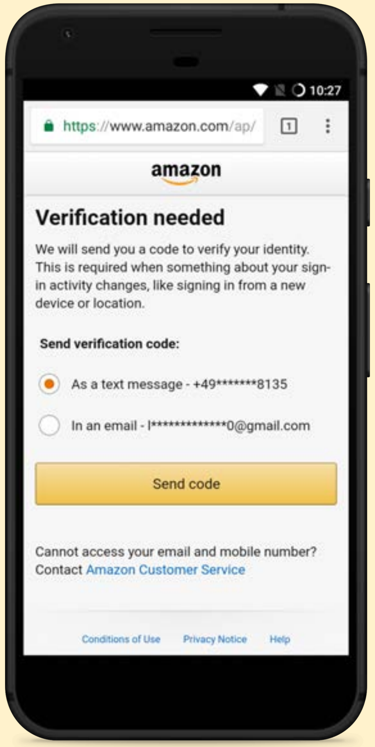
Hochschule
Bonn-Rhein-Sieg
University of Applied Sciences

RUHR
UNIVERSITÄT
BOCHUM

RUB



Verification needed

We will send you a code to verify your identity. This is required when something about your sign-in activity changes, like signing in from a new device or location.

Send verification code:

● As a text message - +49*******8135

○ In an email - l************0@gmail.com

Cannot access your email and mobile number? Contact Amazon Customer Service

More Than Just Good Passwords?

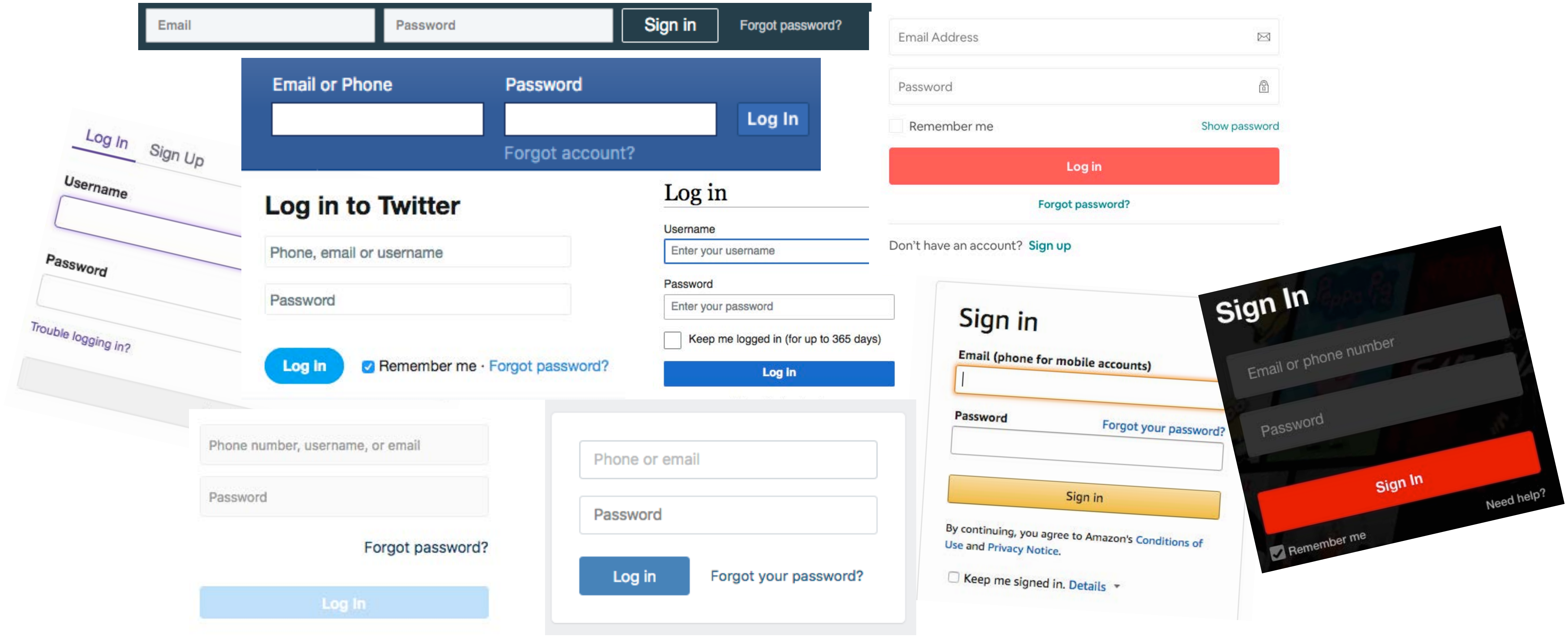
A Study on Usability and Security Perceptions of Risk-based Authentication

Stephan Wiefling*#, Markus Dürmuth#, Luigi Lo Iacono*

H-BRS University of Applied Sciences (*)

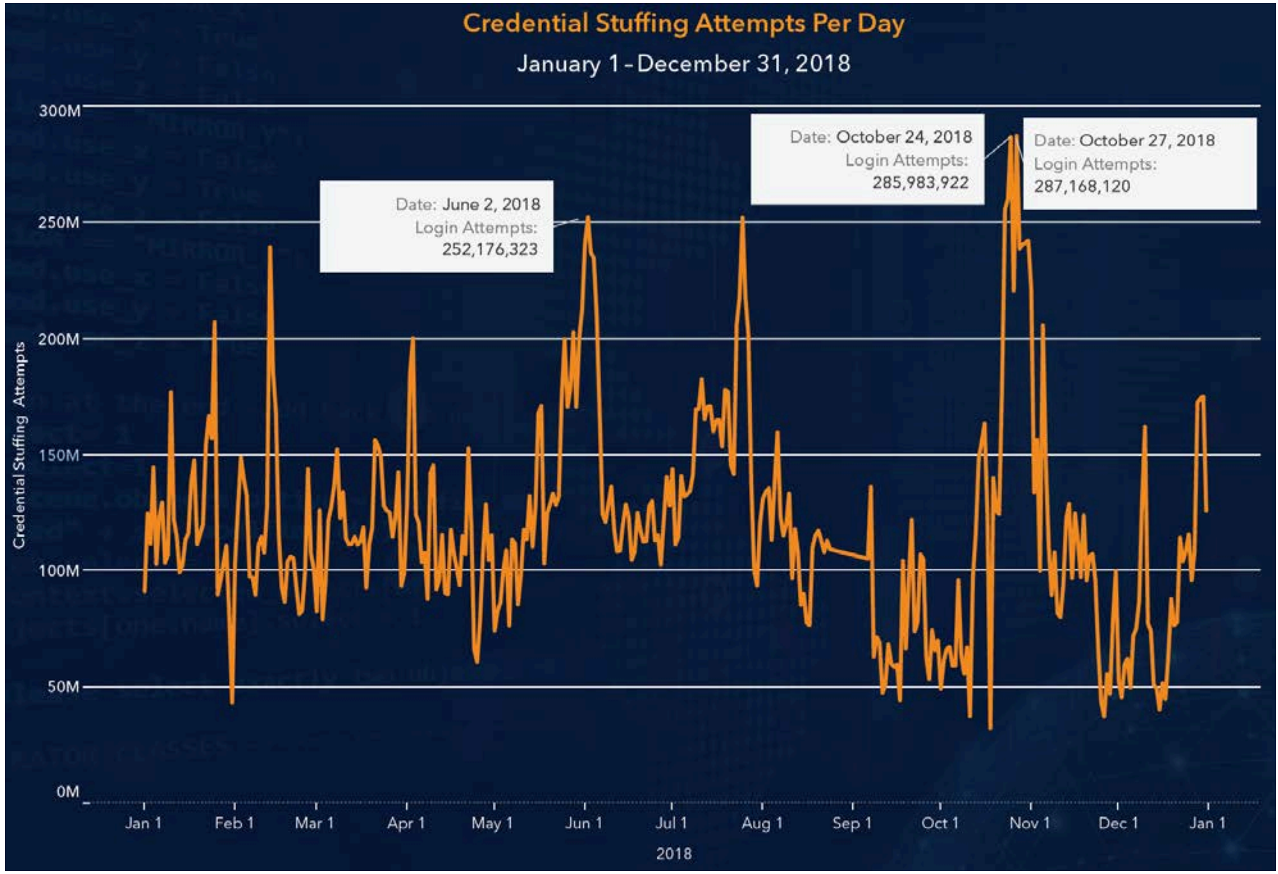
Ruhr University Bochum (#)

Austin, USA | ACSAC 2020


Email
Password
Sign in
Forgot password?
Email or Phone
Password
Log In
Forgot account?
Log In
Sign Up
Username
Password
Trouble logging in?
Log in to Twitter
Phone, email or username
Password
Log in
☑ Remember me · Forgot password?
Log in
Username
Enter your username
Password
Enter your password
□ Keep me logged in (for up to 365 days)
Log In
Email Address
Password
□ Remember me
Show password
Log in
Forgot password?
Don't have an account? Sign up
Phone number, username, or email
Password
Forgot password?
Log In
Phone or email
Password
Log in
Forgot your password?
Sign in
Email (phone for mobile accounts)
Password
Forgot your password?
Sign in
By continuing, you agree to Amazon's Conditions of Use and Privacy Notice.
□ Keep me signed in. Details
Sign In
Email or phone number
Password
Sign In
☑ Remember me
Need help?

Motivation

- Weaknesses in password-based authentication increase
- Large-scale password database leaks
  - Credential Stuffing
- Intelligent password guessing*
- Phishing



Akamai: Credential Stuffing: Attacks and Economies. In: [state of the internet] / security, vol. 5 (2019)

*D. Wang et al.: Targeted online password guessing: An underestimated threat. In CCS '16. ACM (2016)

Motivation

- 2FA is unpopular
- <10% of all Google accounts used 2FA in January 2018*

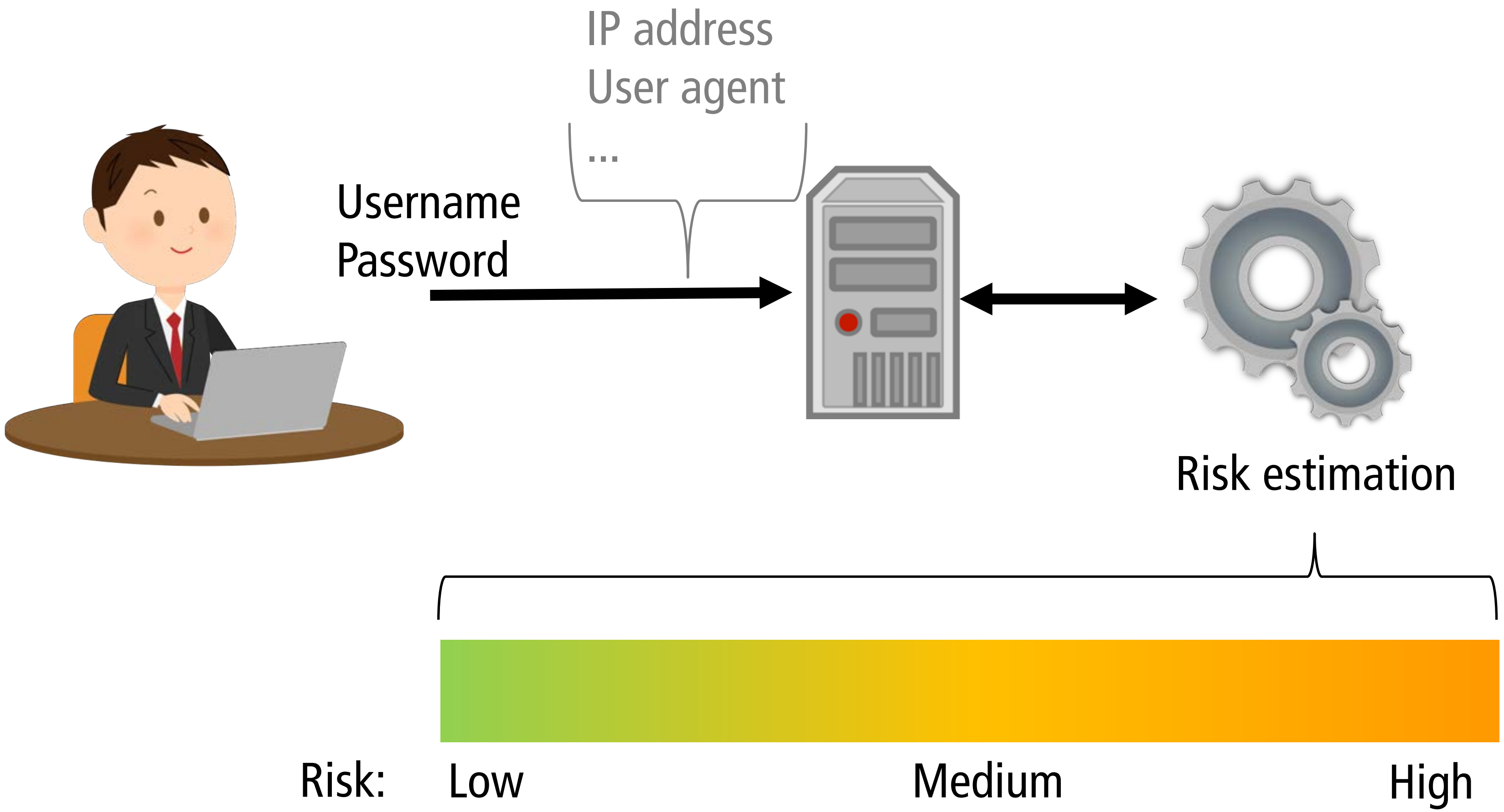
*Milka, G.: Anatomy of Account Takeover. In: Enigma 2018. USENIX (Jan 2018)

