User Perceptions of Five-Word Passwords

Xiaoyuan (Owen) Wu, Collins W. Munyendo, Eddie Cosic, Genevieve A. Flynn, Olivia Legault, Adam J. Aviv
Weak Passwords Are Widely Used

Image source: Security Blanket by Lorrie Faith Cranor

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People Tend to Reuse Passwords

Randomly Generated Password

1XSHuX2@48Xr
Familiar Words Form a Passphrase

this.could.bee.your.password
Who Is Using Passphrase?
Five-Word Password

this.could.bee.your.password
Research Questions

❖ RQ 1: How **memorable** are five-word passwords?

❖ RQ 2: How **different methods** of creating five-word passwords affect **memorability and security**?

❖ RQ 3: What are users’ **perceptions** of five-word passwords?
User Study and Goals

Part One
- **Short** term memorability
- **Different** methods of creating five-word passwords

Part Two
Two Weeks Later
- **Long** term memorability
- **Perceptions** of password generated in part one
- **Thoughts** on five-word passwords in general
Part One -
150 Participants Recruited through Prolific

Instructions → Generate Five-Word Password

three treatments

Initial Recall → End-Survey

Recall

Additional Questions → Screening

Questions

Mid-Survey Recall
Treatment 1 -
All Five Words at Once

dealer.many.bend.borrow.hear

Generate Another Password  Choose this Password
## Treatment 2 - Option to Change Each Word

<table>
<thead>
<tr>
<th>heel</th>
<th>crew</th>
<th>value</th>
<th>e-mail</th>
<th>visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change this Word</td>
<td>Change this Word</td>
<td>Change this Word</td>
<td>Change this Word</td>
<td>Change this Word</td>
</tr>
</tbody>
</table>

Choose this Password
Treatment 3 - Create Your Own

Restrictions:
1. All five words in dictionary of 1,630 words.
2. Four dots in-between five words.
3. Five words are unique.

this.could.bee.your.password

Create Password
Part Two - Two Weeks Later
116/150 Participants Returned

Instructions → Recall Password → Specific Questions → General Questions
RQ 1: How memorable are five-word passwords?
Participants **Remembered** Five-Word Passwords at the **End of the First Part**

![Bar chart showing the percentage of participants who remembered or forgot the passwords for each treatment.]

- **Treatment 1**: 50 remembered, 0 forgot
- **Treatment 2**: 50 remembered, 0 forgot
- **Treatment 3**: 49 remembered, 1 forgot

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Less than Half of the Participants Remembered Five-Word Passwords after Two Weeks

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Remembered</th>
<th>Forgot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment 1</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>Treatment 3</td>
<td>19</td>
<td>21</td>
</tr>
</tbody>
</table>

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Without External Help, few Participants Remembered Five-Word Passwords after Two Weeks

![Bar chart showing the percentage of participants remembered and forgot in different treatments.]

- Treatment 1: 10% remembered, 90% forgot
- Treatment 2: 1% remembered, 99% forgot
- Treatment 3: 1% remembered, 99% forgot

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RQ 2: How the three methods of creating five-word passwords affect security?
Computer Generated Five-Word Passwords Are Random, thus Secure

- 227 unique words were used by 50 participants from treatment 1 (all five at once).

- “escape”, “letter” and “pair” used by three different participants,
  17 words used by two participants
  207 words used by one participant
With the Option to Change Each Word, Still Random, thus Secure

- 240 unique words were used in treatment 2 (change each word).
- “mood” used by three different participants,
  8 words used by two participants
  231 words used by one participant
Human Created Five-Word Passwords Are Less Random

- Users tend to use words more familiar to them.
- 162 unique words were used in treatment 3 (create your own).
Human Created Five-Word Passwords Are Less Secure

Context for Generating a Five-Word Password

Imagine you are asked to come up with a five-word password by your school or employer. The individual words within the password must be between length 3 and 8 and will be checked against a dictionary of common words. Please enter your five word password below with each word separated by a ",", follow the example:

```
this.could.bee.your.password
```
RQ 3: What are users’ perceptions of five-word passwords?
Participants Were **Confident** in Five-Word Passwords Keeping Accounts **Safe**
Participants Were **Confident** Because:

P174:

“I think people usually make up passwords that don’t have the periods or with five words.”

P181:

“because of the length of the password. The amount of words and the periods add a decent amount of complexity to the password.”
Participants Were **Less Confident** in Remembering Multiple Five-Word Passwords

![Bar Chart: Memorability of Five-Word Passwords]

- **Not confident**: 40%
- **Slightly confident**: 35%
- **Moderately confident**: 22%
- **Very confident**: 12%
- **Very very confident**: 7%

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Participants Were **Less Confident** Because:

P39:
“If used regularly it wouldn't be that hard if you treat it like a phrase. I could see some difficulty remembering multiple sets of five words.”

