


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

 [Privacy](#) [Security](#)


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? **clock**

If you do not recognize your Personal Security Image & Caption then DO NOT enter your Password and call us immediately at 1-888-PNC-BANK.

Step 2: Enter Password


User ID: **11111111**


Password: [Forgot Password?](#)

Information Center

NEW Important Notice of Changes to Your Online Banking Service Agreement:

- Click here to view a summary of important changes to the PNC Online Banking Service Agreement.
- Your continued use of PNC Online Banking signifies your acceptance of the agreement as updated.

 Need Help? Call us at (888) 762-2265


 [Online Banking Service Agreement](#)

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?](#)

 **PNC SECURE AREA**
Click for More Details

© Copyright 2009. The PNC Financial Services Group, Inc. All Rights Reserved.
Need Help? Call us at 1-888-PNC-BANK (762-2265) | [Privacy](#) [Security](#) & [Billing](#)

Bank of America Security Image

Bank of America  Privacy & Security

[Sign In](#) [Home](#) | [Locations](#) | [Contact Us](#) | [Help](#)

Search Bank of America 

Overview | Privacy | Account & Card Security | Online & Mobile Security | Report a Problem

SiteKey[®] Security from Bank of America

Your SiteKey

Ground Hog



Passcode

Your SiteKey:
Ground Hog



SiteKey[®] authentication


An additional layer of Online and Mobile Banking security

[What is SiteKey?](#) [How it works](#)

Dollar Bank Security Image

Dollar Bank
Since 1855

Online Banking Login

 What was the name of your first pet?

Secure Image

If your Secure Image does not appear on this screen, do not proceed with you 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



GO

PERSONAL

SMALL BUSINESS

CORPORATE & INSTITUTIONAL

ABOUT ANC

Online Banking Sign On

User ID:

SIGN ON

▶ Forgot Your User ID or Password?

New to Online Banking?
▶ Get Started Now!



TurboTax

TurboTax® puts the power in your hands to keep more of your hard-earned money.

Start Now and Save ▶

1 2 3 4



Turn Your House into a Home.

ANC Has Lending Solutions Designed To Help. [more ▶](#)



Making the Most of Your Money with ANC

Get the information and tools you need to help avoid fees and charges. [more ▶](#)



Economic Reports

Products and Services

ANC's wide range of services can make banking easier, and more convenient than ever. See why ANC is the smart choice for help in meeting your financial goals.

- ▶ [Checking](#)
- ▶ [Online & Mobile Banking](#)
- ▶ [Savings](#)
- ▶ [Mortgages, Loans & Lines of Credit](#)

Solutions

Whatever challenges and opportunities lie ahead, ANC can help. See why working with ANC to plan for life's greatest milestones is the smart choice.

- ▶ [Free Checking](#)
- ▶ [Student Checking](#)
- ▶ [Wealth Management®](#)
- ▶ [Saving for Education](#)
- ▶ [Savings Account](#)

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

The screenshot displays the ANC Online Banking interface. At the top left is the ANC Online Banking logo. On the top right, there are links for Privacy, Security, and Sign Off. Below the logo is a navigation menu with 'My Accounts' highlighted, and other options: Transfer Funds, Pay Bills, Alerts, Customer Service, and My Offers. Under 'My Accounts', there are sub-links for Summary, Account Activity, and Change Password. The main content area features a 'Report Deposit Value' section with a brown header. Below the header, it states 'Available Balance: \$0.60'. A table follows with columns for Date, Description, Withdrawals, Deposits, and Balance. The table contains one row of data: 2013-04-29, Wire Transfer, \$0.00, \$0.60, and \$0.60.

Date	Description	Withdrawals	Deposits	Balance
2013-04-29	Wire Transfer	\$0.00	\$0.60	\$0.60

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 } x5
- 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?



Is this Your Caption?

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

Step 2: Enter Password

User ID: condition9

Password: [Forgot Password?](#)

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)

Control

1 – Control

Appearance
Features

2 – Large image (9 times larger)
3 – Blinking image

Interaction
Features

Before password can be entered, must...
4 – ... click on image
5 – ... type in a random word in image
6 – ... type in the caption

Conditions (II)

Customization
Feature

7 – User-provided security image and caption

Customization +
Appearance +
Interaction Feature

8 – Upload a security image + blinking + require click (combine Cond. 3, 4, 7)

No Security Caption

9 – No security caption

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: [Forgot Password?](#)

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?



