Studying the Effectiveness of Security Images in Internet Banking

Joel Lee and Lujo Bauer
What Are Security Images?

- Personal image chosen by the user
- Displayed at logon when user enters user ID
- Usually comes with a security caption
- Lets users know that they are accessing the actual bank site and not a phished site
PNC Bank Security Image
SiteKey® authentication
An additional layer of Online and Mobile Banking security
Dollar Bank Security Image

Online Banking Login

What was the name of your first pet?

Secure Image  Submit

Exit

If your Secure Image does not appear on this screen, do not proceed with your log in and call 1-800-828-5527, Monday through Friday from 8:00 AM to 8:00 PM and Saturday from 9:00 AM to 3:00 PM.
Do Security Images Work?
Related Work #1

Schechter et al., IEEE S&P 2007

- Lab study of security images; 59 participants
- Role playing / security priming / own bank account
- Replaced security images with a maintenance notice
- Almost all participants entered password when security image was missing

- Concerns:
  - Classroom environment
  - All participants students
  - Required to complete tasks
Related Work #2

Herzberg & Margulies, ESORICS 2011

- Online submission system for a computer science course; ~400 student participants
- Interactive custom image
- Spoofed email with link to a spoofed login page

- 60% detected spoofed page and refused to log in

- Concerns:
  - Expert participant pool
  - Participants explicitly primed and incentivized for detecting attacks
  - Phished email may have alerted participants
Our Research Goals

• How effective are security images?

• What features influence their effectiveness?
  • Changes to appearance
  • Changes to interaction
  • Changes to customization

• How does methodology influence effectiveness?
  • Changes to payment amount (motivation)
  • Changes to study duration (habituation)
Study Methodology

- Mockup of an internet banking website
  - Security images varied by size, appearance, customizability
- Users recruited on Amazon’s Mechanical Turk to test new banking site
- Registered for account with user ID, password, and security image
Study Methodology
Study Methodology

Complete Sign On

Verify Identity

Please verify that your Personal Security Image and Caption are correct

Step 1: Verify Your Personal Security Image and Caption

Is this your Personal Security Image?

Is this Your Caption?  Nice House

If you do not recognize your Personal Security Image & Caption then DO NOT enter your password and email us immediately at

Step 2: Enter Password

User ID:  tyutyu
Password:  

Forgot Password?

Information Center

Online Banking Service Agreement New

Sign On Questions

What is the Personal Security Image and Caption?
What should I do if I forgot my Personal Security Image and/or Caption?
What should I do if the wrong Personal Security Image and/or Caption is showing?
Study Methodology

- Mockup of an internet banking website
  - Security images varied by size, appearance, customizability
- Users recruited on Amazon’s Mechanical Turk to test new banking site
- Registered for account with user ID, password, and security image
- 24 hours later, money deposited into account, users asked to return to report deposit amount
Study Methodology

![Image of ANC Online Banking interface]

### Report Deposit Value

Available Balance: $0.60

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
<th>Withdrawals</th>
<th>Deposits</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013-04-29</td>
<td>Wire Transfer</td>
<td>$0.00</td>
<td>$0.60</td>
<td>$0.60</td>
</tr>
</tbody>
</table>
Study Methodology

• Mockup of an internet banking website
  • Security images varied by size, appearance, customizability

• Users recruited on Amazon’s Mechanical Turk to test new banking site

• Registered for account with user ID, password, and security image

• 24 hours later, money deposited into account, users asked to return to report deposit amount

• Remove image, observe whether users log in
Attack Scenario

Complete Sign On

Verify Identity

Please verify that your Personal Security Image and Caption are correct

Step 1: Verify Your Personal Security Image and Caption

Is this your Personal Security Image?

Under Maintenance

Is this Your Caption?

Your security image and caption cannot be displayed at this time.

Step 2: Enter Password

User ID: condition9

Password: [HIDDEN]  Forgot Password?