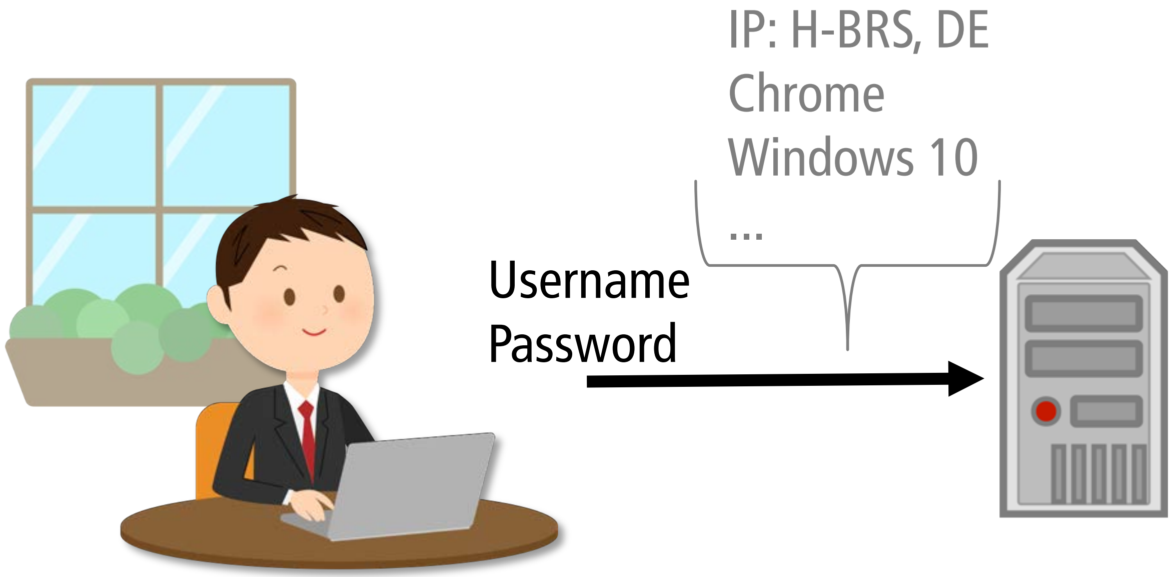
Motivation

- 2FA is unpopular
- <10% of all Google accounts used 2FA in January 2018*

→ Using Risk-based Authentication
to increase account security
with minimal impact on user interaction

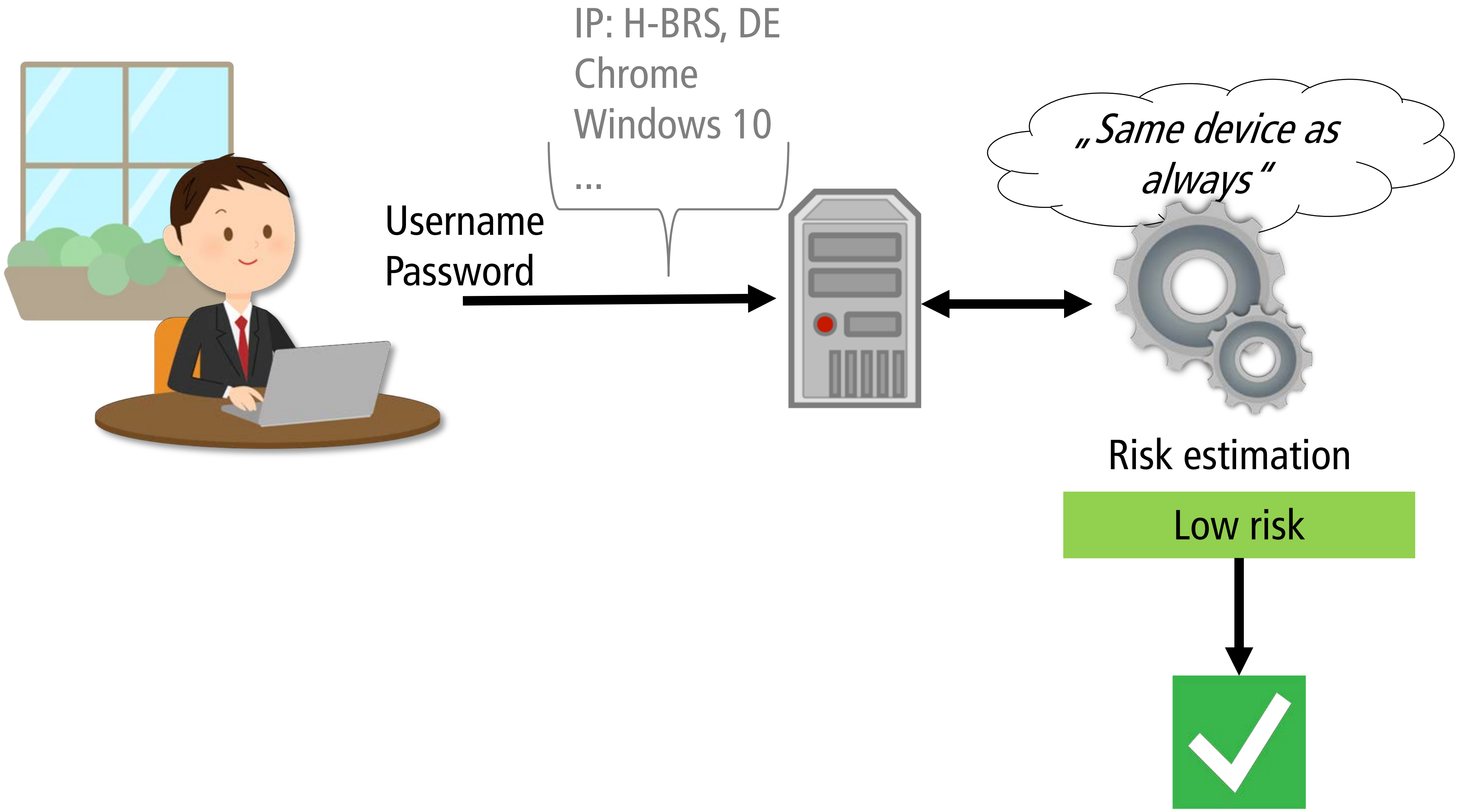
*Milka, G.: Anatomy of Account Takeover. In: Enigma 2018. USENIX (Jan 2018)


IP address
User agent
...
Username
Password
Risk estimation
Risk:
Low
Medium
High



IP: H-BRS, DE
Chrome
Windows 10
...

Username
Password



IP: H-BRS, DE
Chrome
Windows 10
...

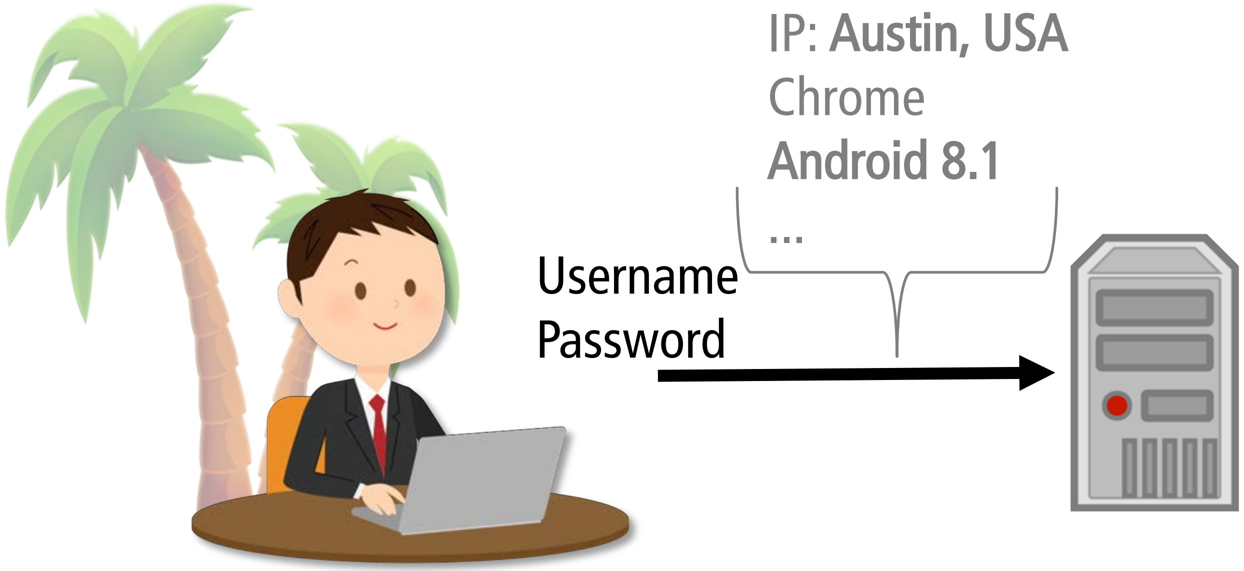
Username
Password

„Same device as always"

Risk estimation

Low risk

✓



IP: **Austin, USA**

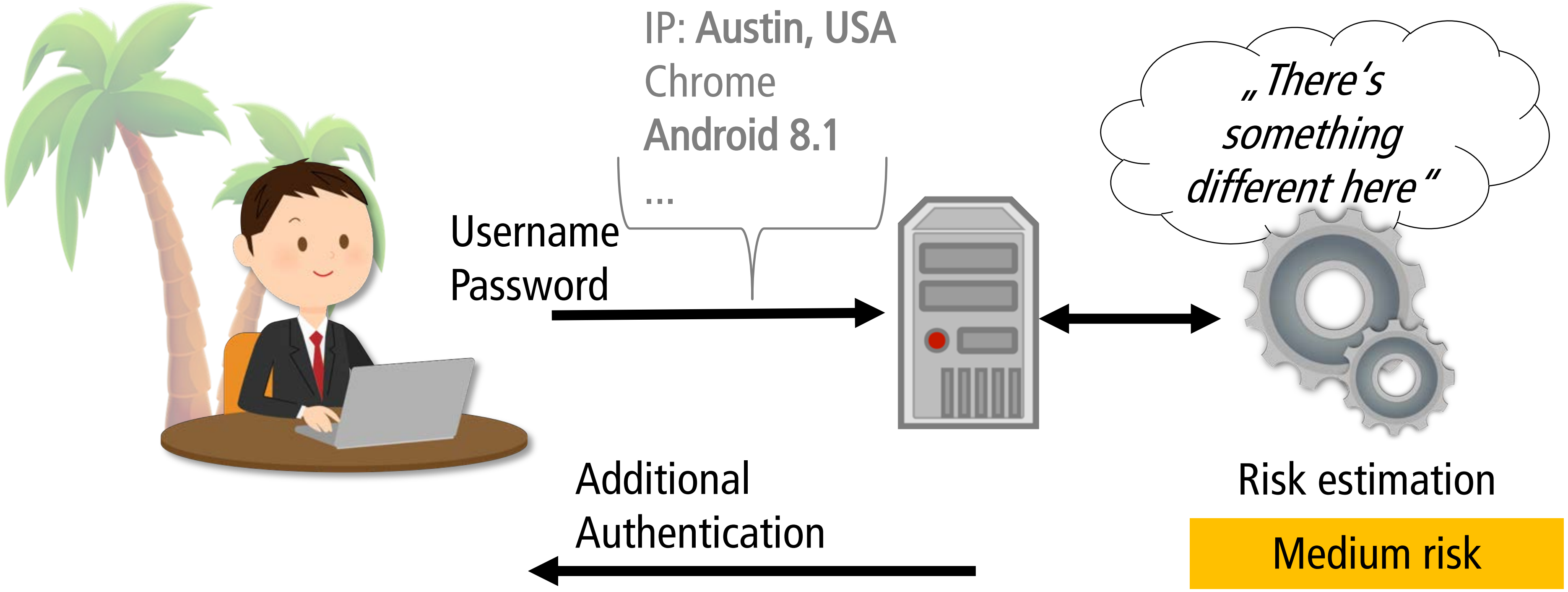
Chrome

Android 8.1

...