P221:
“No. I'm not confident about remembering that many large passwords without some digital way to store them.”
RQ 1: How Memorable Are Five-Word Passwords?

- 99% of participants remembered five-word password in the first part of the survey.
- 40% of participants remembered two weeks later.
- 6% of participants who did not use external help remembered after two weeks.
RQ 2: How Different Methods of Creating Five-Word Passwords Affect Memorability and Security?

- User created five-word passwords did not result in better memorability over computer generated ones.

- Computer generated five-word passwords are more diverse, thus more secure than user created ones.
RQ 3: What Are Users’ Perceptions of Five-Word Passwords?

- Participants were confident in five-word passwords’ ability to keep online accounts safe.

- They were less confident about remembering them, especially multiple unique ones.
Conclusions

❖ Five-word passwords are memorable in the short term. They are challenging to remember in the long term.

❖ User created five-word passwords did not result in better memorability over computer generated ones.

❖ Participants were confident in security, but less so in memorability.
Thank you!

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Demographics

<table>
<thead>
<tr>
<th></th>
<th>Part 1</th>
<th>Part 2</th>
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<tbody>
<tr>
<td><strong>Gender</strong></td>
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<tr>
<td>Female</td>
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<tr>
<td>Male</td>
<td>70</td>
<td>50</td>
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<tr>
<td>Non-binary</td>
<td>6</td>
<td>5</td>
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<tr>
<td><strong>Age</strong></td>
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<td></td>
</tr>
<tr>
<td>18 - 24</td>
<td>38</td>
<td>31</td>
</tr>
<tr>
<td>25 - 34</td>
<td>66</td>
<td>51</td>
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<td>35 - 44</td>
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<td>45 - 54</td>
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<td>55 - 64</td>
<td>4</td>
<td>3</td>
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<tr>
<td>Prefer not to say</td>
<td>1</td>
<td>0</td>
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<tr>
<td><strong>Education</strong></td>
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<td>High School or equiv.</td>
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<td>College or Trade</td>
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<td>Bachelor’s degree</td>
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<td>Doctorate</td>
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<td>4</td>
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<td>Prefer not to say</td>
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<td>0</td>
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<tr>
<td><strong>Background</strong></td>
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<tr>
<td>Technical</td>
<td>46</td>
<td>30</td>
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<tr>
<td>Non-Technical</td>
<td>98</td>
<td>82</td>
</tr>
<tr>
<td>Prefer not to say</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>
Word Length by Treatments

- Average length of 1,630 words is 4.78 characters.

<table>
<thead>
<tr>
<th>Word Length</th>
<th>Treatment 1</th>
<th>Treatment 2</th>
<th>Treatment 3</th>
<th>Total</th>
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<tr>
<td>Length 3</td>
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<td>27</td>
<td>59</td>
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<td>Length 4</td>
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<td>Length 5</td>
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<tr>
<td>Length 6</td>
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<td>75</td>
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<td>165</td>
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<tr>
<td>Avg. Length</td>
<td>4.59</td>
<td>4.82</td>
<td>4.23</td>
<td>4.55</td>
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</tbody>
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## Number of Clicks

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<tr>
<th></th>
<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
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<td><strong>Treatment 1</strong></td>
<td>10.84</td>
<td>1</td>
<td>87</td>
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<tr>
<td><strong>Treatment 3</strong></td>
<td>1.04</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Treatment 2</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Word 1</td>
<td>4.94</td>
<td>1</td>
<td>57</td>
</tr>
<tr>
<td>Word 2</td>
<td>5.18</td>
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<td>78</td>
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<tr>
<td>Word 3</td>
<td>3.44</td>
<td>1</td>
<td>32</td>
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<tr>
<td>Word 4</td>
<td>4.08</td>
<td>1</td>
<td>41</td>
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<tr>
<td>Word 5</td>
<td>6.84</td>
<td>1</td>
<td>144</td>
</tr>
</tbody>
</table>
Semantic Meaning

- Given choice to change each word:
  teach.three.little.green.girl (144 clicks on word 5)

- User created:
  cat.dog.fish.boy.run
  this.winter.would.very.cold
What Platform(s) Participants would Use a Five-Word Password

<table>
<thead>
<tr>
<th>Platform</th>
<th>Would Use</th>
<th>Have Used</th>
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</thead>
<tbody>
<tr>
<td>None</td>
<td>47</td>
<td></td>
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<tr>
<td>Email</td>
<td>40</td>
<td>2</td>
</tr>
<tr>
<td>Social Media</td>
<td>38</td>
<td>4</td>
</tr>
<tr>
<td>Retail Website</td>
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<td></td>
</tr>
<tr>
<td>Bank</td>
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<tr>
<td>Work</td>
<td>18</td>
<td></td>
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