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: [Forgot Password?](#)

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:

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 r
cmu-banking-r



mail us immediately at

Step 2: Enter the word found in the Pers

User ID: tyutyu

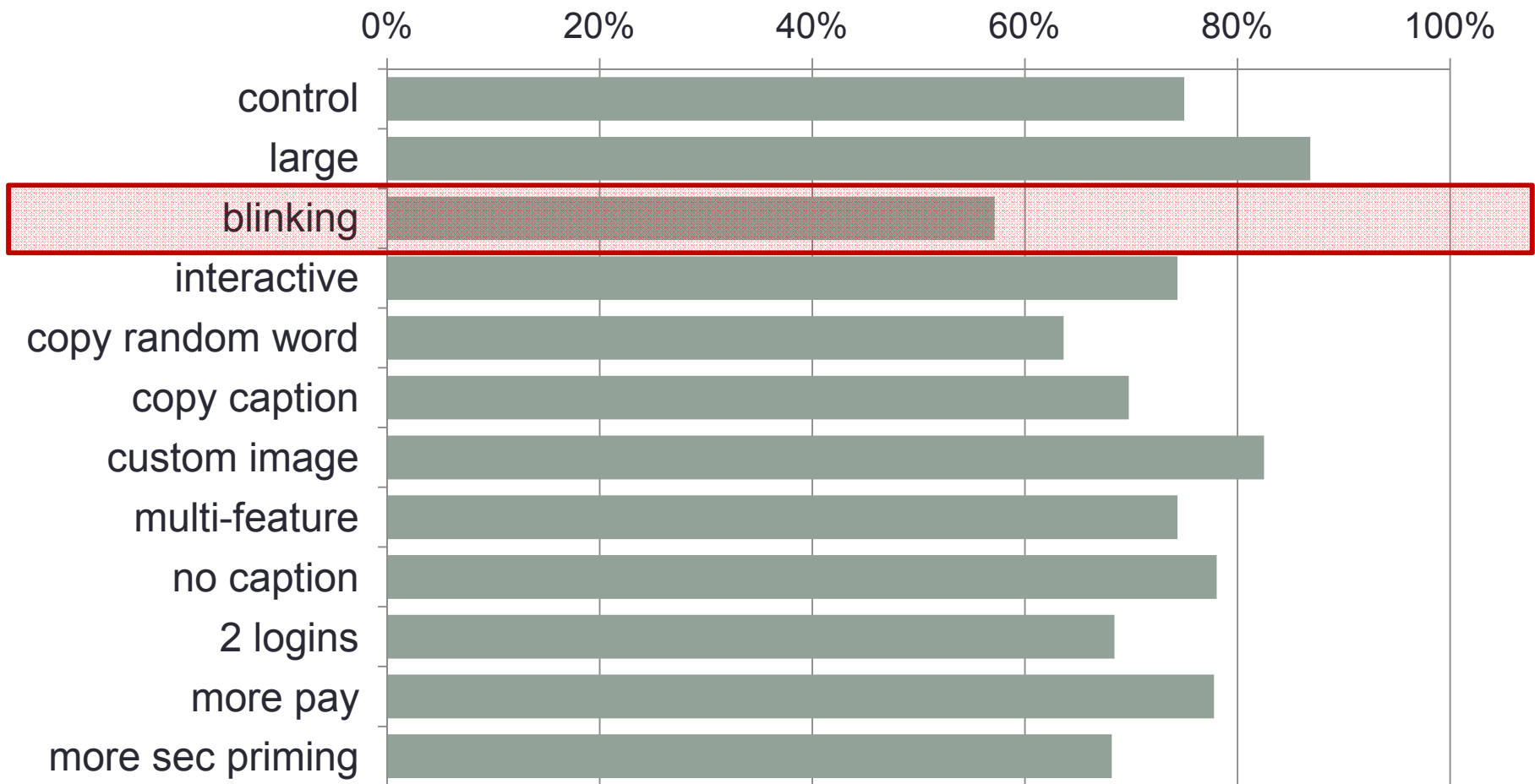
Word:

Results

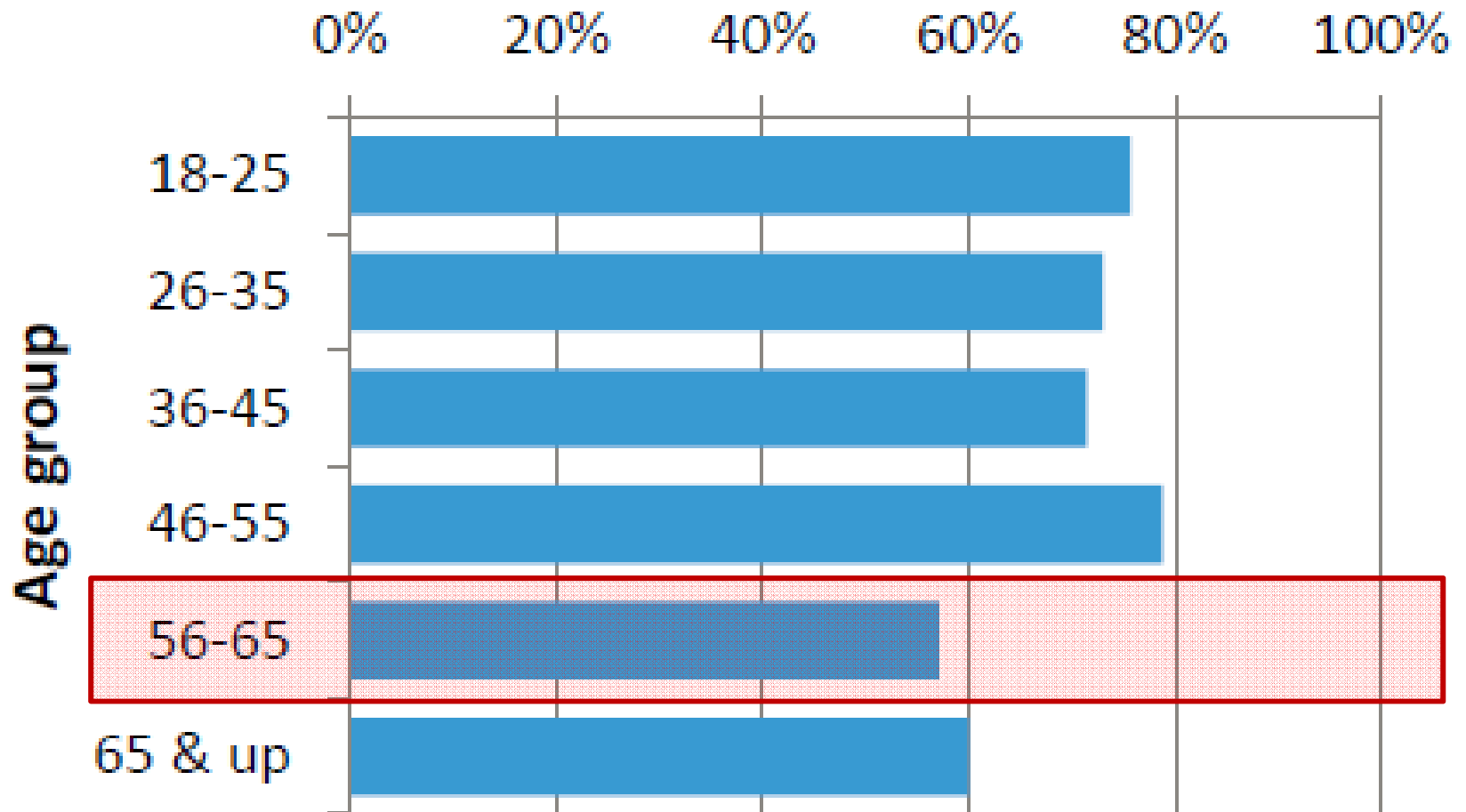
- 482 participants completed the entire study
- Compared all 11 conditions with control condition
- Participants distributed across ages 18 – 65 and up
- 37.6% high school, 51.4% college degree, 10.6% graduate degree