Username

Password



IP: Austin, USA
Chrome
Android 8.1
...

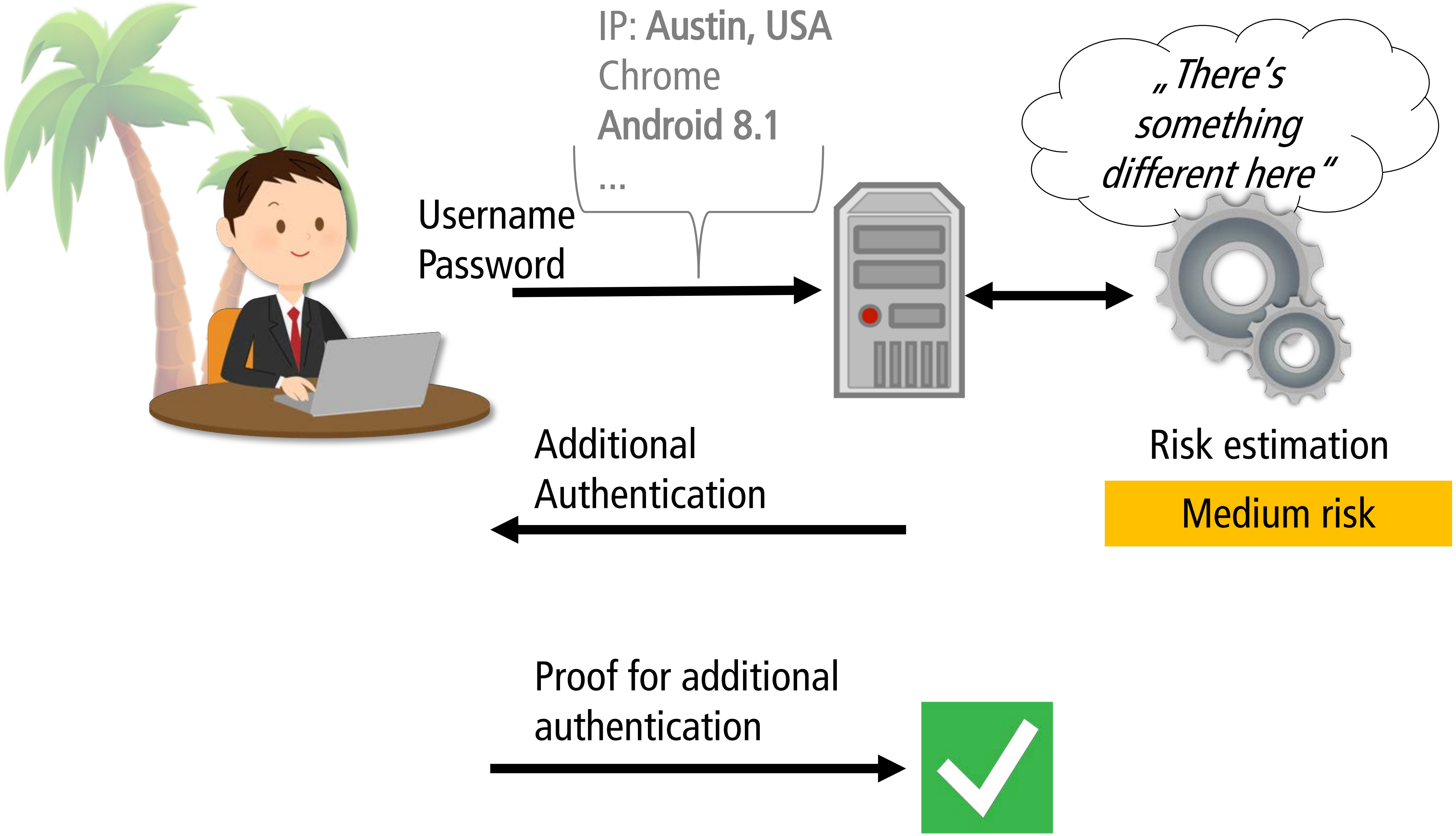
Username
Password

„There's something different here"

Risk estimation

Medium risk

Additional Authentication



IP: Austin, USA
Chrome
Android 8.1
...

Username
Password

„There's something different here"

Risk estimation

Medium risk

Additional Authentication

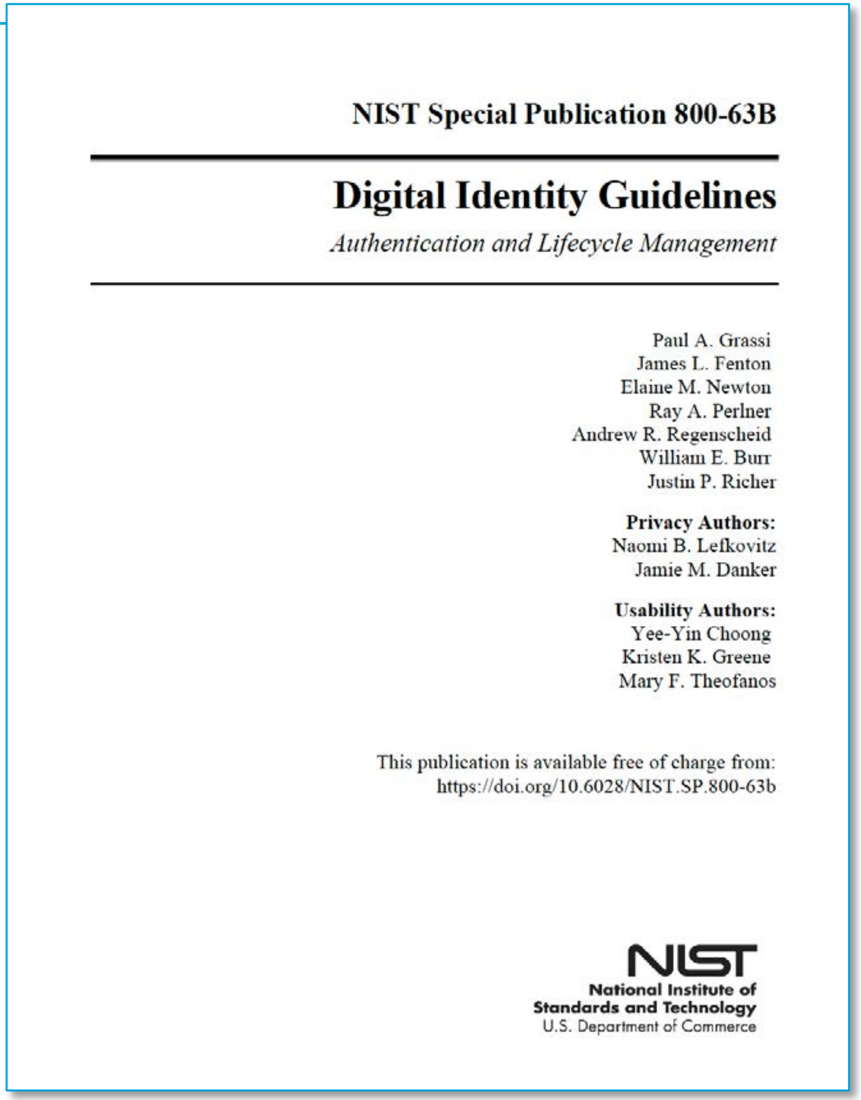
Proof for additional authentication

Risk-based Authentication

- Recommended by NIST digital identity guidelines[1]
- Used by large online services[2]
- Usability not researched so far

[1] Grassi et al.: Digital identity guidelines. Tech. Rep. NIST SP 800-63b (2017)

[2] Wiefling et al.: Is This Really You? An Empirical Study on Risk-Based Authentication Applied in the Wild. In: IFIP SEC '19. Springer (2019)



NIST Special Publication 800-63B

Digital Identity Guidelines

Authentication and Lifecycle Management

Paul A. Grassi
James L. Fenton
Elaine M. Newton
Ray A. Perlner
Andrew R. Regenscheid
William E. Burr
Justin P. Richer

Privacy Authors:
Naomi B. Lefkovitz
Jamie M. Danker

Usability Authors:
Yee-Yin Choong
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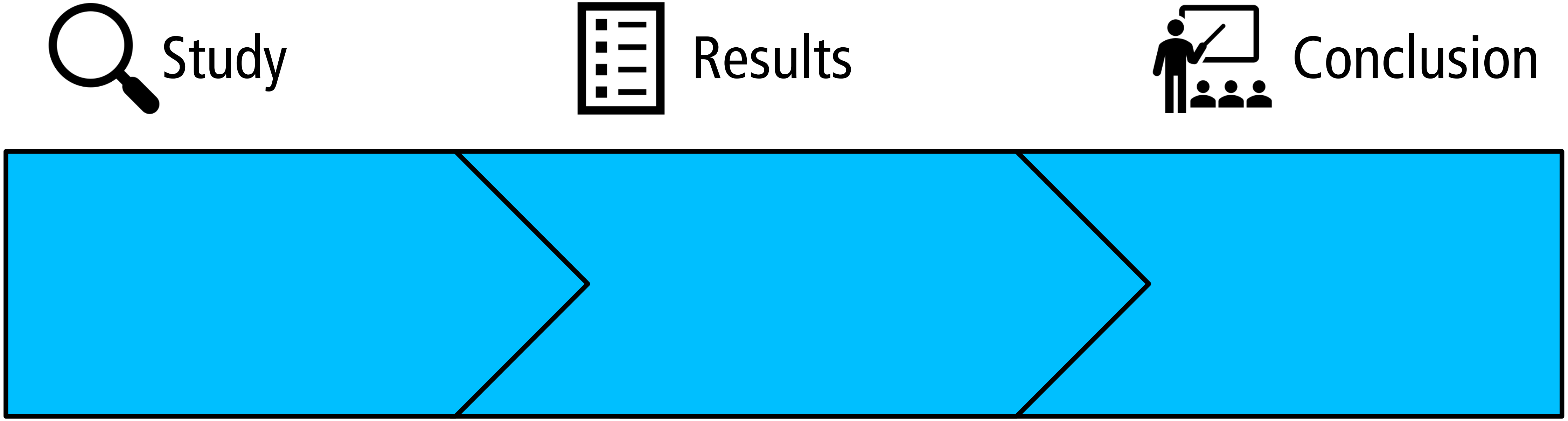
Mary F. Theofanos

This publication is available free of charge from:
https://doi.org/10.6028/NIST.SP.800-63b

NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

Overview

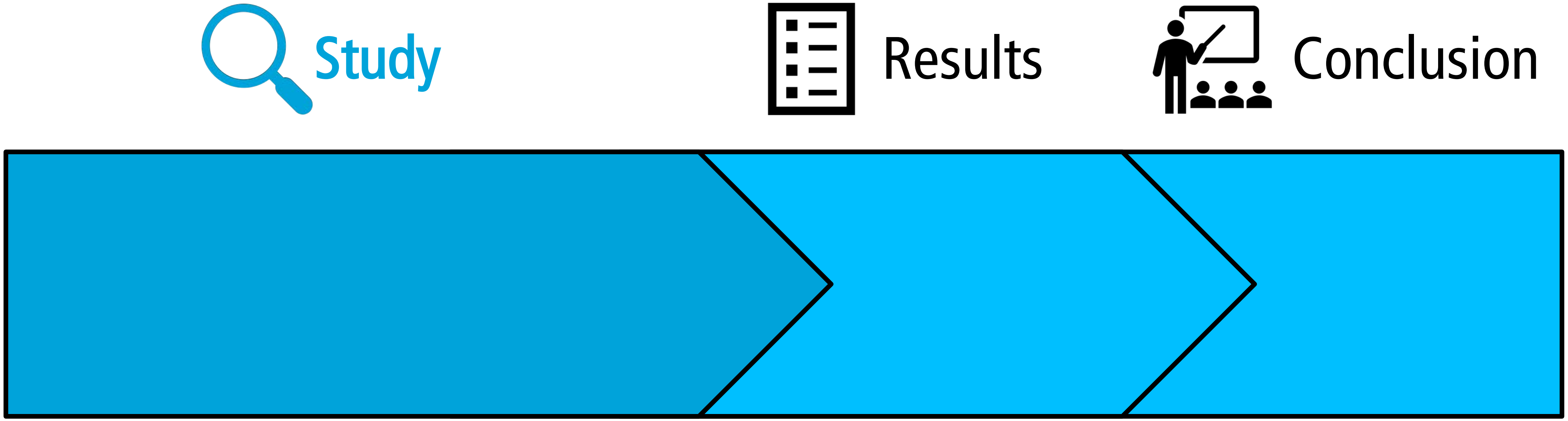


Study

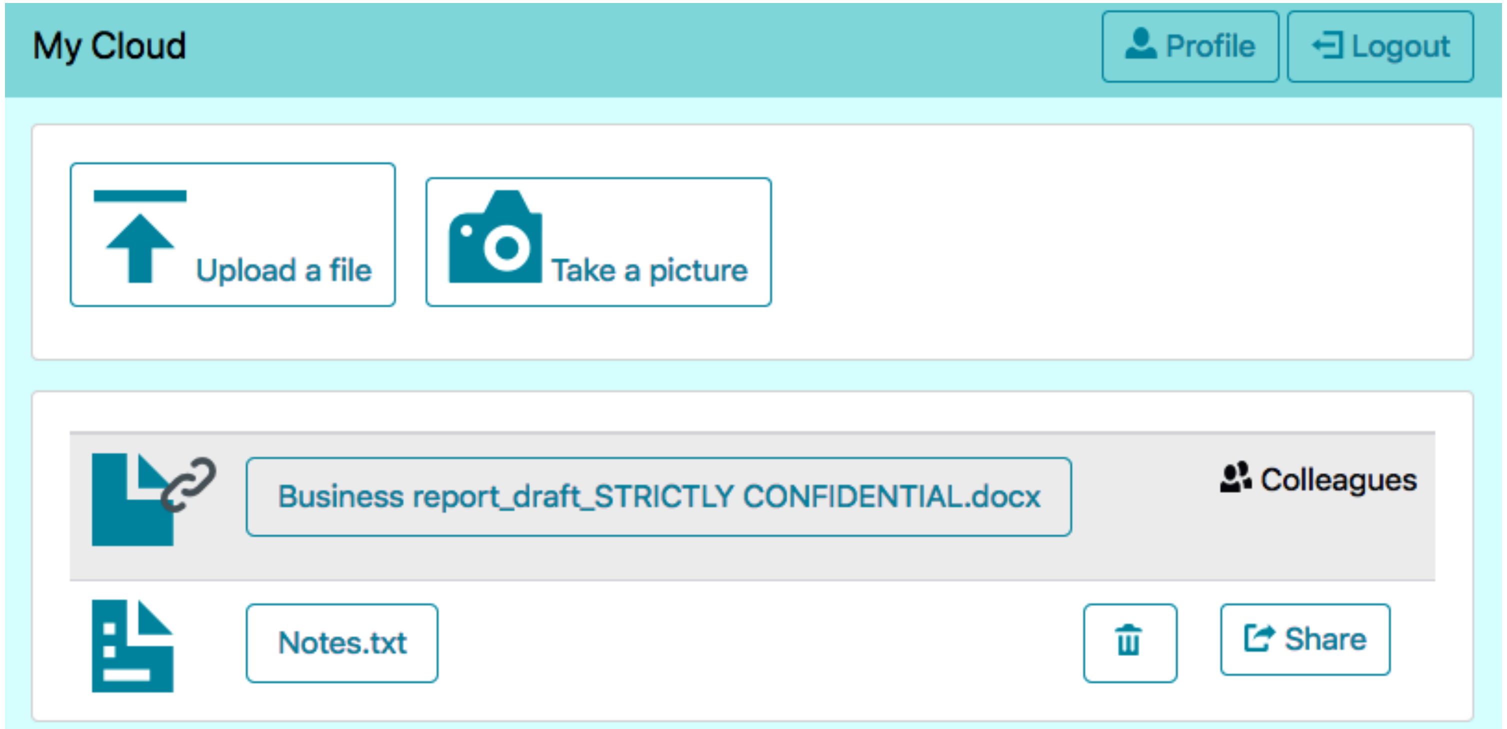
Results

Conclusion

Overview

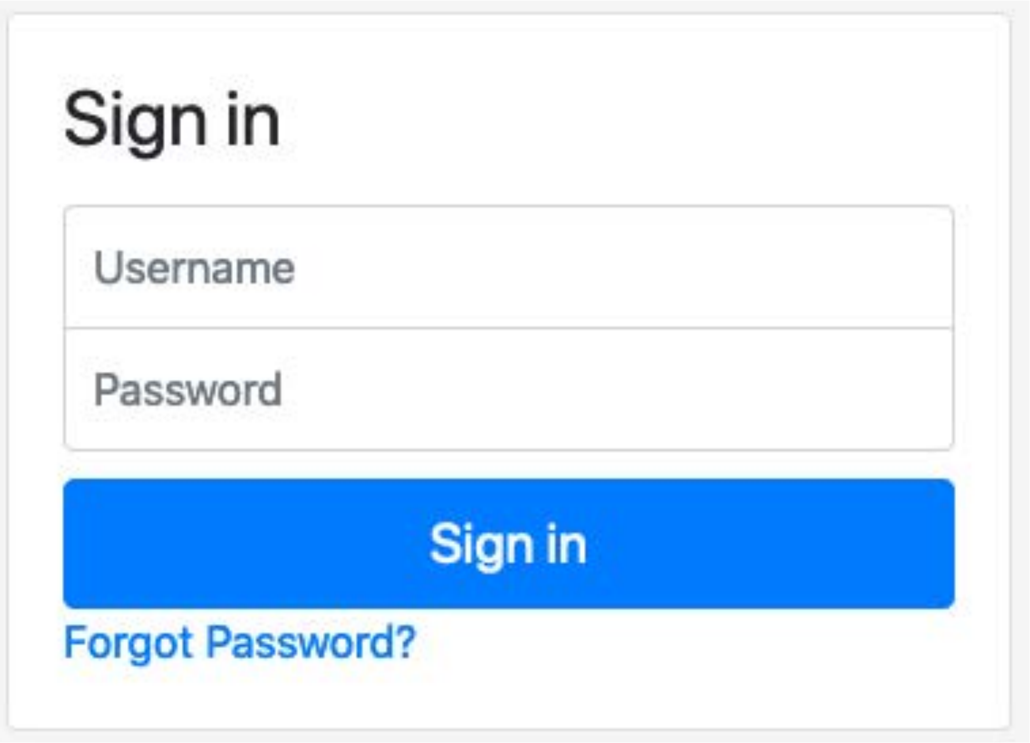


Study Website

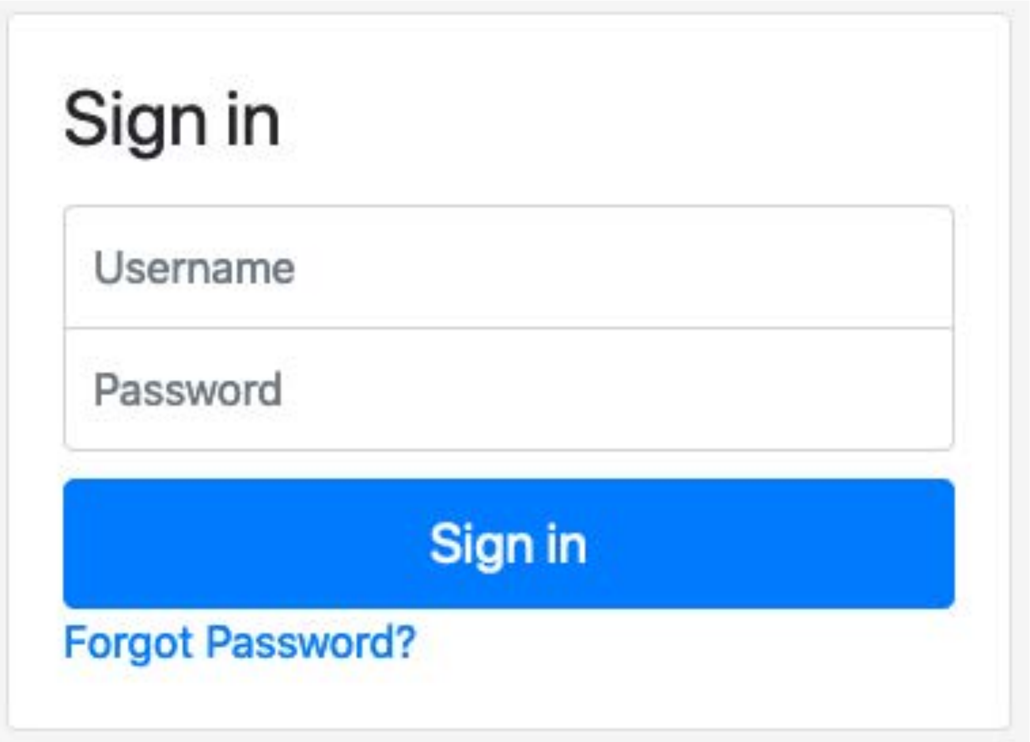


- Introduced as external website to distract from study purpose
- Asked to test website to avoid bias

Study Procedure



Study Procedure



2FA

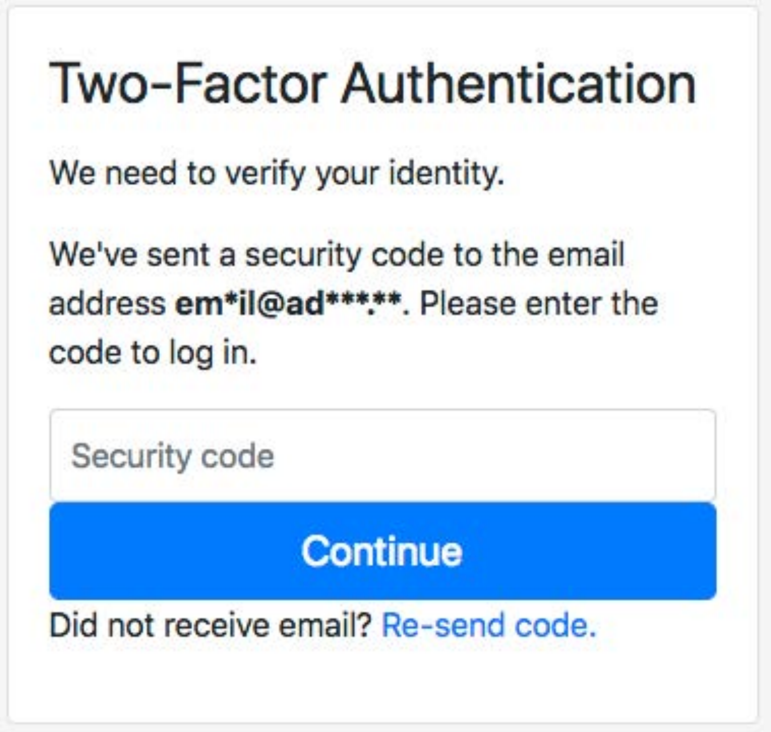
RBA-DEVICE

RBA-LOCATION

PASSWORD-ONLY

Study Procedure

- 2FA
- RBA-DEVICE
- RBA-LOCATION
- PASSWORD-ONLY



Two-Factor Authentication

We need to verify your identity.

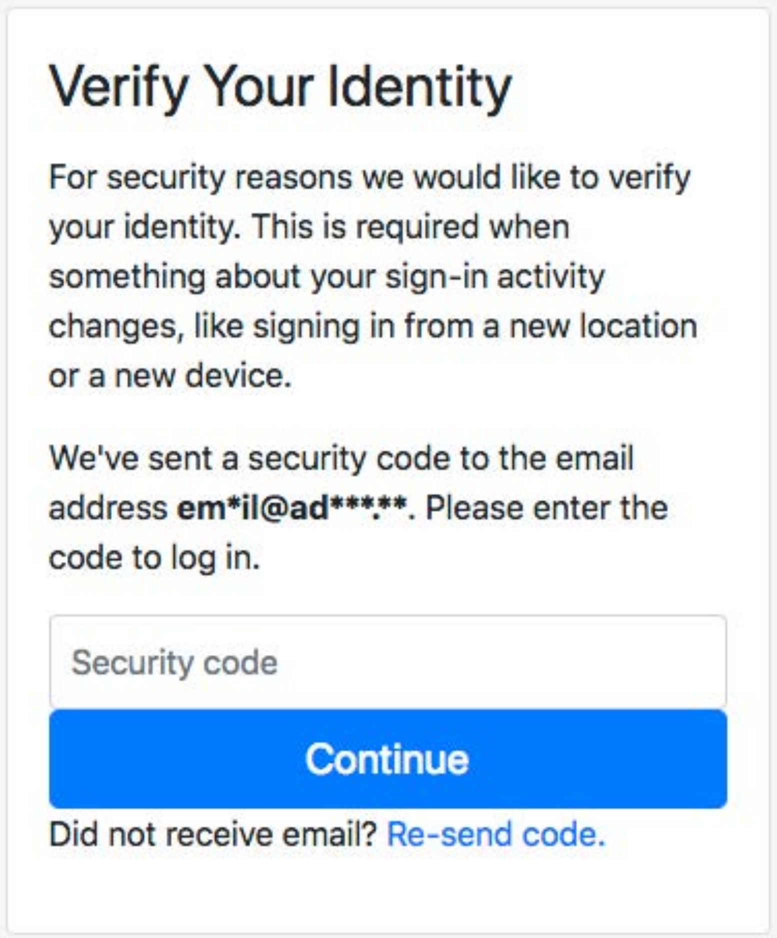
We've sent a security code to the email address **em*il@ad*****. Please enter the code to log in.

