Leveraging the science of learning for language training

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Science of learning for language training

Cognitive science of learning: > 50 years

Application to language learning: under-utilized

Insertion in human- and computer-delivered training: just beginning
Test your learning knowledge

• Imagine:
  o You are given 40 word pairs, such as these Swahili-English pairs:
    – Fununu - Rumor,
    – Mashua - Boat,
    – Tabibu - Doctor
  o You have to study the entire list repeatedly, alternating between study practice and self-evaluation practice.
  o **Study practice** involves looking at the two words and associating them in your mind
  o **Self-evaluation practice** involves covering up the English word, and generating it from memory, given the Swahili word.
  o You are given 40 minutes to accomplish this task
How would you study to enhance your long-term retention of the words? Please, do not share your answers out loud.

1) I would engage in (a) more study practice than self-evaluation practice or (b) more self-evaluation practice than study practice.

2) During study practice, I would (a) put aside words that I can already recall correctly and focus my study on the words that I cannot yet recall correctly or (b) continue to practice all words, whether I can correctly recall them or not.

3) Same question as 2, but now for self-evaluation practice.

4) If error feedback were not available, engaging in self-evaluation practice is something (a) I would do or (b) I would not do.

5) In between repetitions of a list of words, (a) I would or (b) I would not engage in an unrelated activity (e.g., take a minute or two to look at my email).
Testing improves long-term but not short-term retention (Karpicke & Roediger, 2010): **Testing effect**

![Graph showing cumulative proportion recalled over time.](image)

- Short-term retention (initial learning)
- Long-term retention (after 1 week)

Also (not shown): no differences among participants in how well they predicted long-term recall (50%)
Testing effect is well established

- **Materials**
  - Single words, foreign language word pairs, essay texts, studied facts, face-name pairs, maps

- **Feedback**
  - With and without feedback

- **Memory tasks & types**
  - Cued recall, free recall, mpc
  - Declarative, procedural memory

- **Populations:**
  - Children, young & older adults

- **Context**
  - Controlled laboratory studies
  - Educational context

- **Outperforming** encoding strategy of elaboration
## Learning strategies

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Utility</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practice testing</td>
<td>High</td>
<td>Under-utilized</td>
</tr>
<tr>
<td>Distributed practice</td>
<td>High</td>
<td>Under-utilized</td>
</tr>
<tr>
<td>Elaborative interrogation</td>
<td>Moderate</td>
<td>Over-utilized</td>
</tr>
<tr>
<td>Self-explanation</td>
<td>Moderate</td>
<td>Over-utilized</td>
</tr>
<tr>
<td>Highlighting / underlining text</td>
<td>Low</td>
<td>Over-utilized</td>
</tr>
<tr>
<td>Re-reading text</td>
<td>Low</td>
<td>Over-utilized</td>
</tr>
<tr>
<td>Imagery use for text-based learning</td>
<td>Low</td>
<td>Over-utilized</td>
</tr>
<tr>
<td>Key-word mnemonic</td>
<td>Low None</td>
<td>Still used</td>
</tr>
<tr>
<td>Practicing long-term memory as a muscle (e.g., poetry)</td>
<td>Low</td>
<td>Over-utilized</td>
</tr>
</tbody>
</table>

Explanation for underutilization – part 1: trade-off between learning techniques

- Good long-term retention
- Depth of expertise
- Rapid performance gains
- Easy access in working memory
Explanation for underutilization – part 1: trade-off between learning techniques

<table>
<thead>
<tr>
<th>Good long-term retention</th>
<th>Depth of expertise</th>
<th>Practice testing</th>
<th>Practice schedule</th>
<th>Context</th>
<th>Elaboration</th>
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<tr>
<td>Rapid performance gains</td>
<td>Easy access in working memory</td>
<td>Test &gt; Study</td>
<td>Spaced</td>
<td>Variable</td>
<td>Extensive</td>
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<td></td>
<td></td>
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<td>Massed</td>
<td>Constant</td>
<td>Minimal</td>
</tr>
</tbody>
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- **Practice testing**
  - **Test > Study**
  - **Study > Test**

- **Practice schedule**
  - Spaced
  - Massed

- **Context**
  - Variable
  - Constant

- **Elaboration**
  - Extensive
  - Minimal
Explaination for underutilization – part 1: solving the trade-off

- Good long-term retention
- Depth of expertise
- Rapid performance gains
- Easy access in working memory

Learning phase:
- Later
- Early
Explanation for underutilization – part 2: counter-intuitive memory mechanisms

• Does it help to learn additional content that is not on the test?
• Is a learner who experiences memory retrieval difficulties on the right path?
• Am I not the best judge / experiencer of my own performance gains?

 short-term & shallow
 x

 long-term & deep
 x

DIGGING DEEP
CASL Long-term memory course for government employees

- **Instructor-delivered. 4-6 hours**
- **Empirically validated**
- **Brain basis of memory**
- **Learning & memory strategies**
- **Practice with retrieval practice**

**LTM course**

Delivered to various USG government departments and agencies
Infusion model 1: knowledge transfer

CASL
1st) Instructor-Delivered course

US Government
* instructional designers
* training managers
* student counselors
* trainers of teachers
* teachers

2nd) Train-the trainer(s)
Infusion model 2: knowledge exchange (FSI, 2014, CASL with Caplan & Gilzow)

1\textsuperscript{st} CASL-Instructor-delivered course

2\textsuperscript{nd} CASL-facilitated workshop series

* Refresh course content
  • Select learning principles
  • Form project groups
  • Work out project group plans
  • Report out concrete products (student counselors’ handout, teacher brown bag, video clip, classroom activities)

USG language training experts
“Many-for-one” recommendation #1

1) Better language learning
2) Better professional development
3) Better reporters
4) More efficient workshop preparation
5) Anywhere anytime study
6) Cross-agency efficiency

On-line self-study course on learning & memory
“Many-for-one” recommendation #2

1) Technology outcome optimization
2) Easier evaluation of science of learning
3) “Shortening the fuse of big bang”
4) Better focussing of limited teacher resources
5) Anywhere any-time study
6) Cross-agency efficiency

Language learning technology enhanced with science of learning

(c) 2014 University of Maryland Center for Advanced Study of Language
Scientific technical aspects of language training evaluation study

- Random sample of participants from large population
- Random assignment of participants to a training and control condition
- Teaching system and students blind to condition
- Controlled timing of assessments
  
  E.g., pre-test & post-test: 1 week between immediate and delayed recall

- Rich assessments
  
  E.g., log data, accuracy, RT, attention/effort (pupillometry)
Leveraging the science of learning for language learning: conclusions

Government language training professionals should

- take an **on-line course** on learning and memory
- apply the resulting knowledge in **workshops** aimed at improving concrete language learning products
- pay special attention to powerful **under-utilized learning principles**, such as, **practice testing** and **distributed practice**
- partner with industry and academe to create and improve **cognitively enhanced language technology**
- and to explore potential big-bang approaches, such as
  - **implicit learning**
  - **working memory training**
  - **adaptive learning**
- give themselves a pat on the back for promoting **global peace and prosperity** through better communication
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