Sign On
Study Methodology

- Exit survey to get demographics and feedback on security images
- Paid $0.50 for registering for an account, $3.50 for reporting 5 deposit amounts
## Conditions (I)

<table>
<thead>
<tr>
<th>Control</th>
<th>1 – Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance Features</td>
<td>2 – Large image (9 times larger)</td>
</tr>
<tr>
<td></td>
<td>3 – Blinking image</td>
</tr>
<tr>
<td>Interaction Features</td>
<td>Before password can be entered, must…</td>
</tr>
<tr>
<td></td>
<td>4 – … click on image</td>
</tr>
<tr>
<td></td>
<td>5 – … type in a random word in image</td>
</tr>
<tr>
<td></td>
<td>6 – … type in the caption</td>
</tr>
</tbody>
</table>
## Conditions (II)

<table>
<thead>
<tr>
<th>Customization Feature</th>
<th>7 – User-provided security image and caption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customization + Appearance + Interaction Feature</td>
<td>8 – Upload a security image + blinking + require click (combine Cond. 3, 4, 7)</td>
</tr>
<tr>
<td>No Security Caption</td>
<td>9 – No security caption</td>
</tr>
</tbody>
</table>
| Changes to Study Methodology | 10 – Report 2 deposit amounts (not 5)  
11 – 2x participant compensation  
12 – Prime participants to notice images |
Cond. 1 – Control Condition

Verify Identity

Please verify that your Personal Security Image and Caption are correct

Step 1: Verify Your Personal Security Image and Caption

Is this your Personal Security Image?

Is this Your Caption? Nice Place

If you do not recognize your Personal Security Image & Caption then DO NOT enter your password and email us immediately at cmu-banking-research-study@ece.cmu.edu.

Step 2: Enter Password

User ID: tyutyu
Password: [obfuscated]

Forgot Password?

Sign On
Cond. 2 (Appearance) – 9x Larger Image

Verify Identity

Please verify that your Personal Security Image and Caption are correct

Step 1: Verify Your Personal Security Image and Caption

*Is this your Personal Security Image?*

Step 2: Enter Password

*User ID:*
yutyu

*Password:*

Sign On

Illice Place

If you do not recognize your Personal Security Image & Caption then D0 NOT enter your password and email us immediately at cmu-banking-research-study@ece.cmu.edu.
Cond. 4 (Interaction) – Click on Image

Verify Identity

Please verify that your Personal Security Image and Caption are correct

Step 1: Click on Your Personal Security Image

Is this your Personal Security Image?

Is this Your Caption?

Nice Place

If you do not recognize your Personal Security Image & Caption then email us immediately at cmu-banking-research-study@ece.cmu.edu.
Cond. 5 (Interaction) – Random Word

Verify Identity

Please verify that your Personal Security Image and Caption are correct

Step 1: Verify Your Personal Security Image and Caption

Is this your Personal Security Image?

Is this Your Caption? Nice Place

If you do not recognize your Personal Security Image & Caption then email us immediately at cmu-banking-research-study@ece.cmu.edu.

Step 2: Enter the word found in the Personal Security Image

User ID: tyutyu
Word: 

Submit
Cond. 5 (Interaction) – Random Word

Verify Identity

Please verify that your Personal Security Image and Caption are correct

Step 1: Verify Your Personal Security Image and Caption
Is this your Personal Security Image?

Is this your Caption?

Nice Place
If you do not recognize this image, please email us immediately at cmu-banking@support.com

Step 2: Enter the word found in the Personal Security Image
User ID: tyutyu
Word:

Submit
Results

• 482 participants completed the entire study

• Compared all 11 conditions with control condition

• Participants distributed across ages 18 – 65 and up

• 37.6% high school, 51.4% college degree, 10.6% graduate degree
Results

% logged in without security images

- control
- large
- blinking
- interactive
- copy random word
- copy caption
- custom image
- multi-feature
- no caption
- 2 logins
- more pay
- more sec priming

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Results
Results

% found the security image as part of the login process annoying

- control
- large
- blinking
- interactive
- copy random word
- copy caption
- custom image
- multi-feature
- no caption
- 2 logins
- more pay
- more sec priming

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree
Limitations

- Fake internet banking accounts
- Habituation
- Money as motivating factor
- Under maintenance image vs other attack vectors
- No SSL certificate on our website
- Significant results around p=0.05 threshold
Conclusions

- 75% of participants entered password in the absence of a security image in the control condition.
- Appearance, customization, interactivity features have little impact.
  - Blinking image results in significantly greater effectiveness.
  - Performing additional task to log in leads to greater annoyance but does not enhance effectiveness.
- Habituation, level of motivation, and security priming have minimal effect.

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