TRAINING DECAY
IS 1 HOUR LONG ENOUGH?
Agenda

1. What is Training Decay for Usability Validation?
2. What does the FDA say about Training Decay?
3. What does the literature say about Training Decay?
4. How do I select an “appropriate” training decay?
The Form of Forgetting

Results and Discussion

The proportion of correct “yes” responses (i.e., hits over hits plus false alarms) was subjected to an analysis similar to that of the previous experiment. Because the forgetting functions produced by the high and low degree of learning conditions were rather variable, however, the data were averaged across degree of learning in order to yield a smooth forgetting curve. An analysis of variance yielded main effects for degree of learning, $F(1,187) = 29.91, p < .01$, and retention interval, $F(3,187) = 4.60, p < .01$, but the interaction did not approach significance, $F(3,187) = 0.51$. Figure 2 shows the proportions of correct responses averaged over degree of learning.

The mathematical functions shown in Table 1, all of which decline to an asymptote of zero, cannot be directly fitted to the forgetting curve shown in Figure 2, which declines to a theoretical asymptote of 0.50 (the proportion of correct responses produced simply by guessing). To deal with this problem, the dependent measure may be transformed so that chance performance is represented by 0 rather than 0.50 (e.g., by using hits minus false alarms), or the mathematical functions themselves may be modified so that they approach an asymptote of 0.50 rather than 0. At least with regard to the present data, either approach yields the same result. We chose to leave the dependent measure untransformed and fit each mathematical function in the general form

$$p(c) = \frac{f(t)}{f(t) + l}$$

where $p(c)$ represents percent correct and $f(t)$ represents one of the mathematical functions shown in Table 1. An equation of this form results from the assumption that the familiarity of distractors remains constant over time and that subjects respond on the basis of the relative familiarity of old and new items. Expressed in this form, the mathematical functions now decline to the proper asymptote of 0.50 as $f(t)$ approaches zero.

As shown in the third column of Table 2, the pattern of results is strikingly similar to that observed in the previous experiment. The linear benchmark accounts for less than 75% of the variance, and the exponential and hyperbolic functions produce only marginal improvements. The exponential-power function accounts for a reasonable proportion of the data variance but, once again, the logarithmic and power functions account for nearly all of the variance (with the edge going to the latter). The solid curve in Figure 2 represents the best-fitting power function.

EXPERIMENT 3

The results of the first two experiments point to the same conclusion: The course of forgetting is described by the simple power function (or, perhaps, by the logarithmic function). The fact that virtually identical conclusions were reached using such different procedures suggests that the identified form of forgetting may not be restricted to the procedural details of a particular experiment. To further evaluate this assumption, the next experiment involved a different species (pigeons) performing on yet another memory procedure, the DMTS task.

Subjects

The subjects were four experimentally naive White Carneaux pigeons maintained at approximately 80% of their free-feeding weight. They were housed in a vivarium in which lighting and ambient temperature were controlled automatically.

Materials and Apparatus

The pigeons were tested in a conditioning chamber equipped with three response windows mounted side by side on one wall. A high-resolution color graphics computer monitor was situated outside of the chamber directly facing the response windows. By looking through those windows, the pigeons were able to view graphic images displayed on the screen. Two graphic stimuli were used throughout the experiment, a red circle and a green square.

Procedure

A trial began with the display of one of the two stimuli in the center window. After 10 responses to the center window, the stimulus was extinguished and the retention interval began.
What does the FDA Say?
Because retention of training decays over time, testing should not occur immediately following training; some period of time should elapse. In some cases, giving the participants a break of an hour (e.g., a “lunch break”) is acceptable; in other cases, a gap of one or more days would be appropriate, particularly if it is necessary to evaluate training decay as a source of use-related risk.
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The HF Validation study should simulate the effect training decay may have on the users; e.g., simulate the training decay by separating the training and simulated use testing by several hours or days. The protocol should justify the interval to simulate the training decay.
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If USER training is a RISK CONTROL measure and is expected prior to use, that training needs to be received and an appropriate elapsed time to accommodate for learning decay needs to occur. Since in this case the training is a RISK CONTROL measure, the SUMMATIVE EVALUATION cannot evaluate its ‘effectiveness as a RISK CONTROL measure’ if the training has not been delivered in a realistic manner.
What is appropriate?
### Injection Device Training Decays

<table>
<thead>
<tr>
<th>Usability Study</th>
<th>Real-Life Lag between Training and Injection</th>
<th>Usability Validation Training Decay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Usability Study 1</td>
<td>4 hours to 1 day</td>
<td>1 hour</td>
</tr>
<tr>
<td>Usability Study 2</td>
<td>1 week</td>
<td>1 day</td>
</tr>
<tr>
<td>Usability Study 3</td>
<td>2 weeks</td>
<td>1-3 days</td>
</tr>
<tr>
<td>Usability Study 4</td>
<td>1 week</td>
<td>4 days</td>
</tr>
<tr>
<td>Usability Study 5</td>
<td>Unpredictable: 1 day to 1 month</td>
<td>1 week</td>
</tr>
<tr>
<td>Usability Study 6</td>
<td>2 weeks</td>
<td>7-10 days</td>
</tr>
<tr>
<td>Usability Study 7</td>
<td>2 weeks</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Usability Study 8</td>
<td>1 month</td>
<td>1 month</td>
</tr>
</tbody>
</table>
Specialty surgeons from around the country
  Training Decay may reduce the sponsor's ability to recruit from diverse institutions

For products with unique user populations
  Training Decay may reduce the sponsor’s ability to recruit as many users

Reduced number of participants who actually return for the usability validation study.
  Training Decay introduce self-selection bias

Evaluating a team of participants at once (e.g. An Operating Room Team), and ensuring that the same participants return
  Training Decay, and needing to mix teams, may introduce more study artifacts
Decay Curves

Bad

Good
Variables that impact Training Decay

• Depth of learning
  • Meaning, Motivation
• Repetition
• Are there cues?
  • Recognition vs. Recall
Variables that impact Training Decay

- Depth of learning
  - Meaning, Motivation
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- Are there cues?
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Remember to:
- Wash hands
- Clean site

Keep Clean or you'll get an infection!