Did not receive email? Re-send code.

Always prompted

Study Procedure

- 2FA
- **RBA-DEVICE**
- RBA-LOCATION
- PASSWORD-ONLY



Verify Your Identity

For security reasons we would like to verify your identity. This is required when something about your sign-in activity changes, like signing in from a new location or a new device.

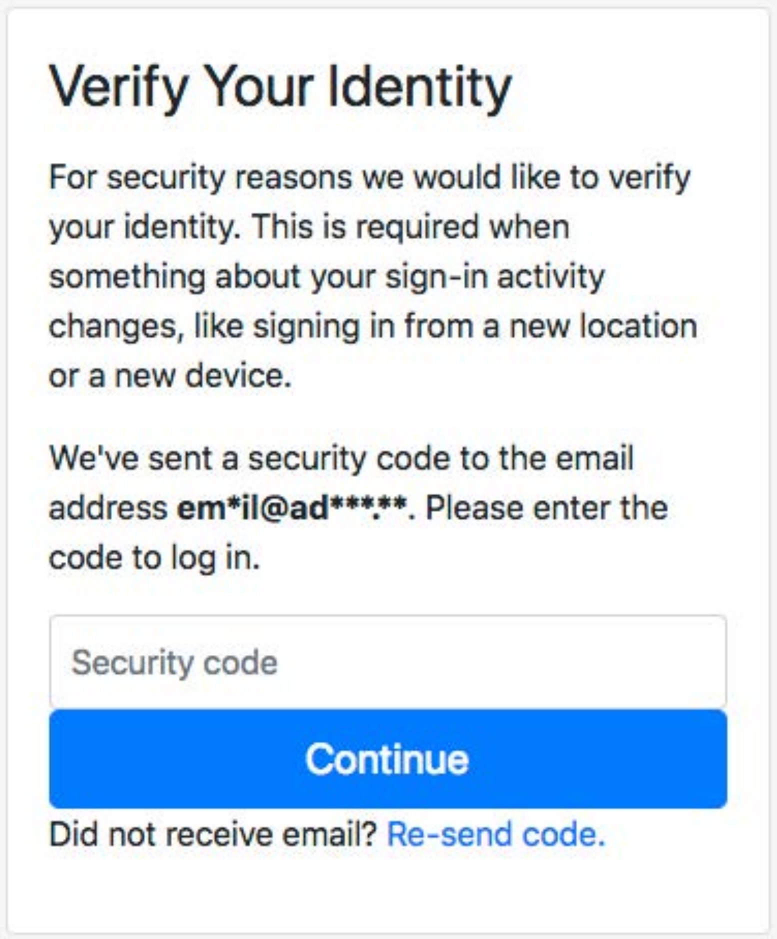
We've sent a security code to the email address **em*il@ad*****.**. Please enter the code to log in.

Did not receive email? Re-send code.

Prompted on unknown device

Study Procedure

- 2FA
- RBA-DEVICE
- **RBA-LOCATION**
- PASSWORD-ONLY



Verify Your Identity

For security reasons we would like to verify your identity. This is required when something about your sign-in activity changes, like signing in from a new location or a new device.

We've sent a security code to the email address **em*il@ad*****.****. Please enter the code to log in.

Did not receive email? Re-send code.

Prompted on unknown location

Study Procedure

2FA

RBA-DEVICE

RBA-LOCATION

PASSWORD-ONLY

Never prompted

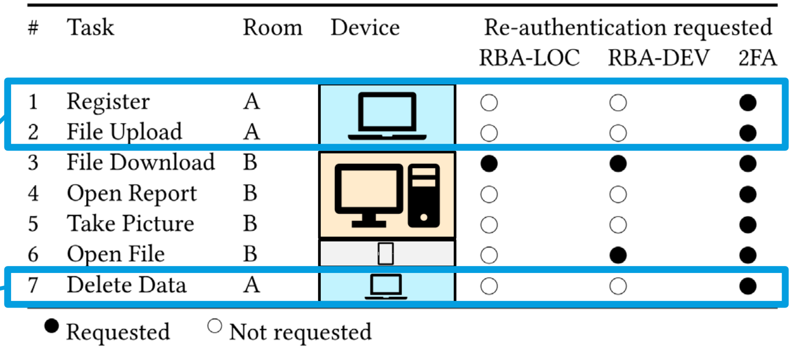
Study Tasks

#	Task	Room	Device	Re-authentication requested		
				RBA-LOC	RBA-DEV	2FA
1	Register	A	💻	○	○	●
2	File Upload	A		○	○	●
3	File Download	B	🖥	●	●	●
4	Open Report	B		○	○	●
5	Take Picture	B		○	○	●
6	Open File	B	📱	○	●	●
7	Delete Data	A	💻	○	○	●

● Requested ○ Not requested

- Create realistic study scenario
- Involve sensitive data and personal devices to increase immersion

Study Tasks

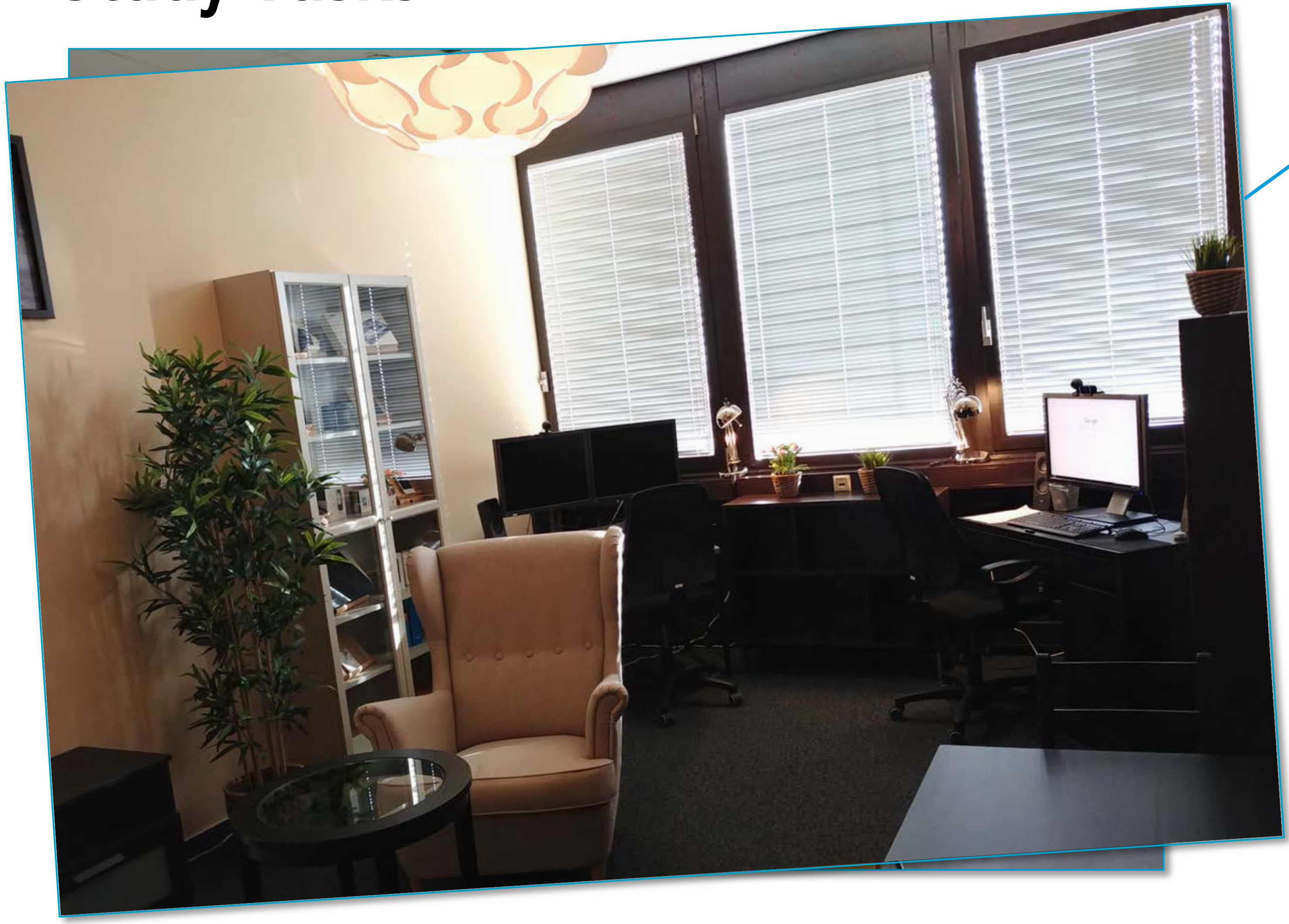


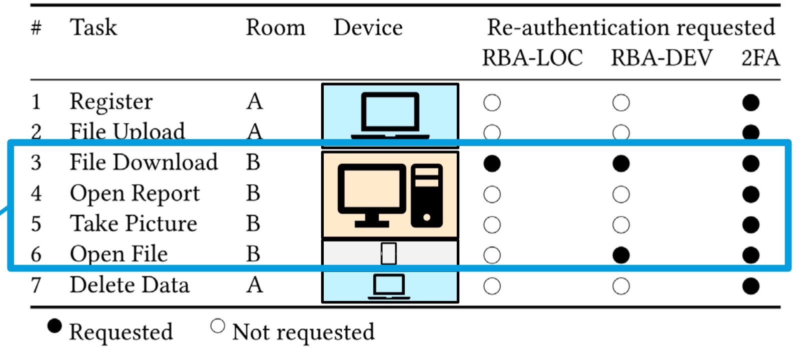
#	Task	Room	Device	Re-authentication requested		
				RBA-LOC	RBA-DEV	2FA
1	Register	A	💻	○	○	●
2	File Upload	A		○	○	●
3	File Download	B	🖥	●	●	●
4	Open Report	B		○	○	●
5	Take Picture	B		○	○	●
6	Open File	B	📱	○	●	●
7	Delete Data	A	💻	○	○	●

● Requested ○ Not requested

- Authentication as secondary task
- Room changes to support understanding

Study Tasks





#	Task	Room	Device	Re-authentication requested		
				RBA-LOC	RBA-DEV	2FA
1	Register	A	💻	○	○	●
2	File Upload	A		○	○	●
3	File Download	B	🖥	●	●	●
4	Open Report	B		○	○	●
5	Take Picture	B		○	○	●
6	Open File	B	📱	○	●	●
7	Delete Data	A	💻	○	○	●

● Requested ○ Not requested

- Authentication as secondary task
- Room changes to support understanding

Study Procedure

Exit survey*

Semi-structured interview

* Questions partially based on
Brooke, J.: SUS: A quick and dirty usability scale. (1996)
H. Khan et al.: Usability and Security Perceptions of Implicit Authentication: Convenient, Secure, Sometimes Annoying. In: SOUPS '15. USENIX (2015)
L. Agarwal et al.: Ask Me Again But Don't Annoy Me: Evaluating Re-authentication Strategies for Smartphones. In: SOUPS '16. USENIX (2016)

Study Procedure

Exit survey*

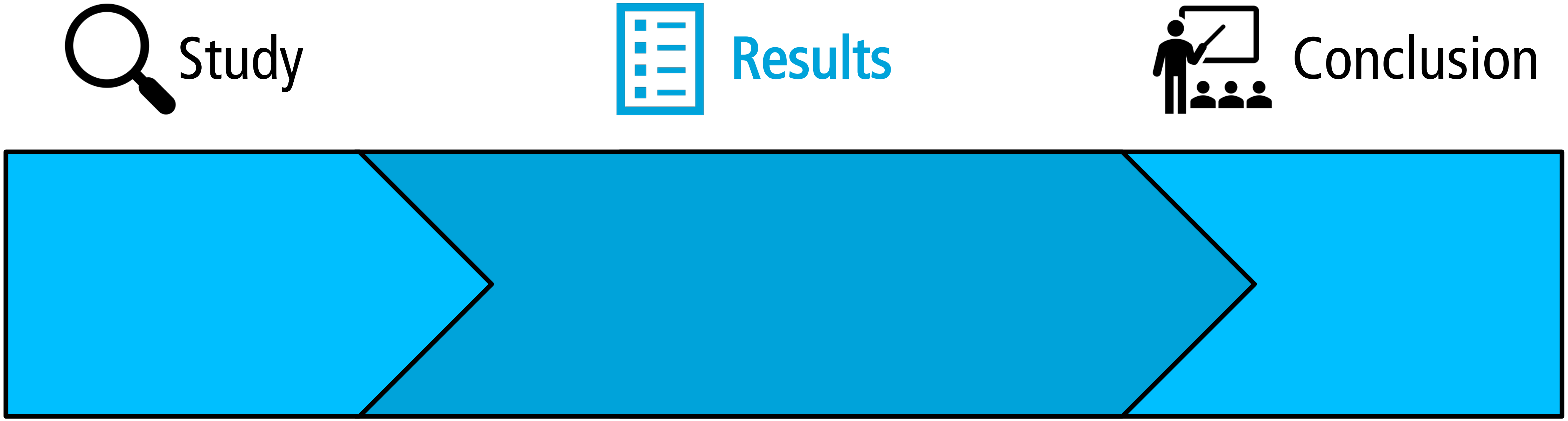
Measure usability and security perceptions

