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
  - 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

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Sum</th>
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<td>3.5</td>
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Roediger & Karpicke (2004)

Table 5

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

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<td>.83</td>
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Roediger & Karpicke (2004)
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)

- 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.
Percentage Correct

Practice

Mixed  Blocked

60%  89%

Final Test

Mixed  Blocked

63%  20%
Mannes & Kintsch (1987)

CONSISTENT OUTLINE

OR

INCONSISTENT OUTLINE

TARGET ARTICLE

"INDUSTRY IN FERMENT:
INDUSTRIAL USES OF MICROBES"

TRUE-FALSE, RECALL, AND PROBLEM-SOLVING TESTS
Mannes & Kintsch (1987)

The graph shows the results of the study conducted by Mannes & Kintsch (1987), comparing verbatim and inference in the context of consistent and inconsistent conditions. The graph indicates that the performance in the verbatim condition is generally higher than in the inference condition, with a notable difference in the consistent condition.
Mannes & Kintsch (1987)

![Graph showing the comparison between Verbatim and Inference with Consistent and Inconsistent categories.](image_url)
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)
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?

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

-Ernst Rothkopf
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?
“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?*
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.

"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?

Doing the Readings

Then

Attending Lecture

OR

Attending Lecture

Then

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


References (continued)