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Variables that impact Training Decay

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Recognition vs. Recall
Loh (1922)
## Decay Curves

<table>
<thead>
<tr>
<th></th>
<th>Frequently Used</th>
<th>Infrequently Used</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simple</strong></td>
<td><img src="chart1.png" alt="Graph" /></td>
<td><img src="chart2.png" alt="Graph" /></td>
</tr>
<tr>
<td><strong>Complex</strong></td>
<td><img src="chart3.png" alt="Graph" /></td>
<td><img src="chart4.png" alt="Graph" /></td>
</tr>
</tbody>
</table>
Memory with Cues

Faces (Wixted)

Word Stem Completion (Luh)
Nonsense Words (Luh) 24 hrs
Nonsense Words (Underwood) 5 hrs
50 Monosyllabic Words (Williams) 1 day 3 days
Meaning of Prose read only one time

Source: Dietz and Jones, 1931
CPR - Adequate Compression Depth

6 months

CPR - Check Respiration

6 months

Look, listen and feel for breathing
<table>
<thead>
<tr>
<th>Fact Memory</th>
<th>Skills Memory</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Declarative, Explicit</strong>&lt;br&gt;Semantic</td>
<td><strong>Non-Declarative, Implicit</strong>&lt;br&gt;Procedural</td>
</tr>
<tr>
<td><strong>Verbal Retention</strong></td>
<td><strong>Motor Retention</strong></td>
</tr>
</tbody>
</table>
| Learned quickly, easy to forget | Problem solving, analogies, generalizations

“Procedural memory (how to do things) is best learned by actively practicing a skill and appears to be very slow to decay (e.g., riding a bicycle).”

Sources:
HE-75
Tulving, 1985
CPR Tasks

Meta-analysis suggested that these tasks were "binary."

Skills Memory

Ventilate properly
Technique based on motor skills (e.g. don't over-ventilate)

Open Airway properly

Compression Depth

Proper Hand position
Remember where hand is located
Feel for proper hand positioning
## Drug Delivery Device
Syringe, Autoinjector

<table>
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<tr>
<th>Fact Memory</th>
<th>Skills Memory</th>
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</table>
| **1) Device is delicate & drug is sensitive.**  
Store in fridge  
Wait for drug to warm  
Don't let it sit out too long  
Don't expose to direct sunlight | **Orient device properly**  
(correct angle, correct side, etc.)  
**Apply enough force to the button/plunger**  
**Apply enough force to remove the cap**  
**Pinch skin** |
| **2) Clean**  
Wash hands  
Clean site | |
| **3) Safety-checks**  
Confirm dose  
Inspect drug  
Check expiration | |
Drug Delivery Device
Syringe, Autoinjector

Fact Memory

1) Device is delicate & drug is sensitive.
   Store in fridge
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2) Clean
   Wash hands
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3) Safety-checks
   Confirm dose
   Inspect drug
   Check expiration

Recall
Recall has a steep decay

Recognition vs. Recall
Loh (1922)
Drug Delivery Device
Syringe, Autoinjector

Skills Memory

- Orient device properly
  (correct angle, correct side, etc.)
- Apply enough force to the button/plunger
- Apply enough force to remove the cap
- Pinch skin

Recognition vs. Recall
Loh (1922)

- Does the device offer a visual cue for proper orientation?
- Is this confirmed through a Heuristic Analysis or Formative Usability Study?
- If so, RECOGNITION is sufficient for promoting proper orientation.
- If not, RECALL is necessary.

Recognition vs. Recall
Loh (1922)
Drug Delivery Device
Syringe, Autoinjector

Motor skills have a lot of “inertia.”
They’re hard to acquire, but then “stick.”

Literature suggests to view these tasks as “binary.” After an hour, a user will either “know” or “not know” how to perform the task.

Skills Memory

- Orient device properly
  (correct angle, correct side, etc.)
- Apply enough force to the button/plunger
- Apply enough force to remove the cap
- Technique to Pinch skin


Sources


Thank You
Questions?

Shannon E. Clark, P. E.
(650) 996-7480
Shannon.Clark@UserWiseConsulting.com
www.UserWiseConsulting.com
You can't rely on the user to provide adequate compression depth

Fig. 10. Mean percentage of compressions with adequate depth, as measured by the sensored manikin.

Fig. 9. Mean percentage of compressions performed with proper hand placement, as measured by the sensored manikin.
What if this were a Usability Validation?

**Use error occurs 10% of the time after 30 minutes**
10 users ➔ 65% chance of catching at 30 minutes

**Use error occurs 40% of the time at >30 days**
10 users ➔ 100% chance of catching after 30 or more days
Use error occurs 20% of the time after 30 minutes
10 users  ➡️  85% chance of catching at 30 minutes

Use error occurs 30% of the time at >30 days
10 users  ➡️  95% chance of catching after 30 or more days

Conclusion: 30 minutes is sufficient
Strong transfer of learning, here—we've been trained to call 911 since we were children
Use error occurs 10-30% of the time with no decay or 1 month decay
Decay curves appear to be highly dependent on training

Conclusion: May need to test at 3 to 6 months in order to see effect of decay.
Meta-analysis: Use error occurs 10-70% of the time with no decay or 1 month decay
Decay curves appear to be highly dependent on training or study set-up