee and Bjork (2004)

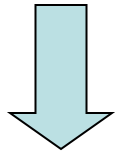
Which Order Is Optimal?

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Doing the
Readings

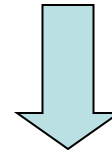
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Attending
Lecture



Then

OR



Then

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Attending
Lecture

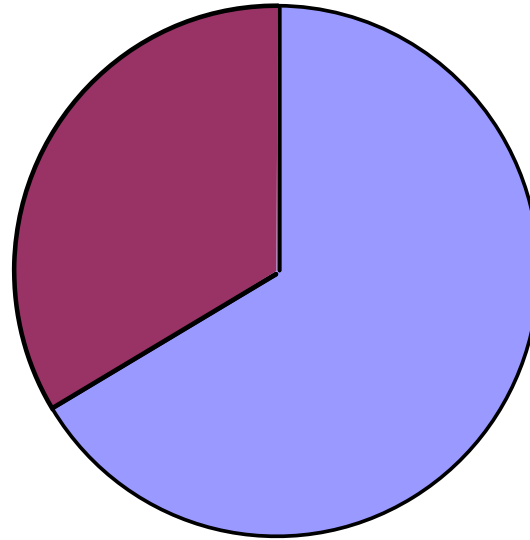
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Doing the
Readings

What Do You Do?

34%

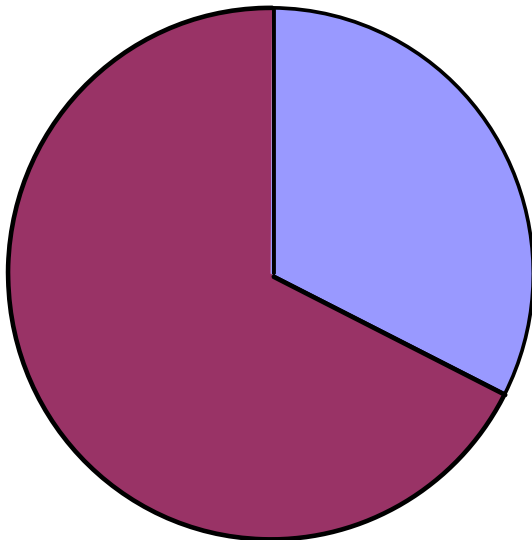
66%



Which Is More Effective?

67%

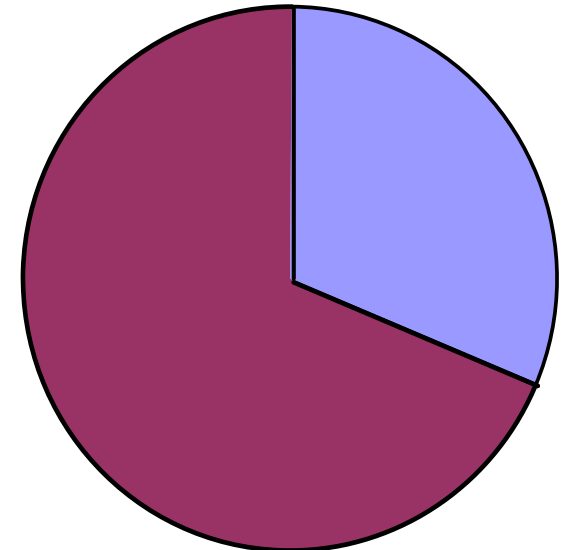
33%



Which Is More Difficult?

66%

34%



Text then Lecture



Lecture then Text

The bottom line ...

- *We all*, barring an organic disorder, have an incredible capacity to learn

Reinventing undergraduate education

- If students do not tend to engage in the learning activities that produce durable and flexible learning,
 - the fault is primarily ours;
 - who among us, during our student days, would have answered those survey questions differently?
- We need to structure courses, curricula, requirements, and activities to engage the processes that enhance learning, comprehension, and knowledge integration
 - Doing so requires, among other things, adopting the perspective of a student
 - Newton (1990) as a parable of teaching
 - Piaget (1962) quote
 - Calvin and Hobbes cartoon.

■ The end

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