Results

% logged in without security images

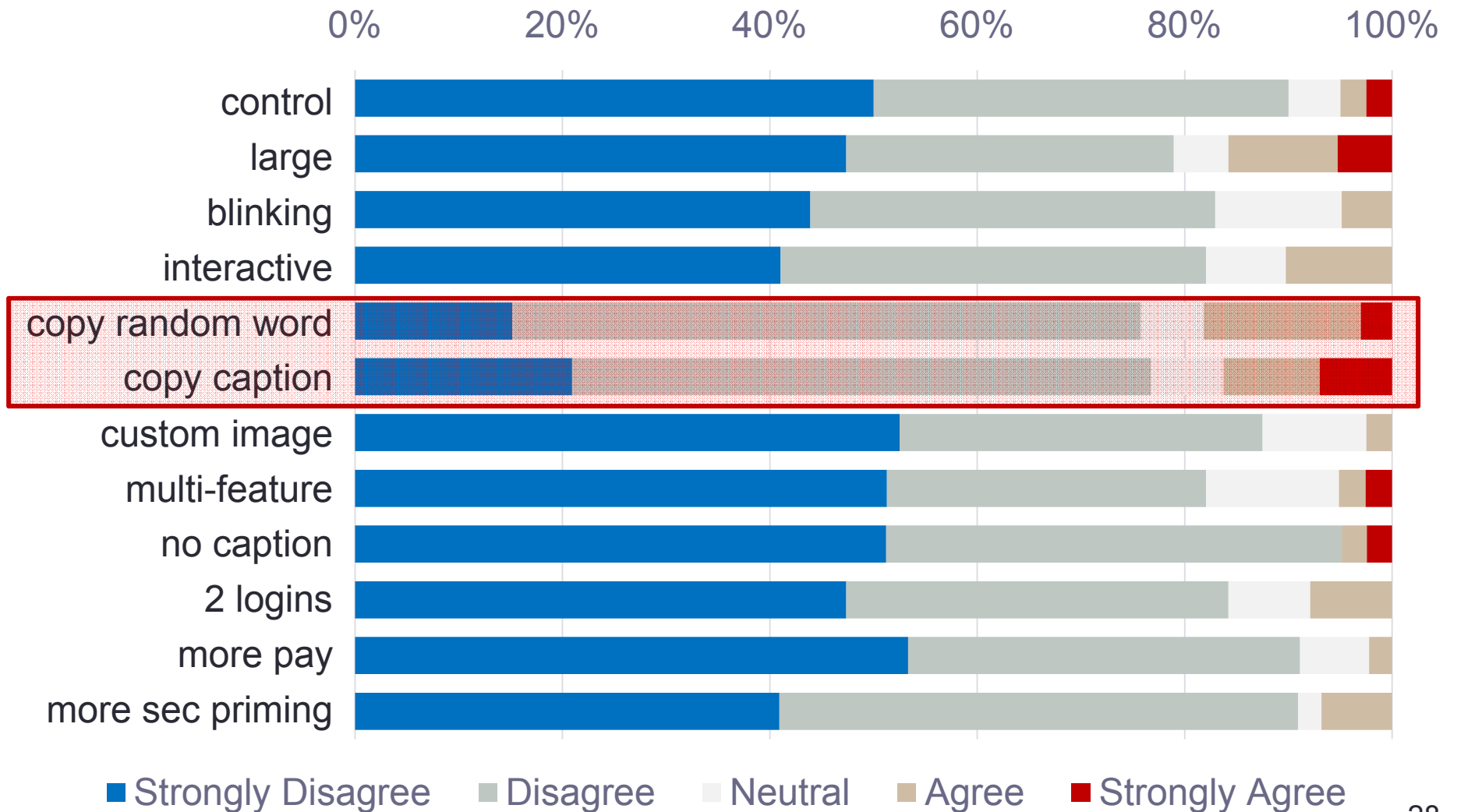


Results



Results

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



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 effectiveness
- Habituation, level of motivation, and security priming have minimal effect