Overlapping Waves in Knowledge Retrieval

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Overlapping waves
Low-Performing Community College Students
High-Performing Community College Students
Highly Selective University Students

Percent Use

Logical Necessity
Intermediate Steps
Usually Correct
Questionable

Fazio, DeWolf, & Siegler, 2016
\[
\frac{5 \times 4}{6 \ 6} = \\
\frac{5 \times 4 \times 6 \times 6}{36} = 20
\]

\[
\frac{5 \times 4}{6 \ 6} = \frac{5 \times 4}{6 \ 6} = 20
\]

\[
\frac{5 \times 4}{6 \ 6 \times 4 \times 6} = 30
\]

Fazio & Siegler, unpublished
\[
\frac{5}{6} \times \frac{4}{6} =
\]
\[
\frac{4}{7} \times \frac{1}{7} =
\]
\[
\frac{2}{9} \times \frac{5}{9} =
\]

• 85% include both correct and incorrect strategies

Fazio & Siegler, unpublished
Week 1

Week 2

Prp Correct

Fazio et al., 2013, JEP:General
Given Correct at Week 1

Fazio et al., 2013, JEP:General
Overlapping waves

Percent Use

Time

Answer 1
Answer 2
Answer 3
Answer 4
Main Questions

1) How common is instability in general knowledge?

2) Are there patterns in the direction of the switches?

3) What factors affect knowledge instability?
   • Question ease
   • Length of time between answers
   • Number of times seen
Study 1

• Data from Dr. Claudia von Bastian

• Participants answered 100 trivia questions once a day for 20 days
  • Pool of ~3500 questions

• Questions increase/decrease in difficulty depending on performance
Example Questions

• Which river flows through Paris?
  a) Seine
  b) Werra
  c) Niger
  d) Nile

  Correct

• Which town is not in Europe?
  a) Atlanta
  b) Arnhem
  c) Antwerp
  d) Amsterdam

  Incorrect
Sample

- 15 participants
- 50 easy questions (out of 430)
- All European Geography

- On average 92% correct
Median participant

![Graph showing correct and incorrect responses over sessions.](image-url)
Median participant

Correct

Incorrect

Session
Median participant

![Graph showing correct and incorrect responses over sessions.](image)
Median participant

Correct

Incorrect

Session
Median participant

[Graph showing the performance of participants over sessions, with correct and incorrect data points marked.]

Session
Main Questions

1) How common is instability in general knowledge facts?
   • Each question appeared ~4.3 times
   • Switched answer 8% of opportunities [4-13%]

2) Are there patterns in the direction of the switches?

3) What factors affect knowledge instability?
   • Question ease
   • Length of time between answers
   • Number of times seen
Main Questions

1) How common is instability in general knowledge facts?

2) Are there patterns in the direction of the switches?

3) What factors affect knowledge instability?
   • Question ease
   • Length of time between answers
   • Number of times seen
Directionality

- Given Correct
- Given Incorrect
Main Questions

1) How common is instability in general knowledge facts?

2) Are there patterns in the direction of the switches?

3) What factors affect knowledge instability?
   - Question ease
   - Length of time between answers
   - Number of times seen
Effect of question ease

• Reminder these were very easy questions
  • 92% correct

• But variation across participants
  • 82 – 96% correct
Ease and prp switches by person

R² = .35
Ease and prp switches by question

![Graph showing the relationship between Prp Switches and Prp Correct with R² = .60]
Main Questions

1) How common is instability in general knowledge facts?

2) Are there patterns in the direction of the switches?

3) What factors affect knowledge instability?
   • Question ease
   • Length of time between answers
   • Number of times seen
Gap between answers

Avg correlation = -.27
Main Questions

1) How common is instability in general knowledge facts?

2) Are there patterns in the direction of the switches?

3) What factors affect knowledge instability?
   • Question ease
   • Length of time between answers
   • Number of times seen
Repetition

![Graph showing the relationship between number of times seen and repetition. The graph indicates a decrease in Prp Switches as the number of times seen increases. The average correlation is -0.38.]
Interim Conclusions

• Switches were rare but do occur
• Correct answers more stable (but feedback)
• Strong relation between ease and likelihood of switching
• Less likely to switch with larger gap
  • Likely due to feedback
• Less likely to switch with additional repetitions
Study 2

• 14 college students
• Answer cued recall general knowledge questions 1x a week for 5 weeks
• Online study
• No feedback
Stimuli

Manipulated ease:

Easy: 64% - 82% correct, $M = 75\%$, actual 90%
Medium: 44% - 57% correct, $M = 50\%$, actual 72%
Hard: 19% - 30% correct, $M = 25\%$, actual 48%

And repetition:

2x: 1\textsuperscript{st} and 5\textsuperscript{th} week
3x: 1\textsuperscript{st}, 3\textsuperscript{rd} and 5\textsuperscript{th} week
5x: 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd}, 4\textsuperscript{th}, and 5\textsuperscript{th} week
Sample Questions

*Easy*
What animal runs the fastest?

*Medium*
What is the name of the crime in which a building or property is purposely set on fire?

*Hard*
What is the name of the liquid portion of whole blood?
Main Questions

1) How common is instability in general knowledge facts?
   • Switched answer 12% of opportunities [5-25%]

2) Are there patterns in the direction of the switches?

3) What factors affect knowledge instability?
   • Question ease
   • Length of time between answers
   • Number of times seen
Main Questions

1) How common is instability in general knowledge facts?

2) Are there patterns in the direction of the switches?

3) What factors affect knowledge instability?
   • Question ease
   • Length of time between answers
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Main Questions

1) How common is instability in general knowledge facts?

2) Are there patterns in the direction of the switches?

3) What factors affect knowledge instability?
   - Question ease
   - Length of time between answers
   - Number of times seen
Prp Switches by Ease

- Easy: 0.05
- Medium: 0.15
- Hard: 0.20
Ease and prp switches by person

R² = 0.62
Ease and prp switches by question

\[ R^2 = .46 \]
Main Questions

1) How common is instability in general knowledge facts?

2) Are there patterns in the direction of the switches?

3) What factors affect knowledge instability?
   • Question ease
   • Length of time between answers
   • Number of times seen
Gap between answers

The figure shows the relationship between the size of the gap and the number of Prep Switches. The x-axis represents the size of the gap, with values 0, 1, and 3. The y-axis represents the number of Prep Switches. The error bars indicate the variability in the data.
Main Questions

1) How common is instability in general knowledge facts?

2) Are there patterns in the direction of the switches?

3) What factors affect knowledge instability?
   • Question ease
   • Length of time between answers
   • Number of times seen
Repetition

Number of times seen

Avg correlation = -.70
Interim Conclusions

• Again saw knowledge instability
• Correct answers more stable
  • Overall most likely to stay same, but go to other two options equally often
• Strong relation between ease and likelihood of switching
• No effect of size of gap
• Less likely to switch with additional repetitions
Overall Conclusions

• Just like strategies, what we can recall from memory is variable

• Correct answers more stable

• Affected by
  • Ease of question (amount of learning)
  • Repetition

• Less of an effect for time between presentations
Overlapping waves
Thank you!

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