Semi-structured interview

Understand survey responses

* Questions partially based on
Brooke, J.: SUS: A quick and dirty usability scale. (1996)
H. Khan et al.: Usability and Security Perceptions of Implicit Authentication: Convenient, Secure, Sometimes Annoying. In: SOUPS ‘15. USENIX (2015)
L. Agarwal et al.: Ask Me Again But Don’t Annoy Me: Evaluating Re-authentication Strategies for Smartphones. In: SOUPS ‘16. USENIX (2016)

Overview



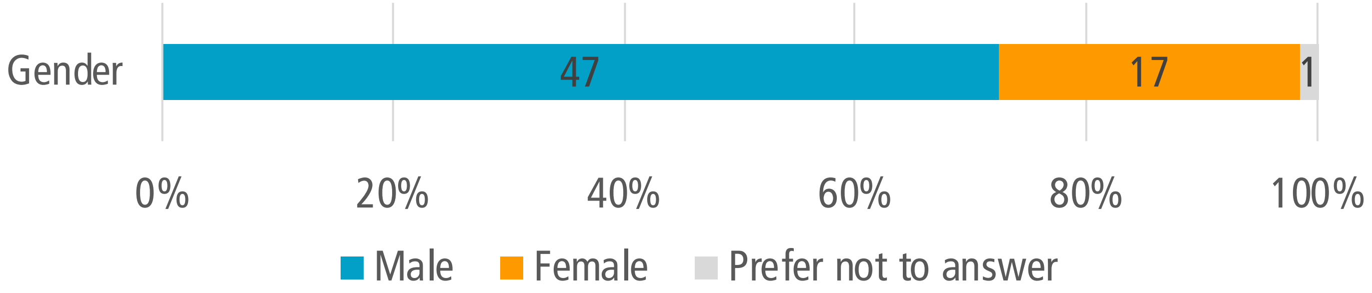
Study

Results

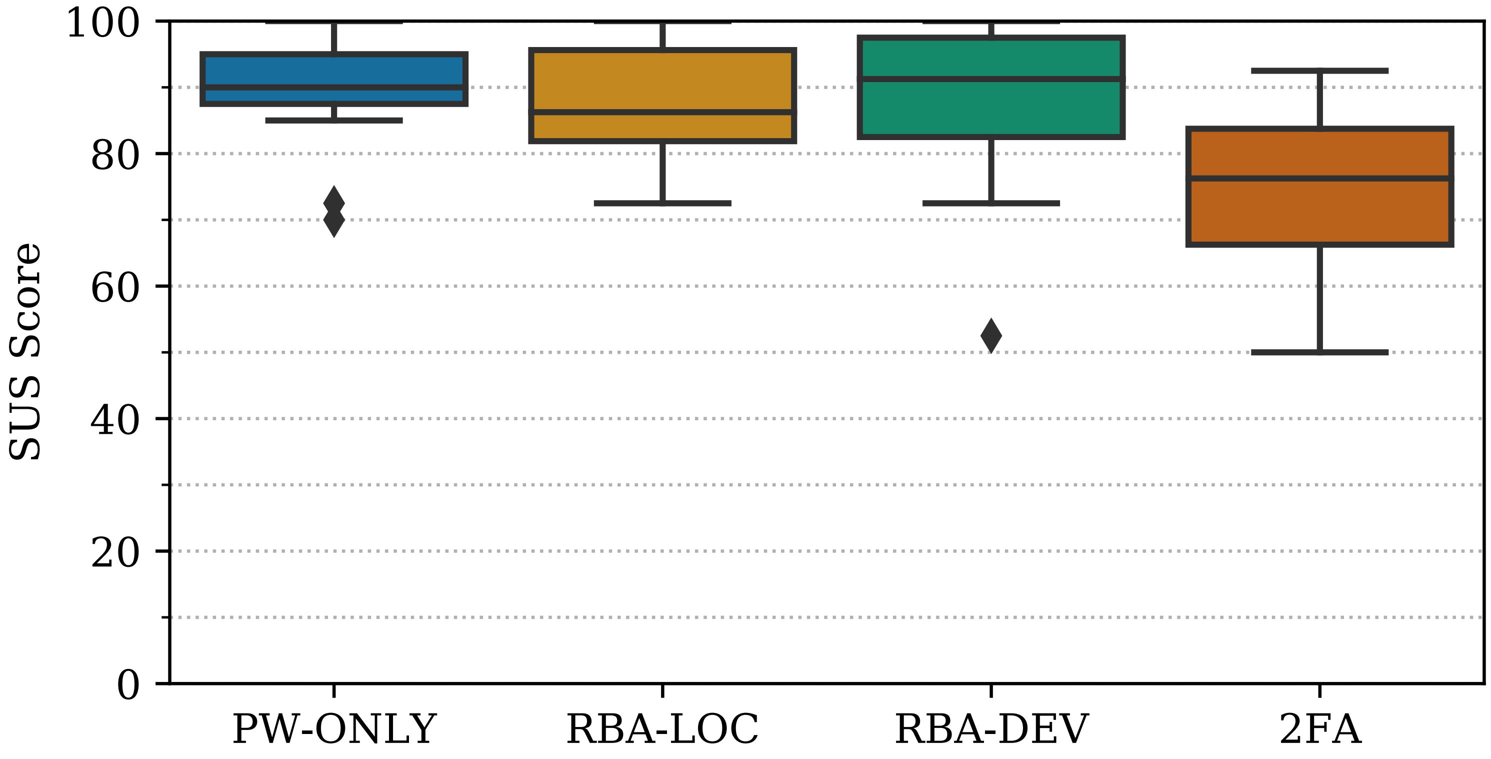
Conclusion

Demographics

- N=65
  - 17 in PW-ONLY
  - 16 all other conditions
- Age: 19-33 years
  (mean: 24.57, SD: 3.22)



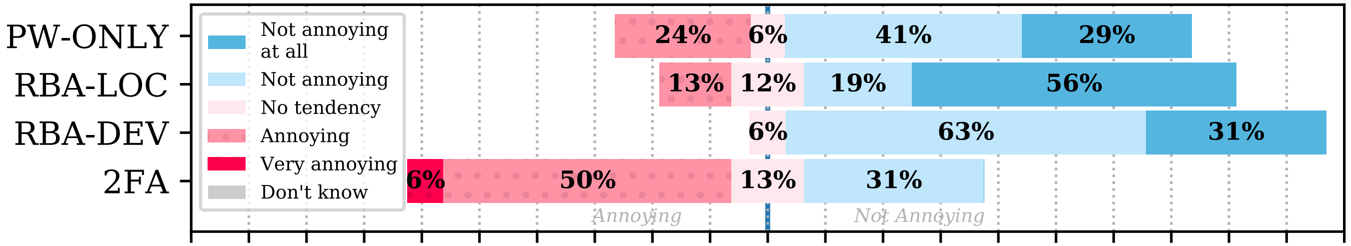
RBA and PW-ONLY Usability higher than 2FA



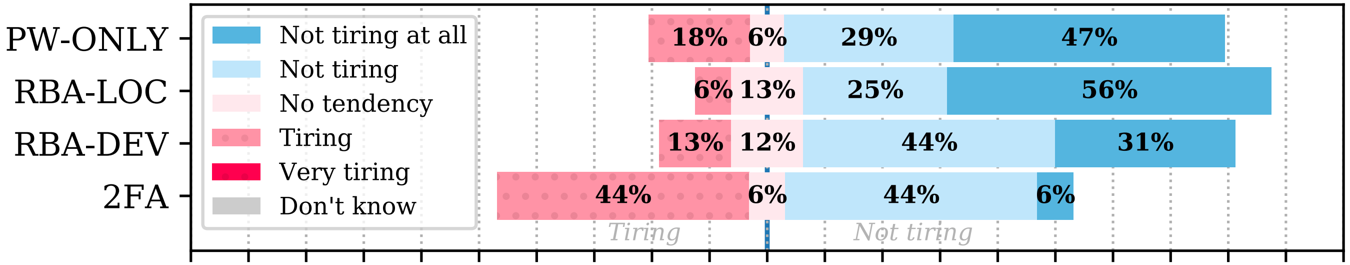
- System Usability Scale (SUS) scores or subquestion answers significantly lower for 2FA ($p<0.05$)

RBA more accepted than 2FA

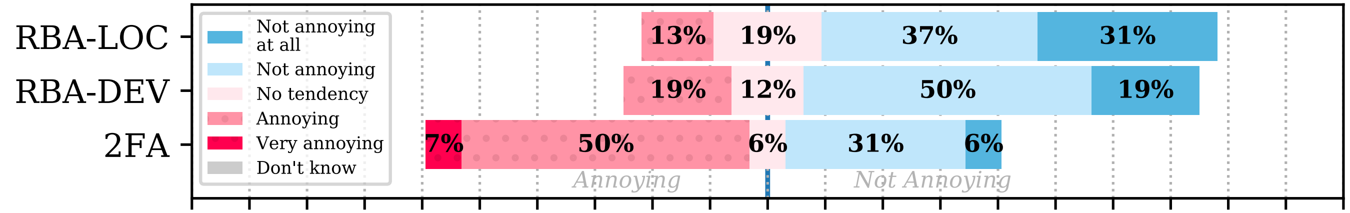
(U1a) How annoying or not annoying did you perceive this login procedure?



(U1b) How tiring or not-tiring did you find this login procedure?

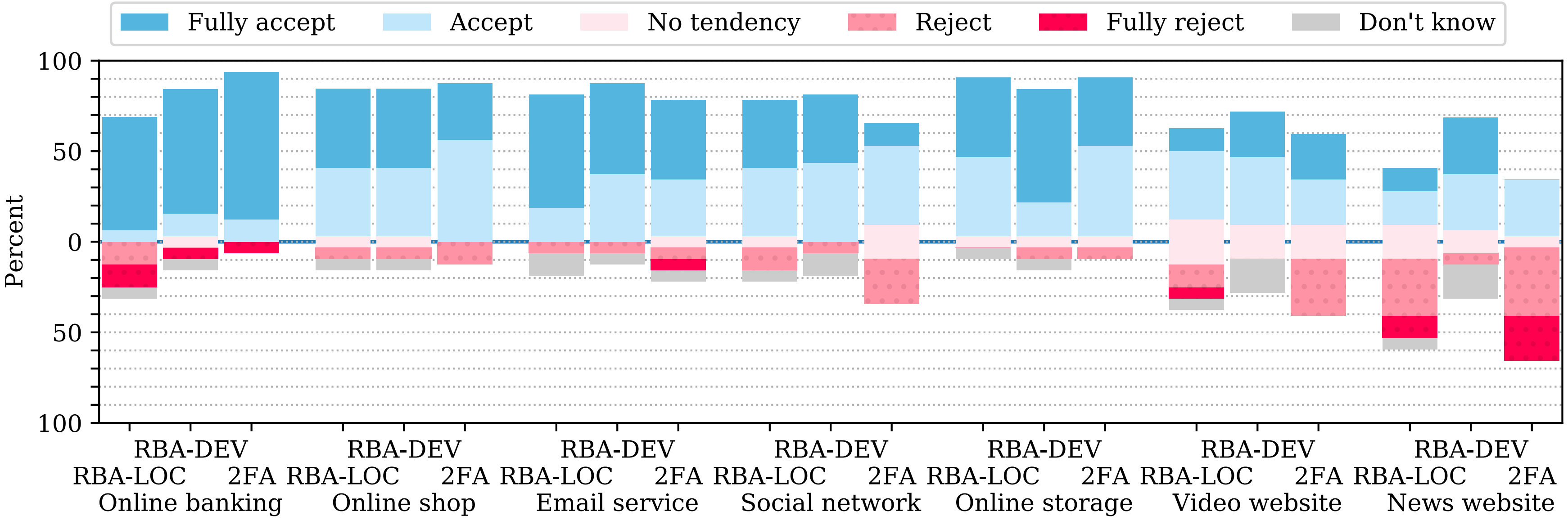


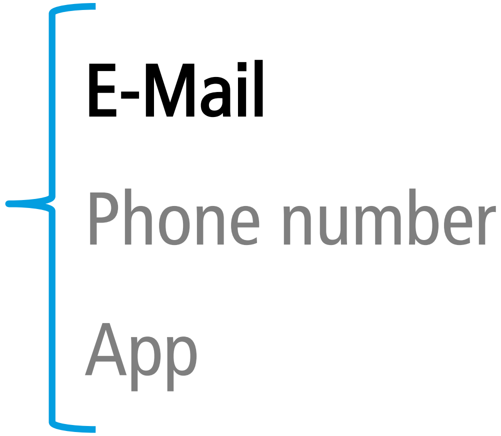
(U1c) How did you perceive the interruptions for confirming the identity?



