Learning system-assigned passwords (up to 56 bits) in a single registration session with the methods of cognitive psychology

S M Taiabul Haque (University of Central Missouri)
Mahdi Nasrullah Al-Ameen (Clemson University)
Matthew Wright (Rochester Institute of Technology)
Shannon Scielzo (UT Southwestern Medical Center)

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System-assigned Random Password

Password: patriots

Password: patriots

Password: Patriots12

Password: tombrady

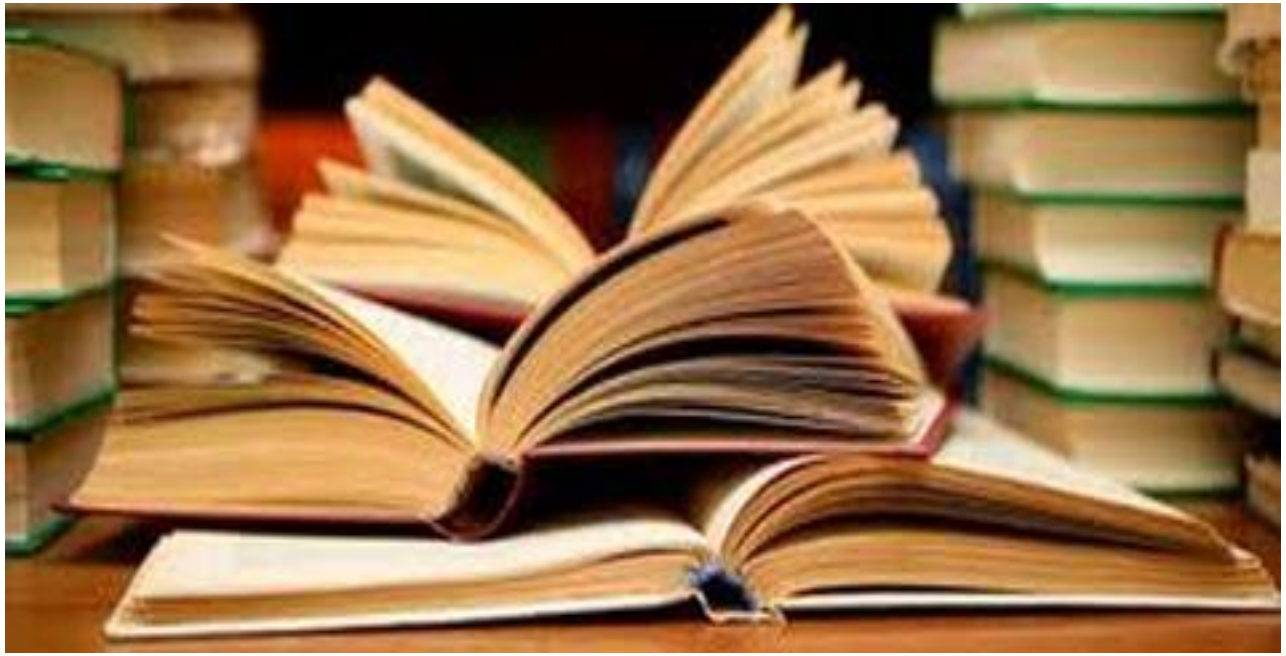
System-assigned Random Password

System-assigned Random Password

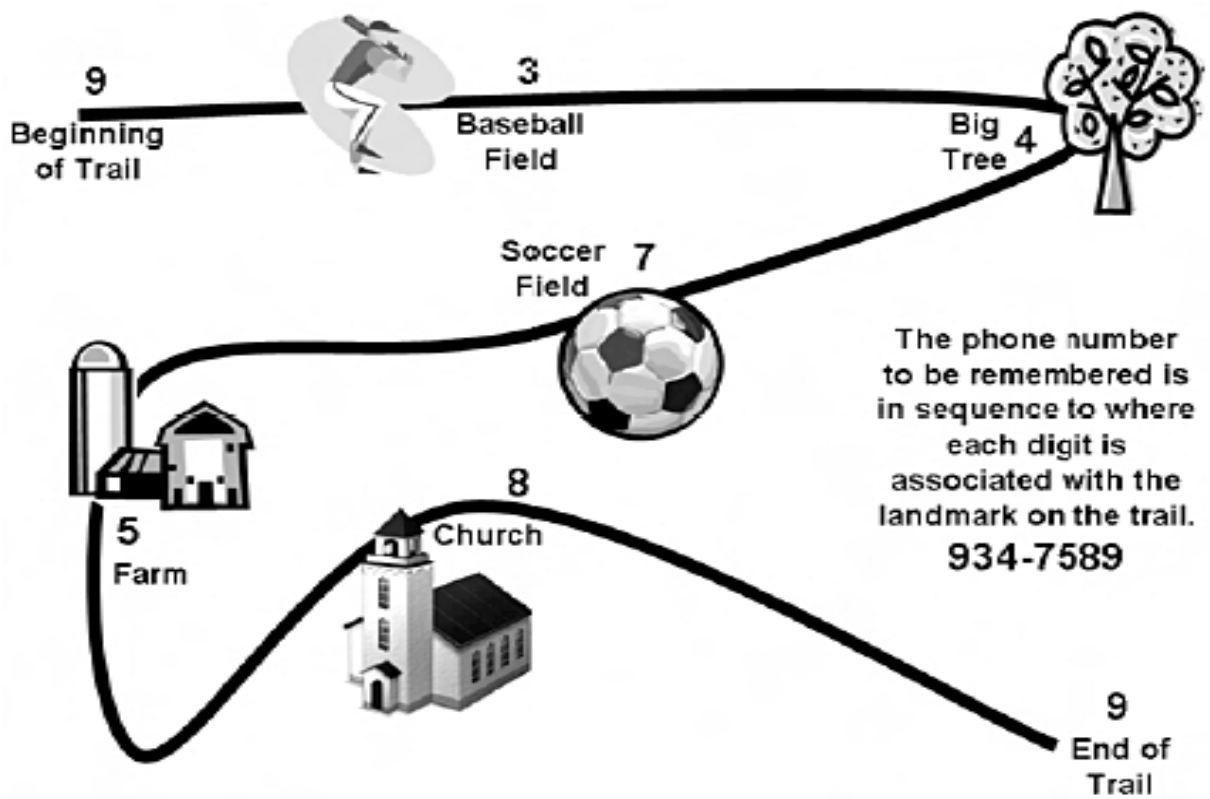
Research Constraints

- Entropy (minimum 20 bits)
- Time (< 3 minutes)
- Automation (no unaided user action)