- RBA in many cases significantly higher than 2FA

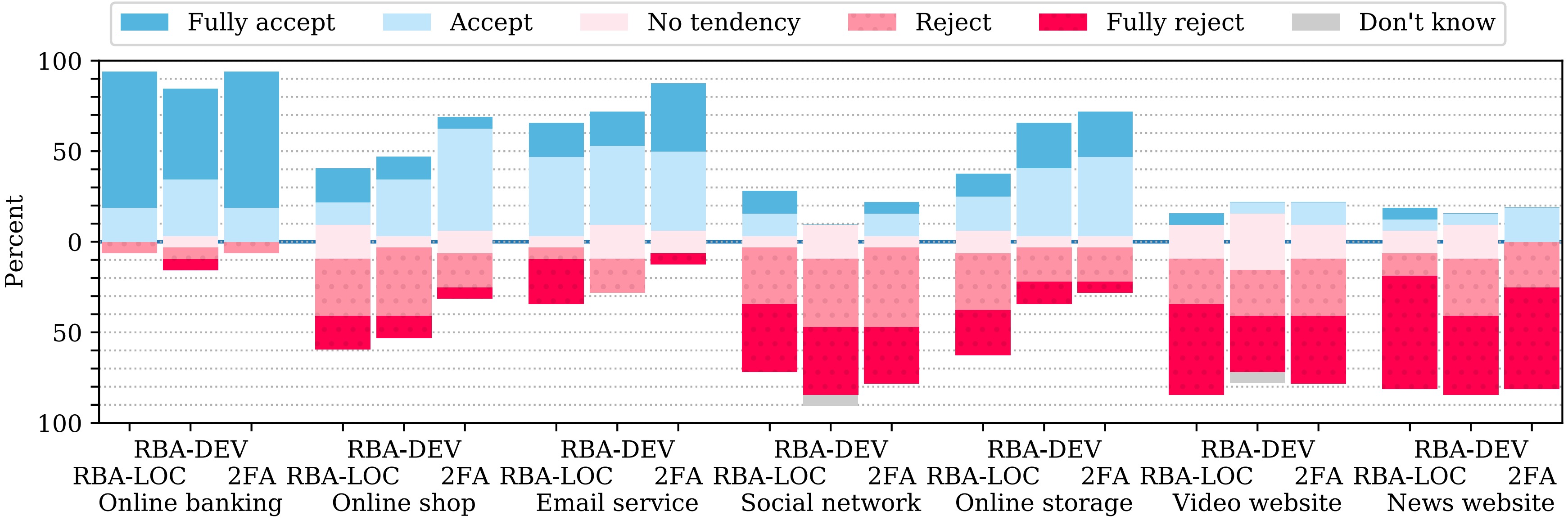
But: Acceptance differs





- Re-authentication factor
- Data sensitivity in use case scenario

But: Acceptance differs



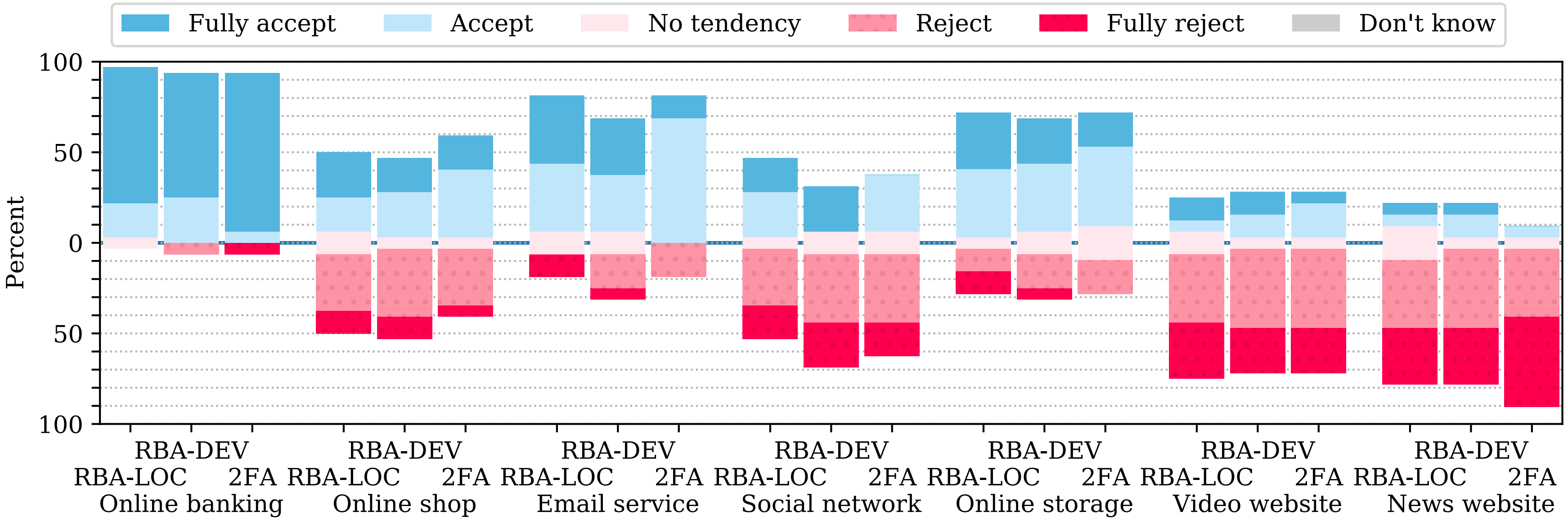
E-Mail

Phone number

App

- Re-authentication factor
- Data sensitivity in use case scenario

But: Acceptance differs



E-Mail

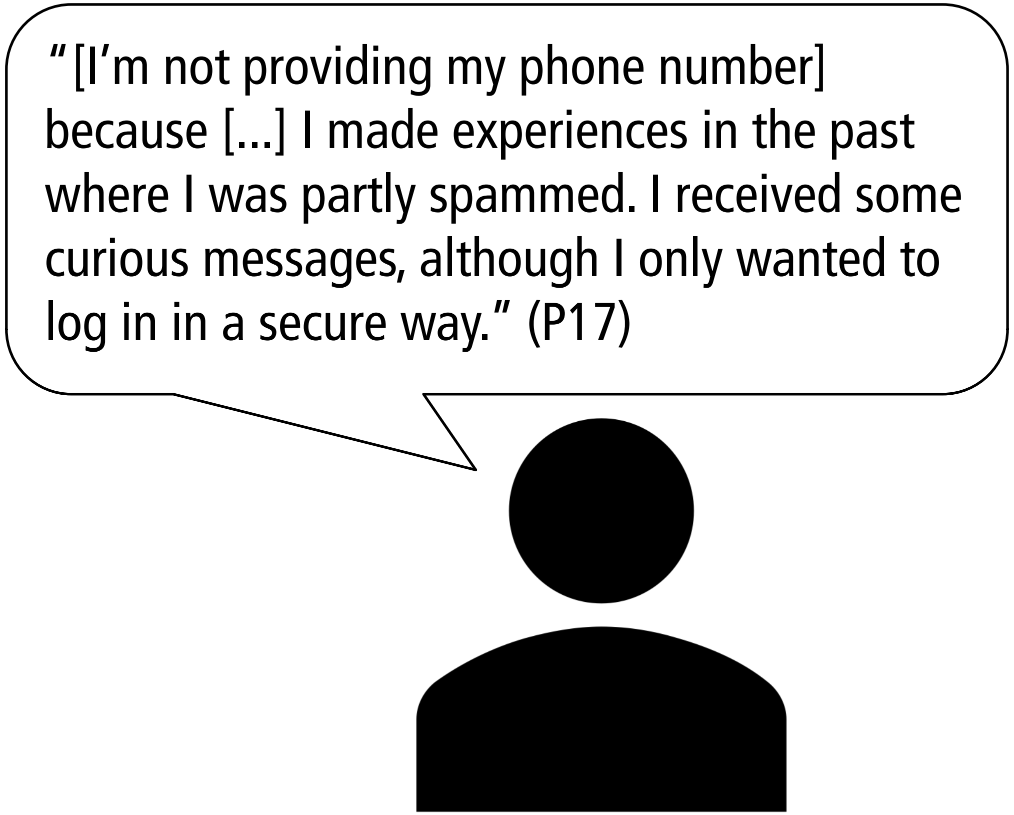
Phone number

App

- Re-authentication factor
- Data sensitivity in use case scenario

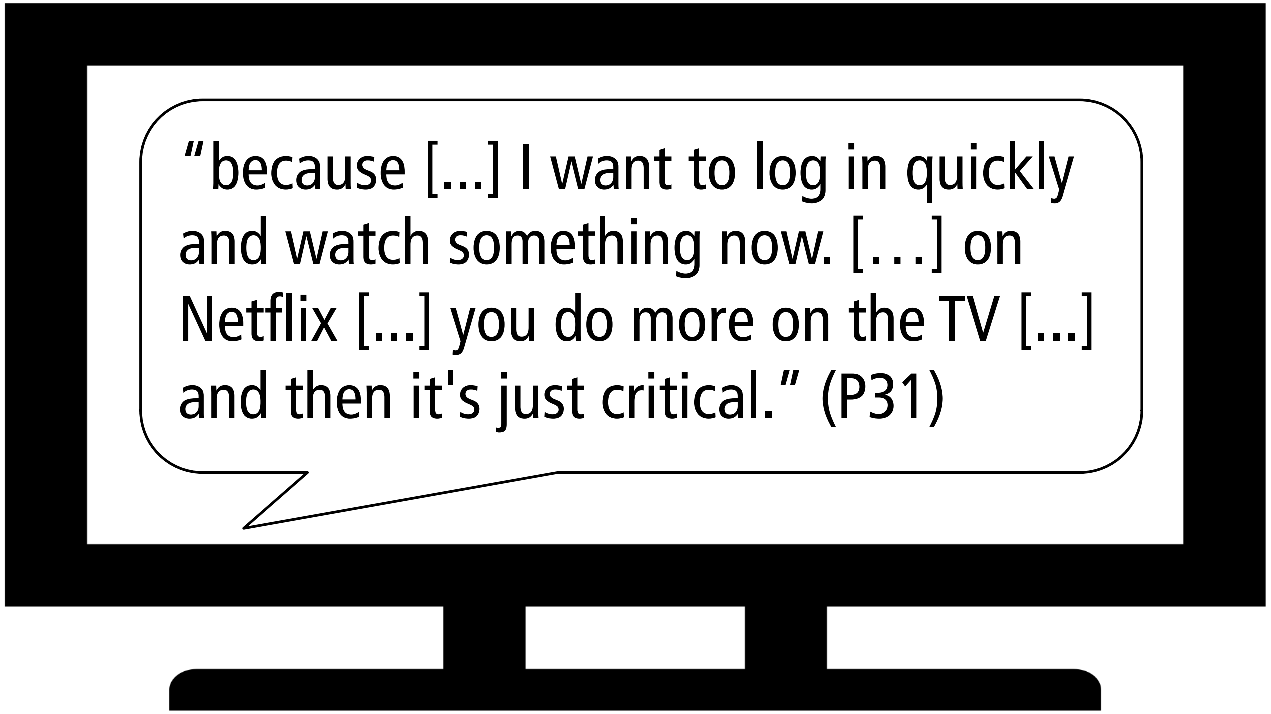
Factors influencing acceptance

Trust in online service



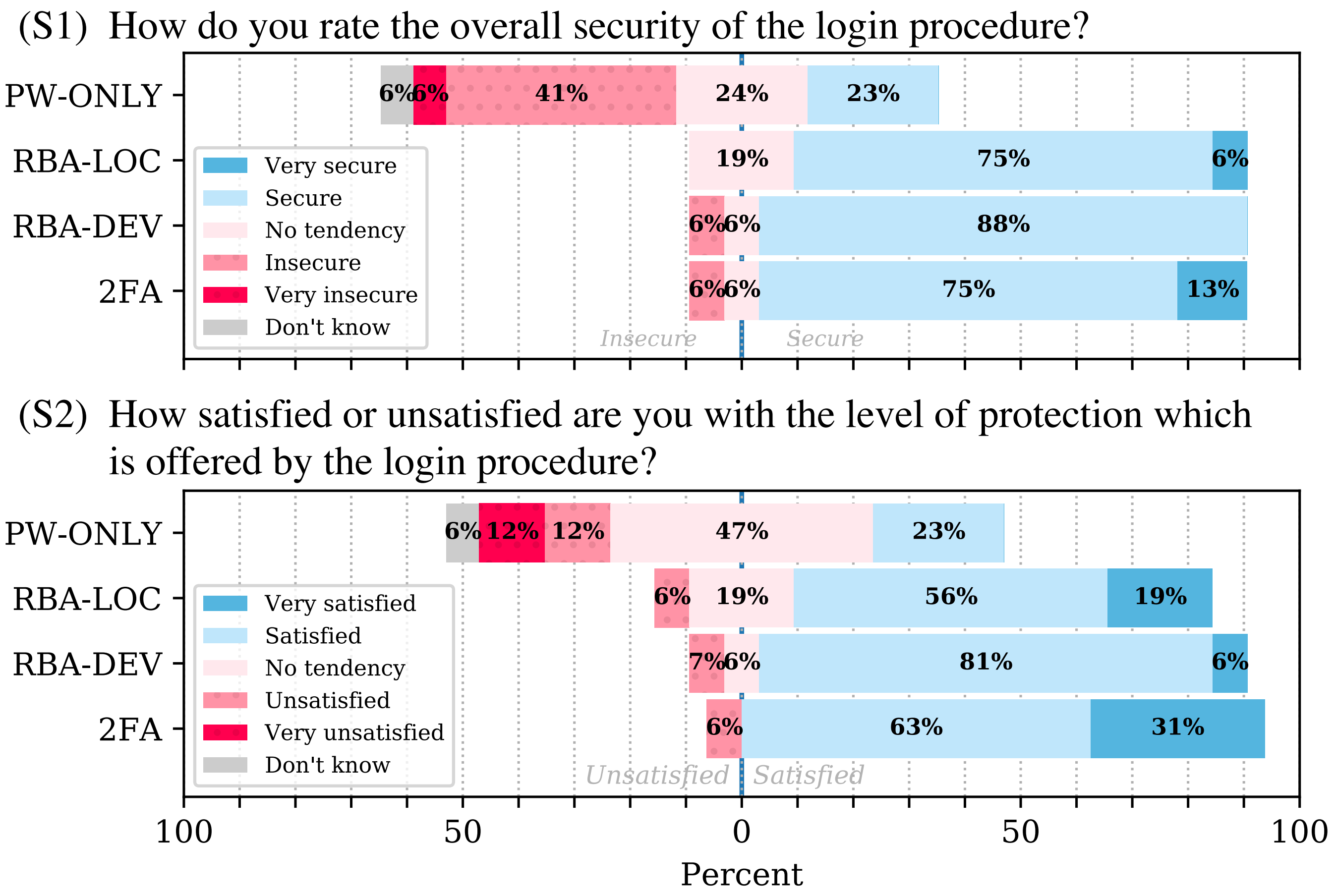
“[I’m not providing my phone number] because [...] I made experiences in the past where I was partly spammed. I received some curious messages, although I only wanted to log in in a secure way.” (P17)

Device involved



“because [...] I want to log in quickly and watch something now. [. . .] on Netflix [...] you do more on the TV [...] and then it's just critical.” (P31)

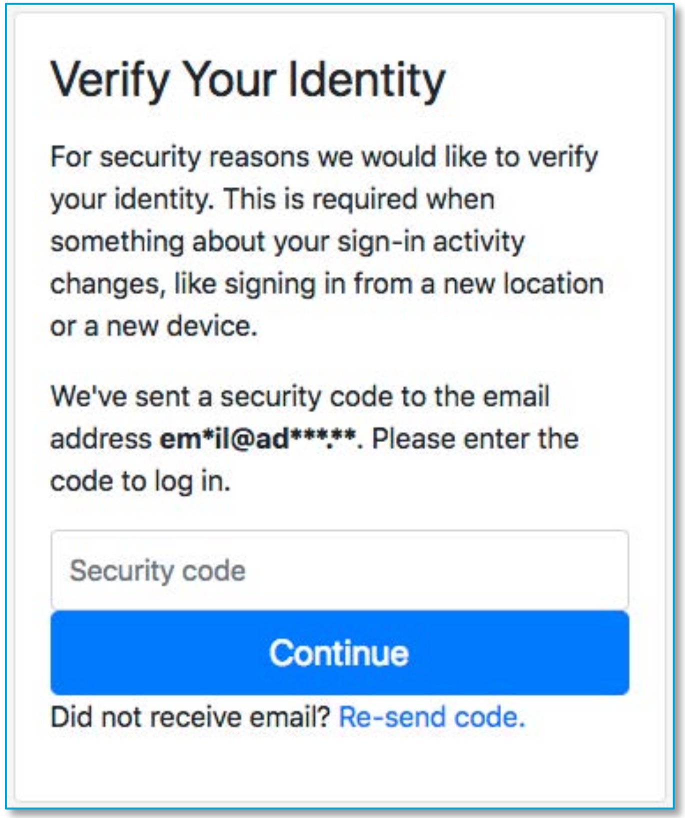
RBA and 2FA perceived more secure (p<0.05)



RBA > PW
RBA ≈ 2FA

Additional Findings

Deadlock Problem



Verify Your Identity

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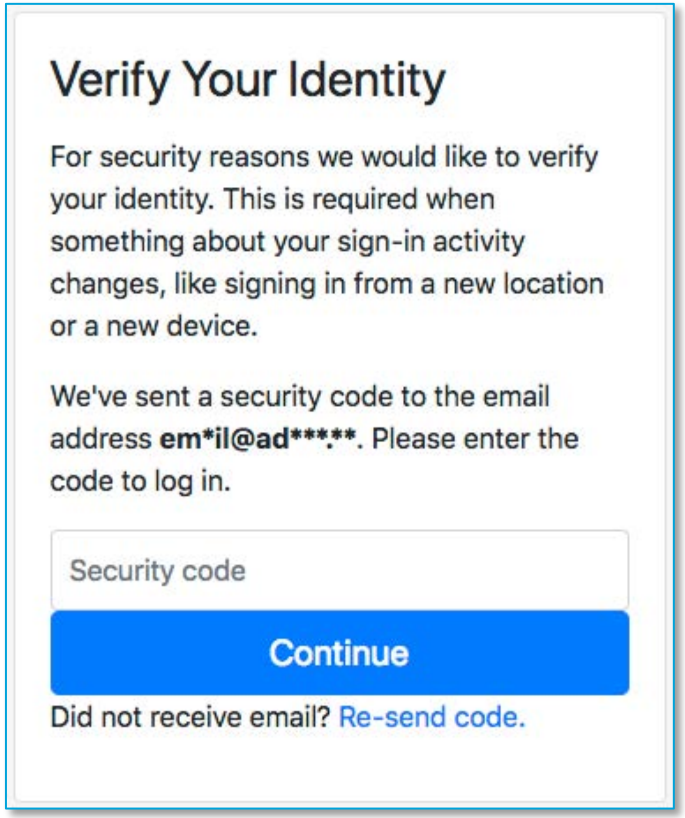