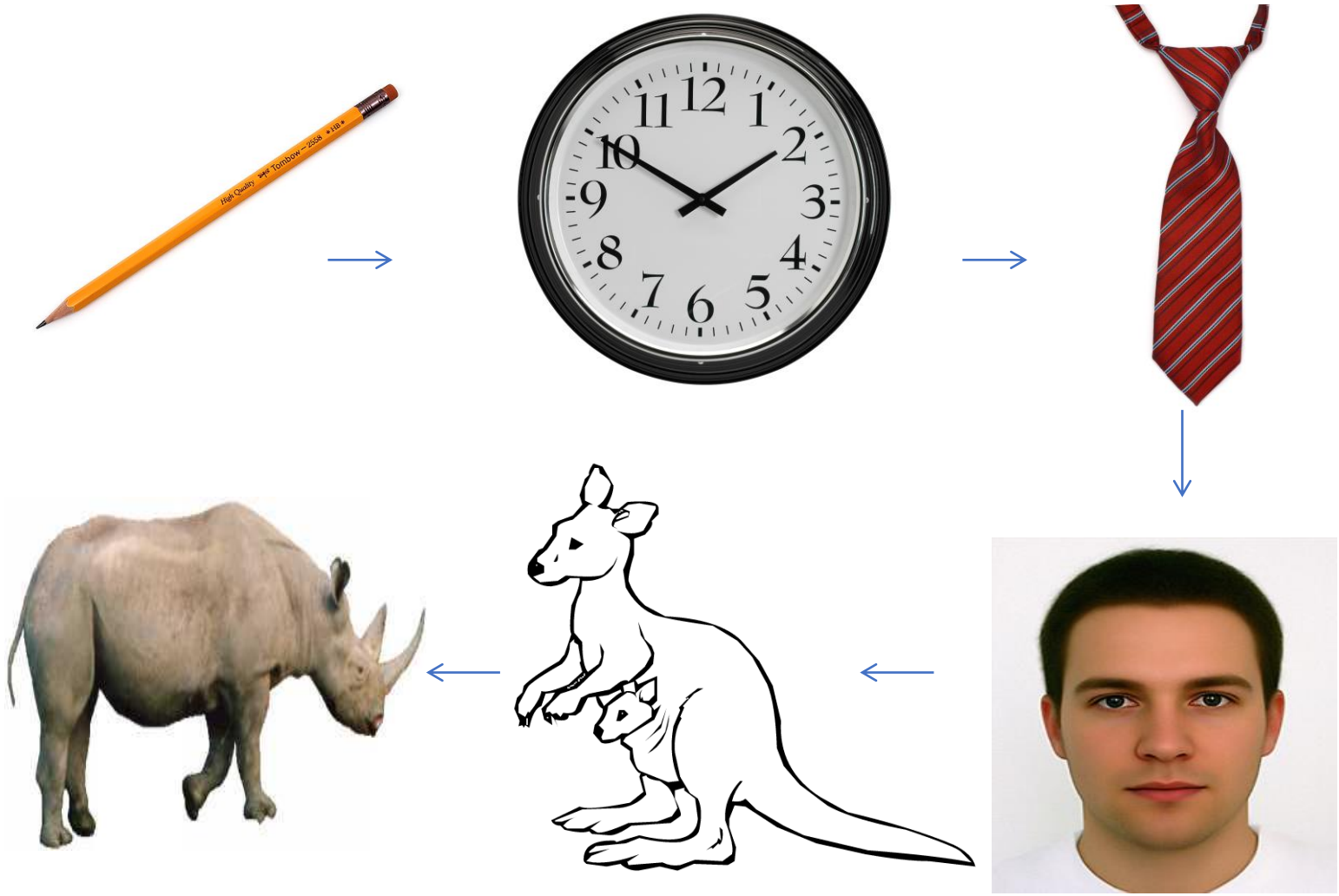
Memorization Techniques



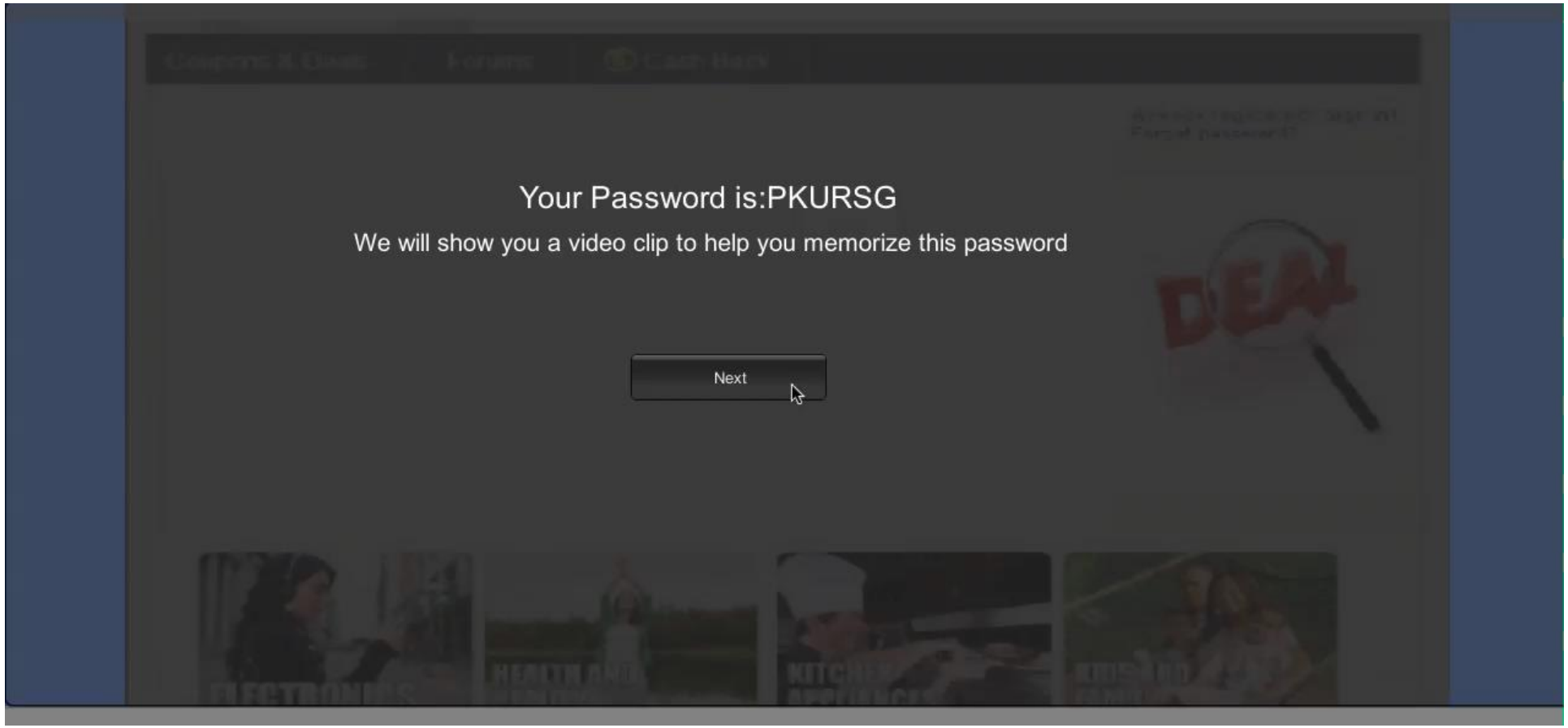
Method of Loci



Link/Story Method



Sample Clip (The Method of Loci)



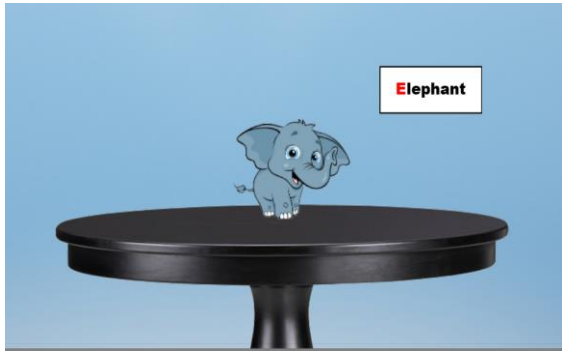
Sample Screenshots (The Link Method)

1

2

3

6



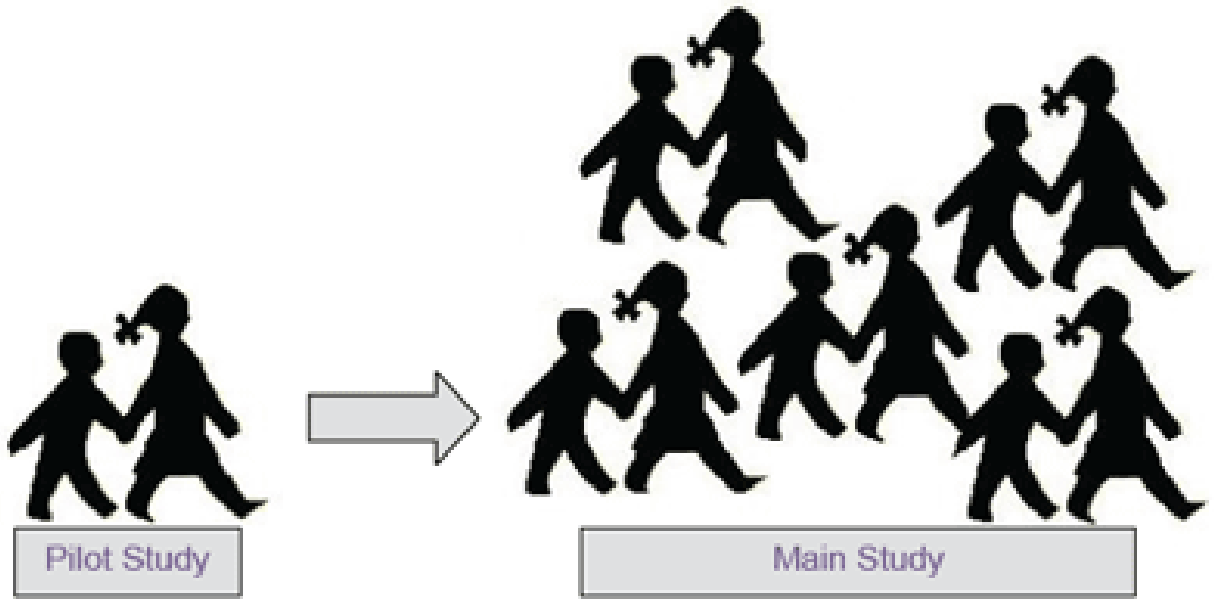
5

4

Development Platform/Tool

- Max3D
- Unity3D
- Adobe Photoshop CS5
- C#

Pilot Study



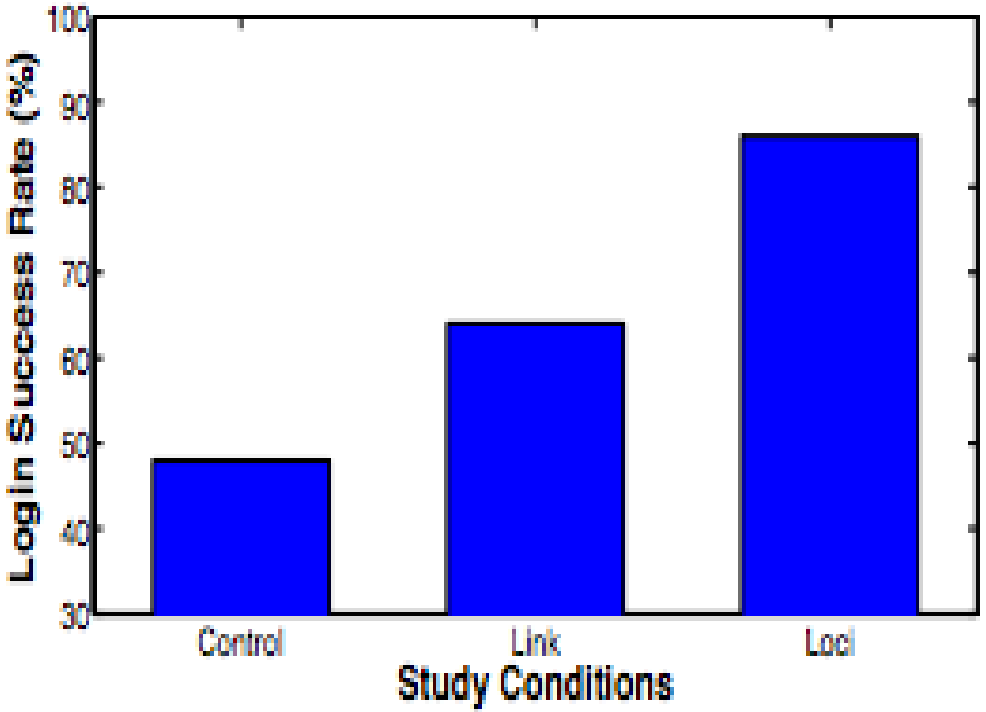
System Design (Registration)

- Randomly assign a password with six lowercase letters
- Generate a video based on the assigned password
- Quick adoption of the memorization techniques

Study Design

- Within-group
- 52 participants (psychology research pool)
- Control, Loci, and Link
- Follow-up study after a week

Results (Memorability)



Loci > Control ($p < 0.01$)

Link > Control ($p < 0.05$)

Loci > Link ($p < 0.05$)

Results (Login Time)

- Median login time:

  Control 5 seconds

  Link 6 seconds

  Loci 9 seconds

- Nominal compared to recognition-based methods

Results (User Feedback)

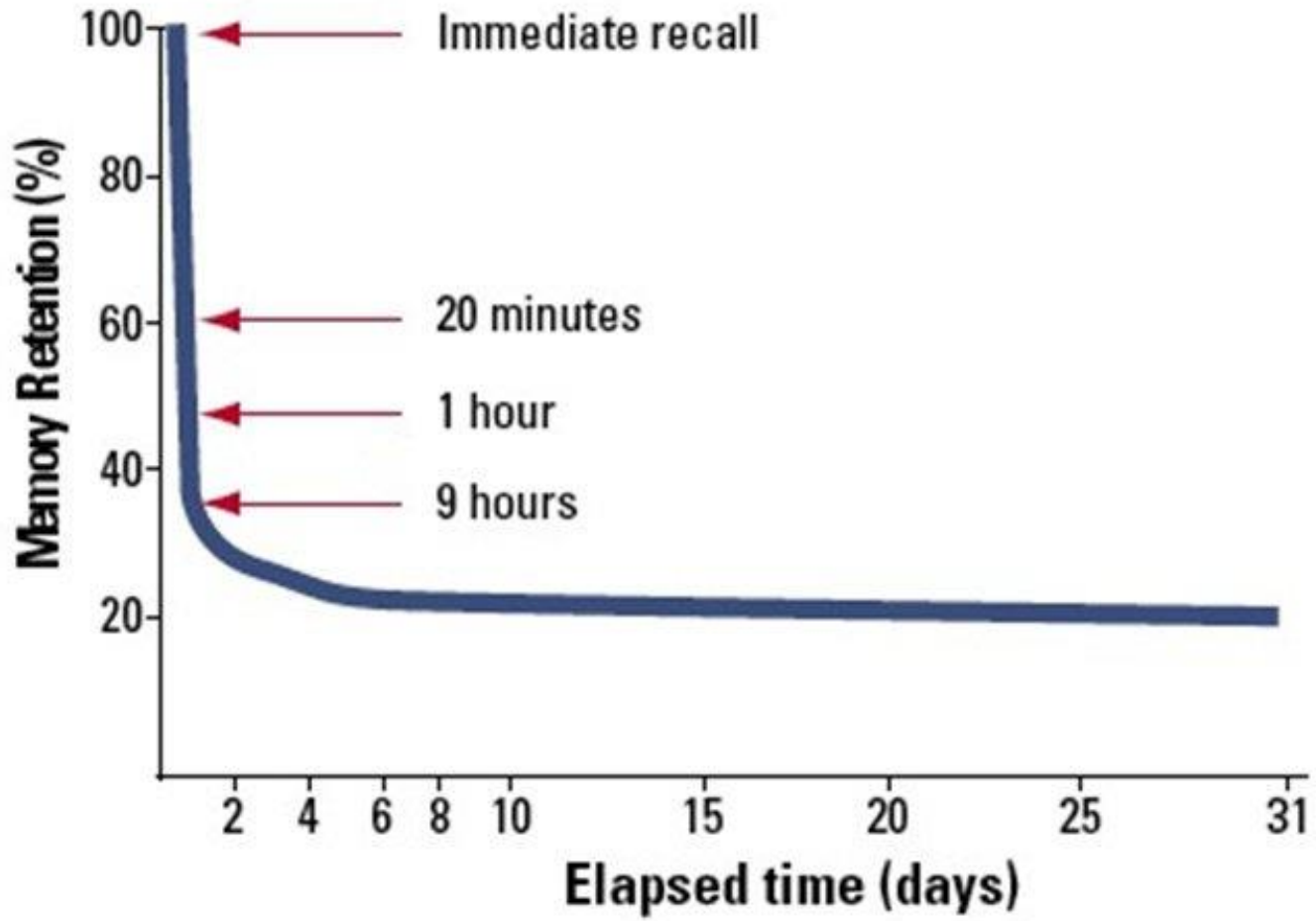
Category	Loci	Link
Efficacy in providing satisfactory memorability	Median: 4 Mode: 5	Median: 3 Mode: 2
Requirement of writing down the password	Median: 4 Mode: 5	Median: 4 Mode: 4
Time spent for learning was worth it	Median: 4 Mode: 5	Median: 3 Mode: 2

5-point scale, higher score indicates a positive result

Cryptographically-strong Passwords

- < 20 bits (PIN-level)
- 20 – 60 bits (password–level)
- > 60 bits (crypto-level)

Spaced Repetition



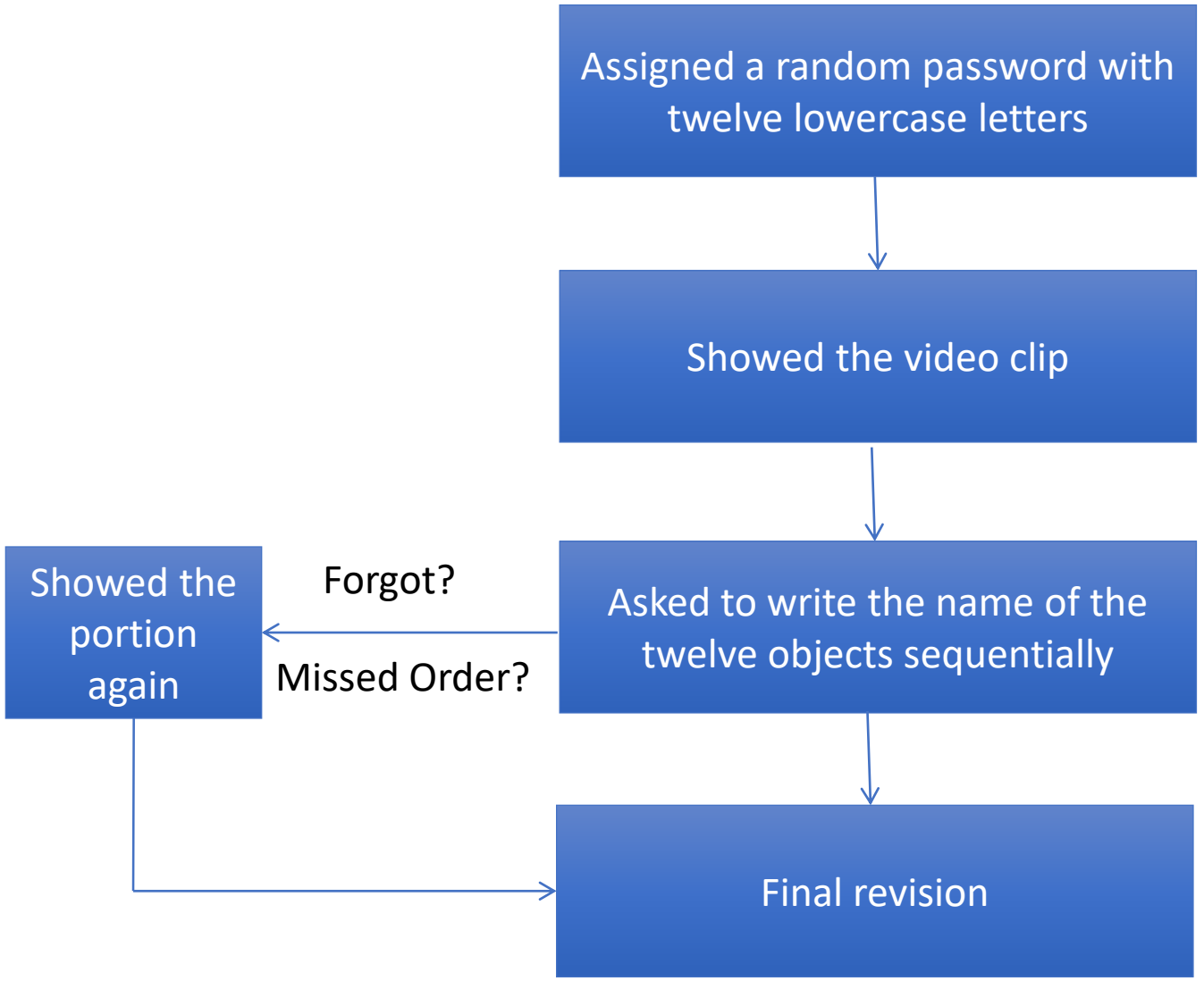
Spaced Repetition

- Log into a website up to 90 times across 15 days
- 82% recall success rate
- Is there an alternative, can we do it in just one session?

Method of Loci for Cryptographically-strong Secrets

- Extend from six to twelve loci
- Include a virtual office model
- A reception room, a copier room, a file cabinet room, a cubicle room, a recreation room, and a conference room

Study 2


Assigned a random password with twelve lowercase letters
Showed the video clip
Asked to write the name of the twelve objects sequentially
Forgot?
Missed Order?
Showed the portion again
Final revision

Study 2 (Session 1)

- 26 participants
- 10-dollar Subway gift card
- Returned after a week for follow-up

Mean registration time 12 minutes 16 seconds

Study 2 (Session 2)

- Three attempts to recall the password
- Hint showed if failed after three attempts
- Showed the twelve loci without the objects

Results

- 15 out of 26 (58%) without the hint
- 21 out of 26 (81%) with the hint
- Median login time 28 seconds without the hint and 171 seconds with the hint

Conclusion

- First study to apply the method of loci to help users memorize system-assigned passwords
- Sufficient password-level strength, easy-to-follow video clip, reasonable training duration, no unaided user action, no login overhead (Study 1)
- Method of loci can be leveraged to help users memorize a cryptographically-strong secret in just one session (Study 2)