We've sent a security code to the email address **em*il@ad*****.**. Please enter the code to log in.

Did not receive email? Re-send code.

Deadlock Problem



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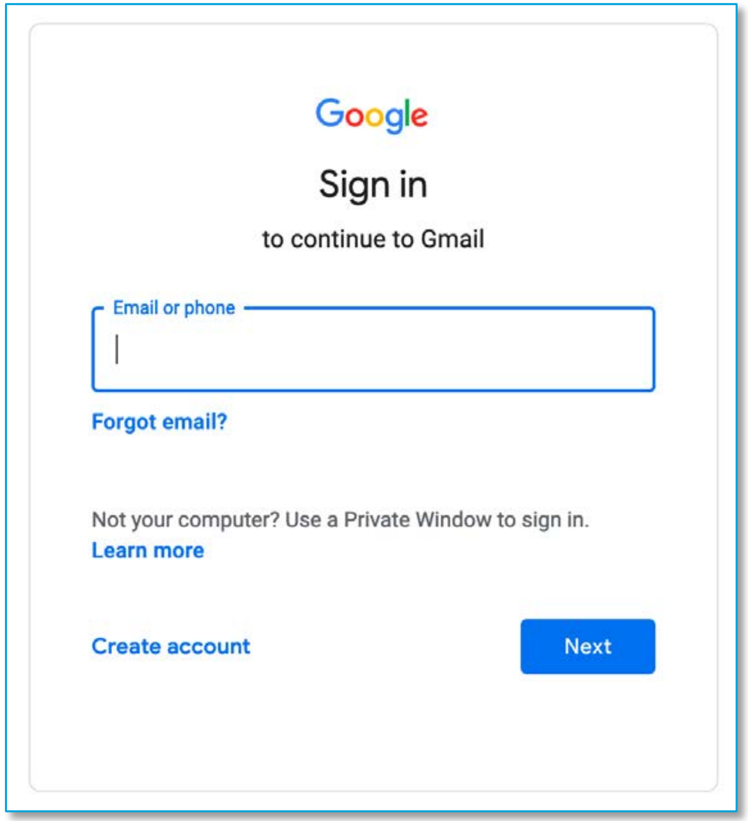
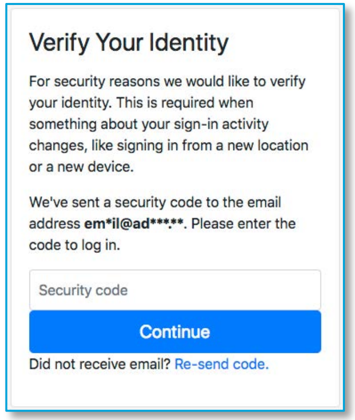


to continue to Gmail

Not your computer? Use a Private Window to sign in.

Deadlock Problem



Verify Your Identity

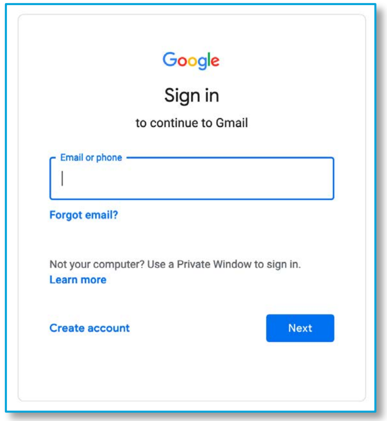
For security reasons we would like to verify your identity. This is required when something about your sign-in activity changes, like signing in from a new location or a new device.

We've sent a security code to the email address **em*il@ad***.****. Please enter the code to log in.

Security code

Continue

Did not receive email? Re-send code.



Google

Sign in

to continue to Gmail

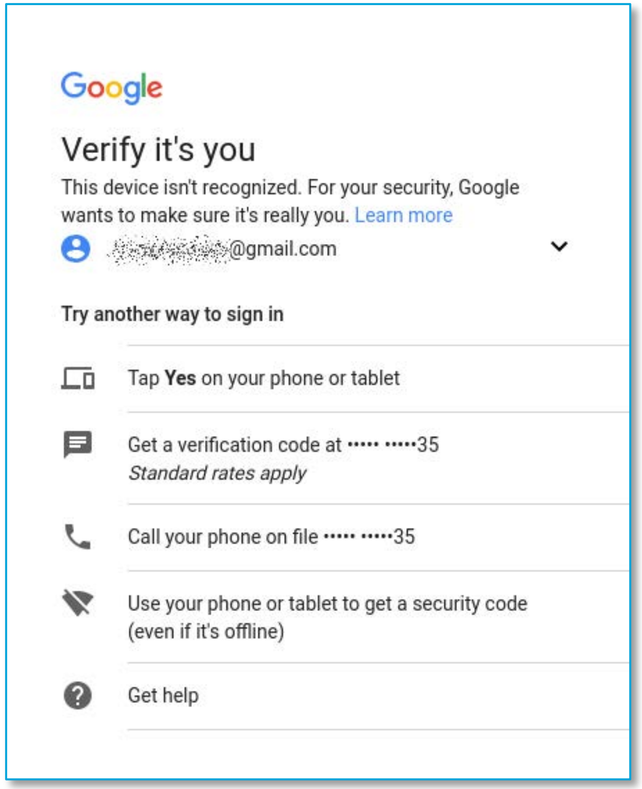
Email or phone

Forgot email?

Not your computer? Use a Private Window to sign in.
Learn more

Create account

Next



Google

Verify it's you

This device isn't recognized. For your security, Google wants to make sure it's really you. Learn more

[redacted]@gmail.com

Try another way to sign in

Tap **Yes** on your phone or tablet

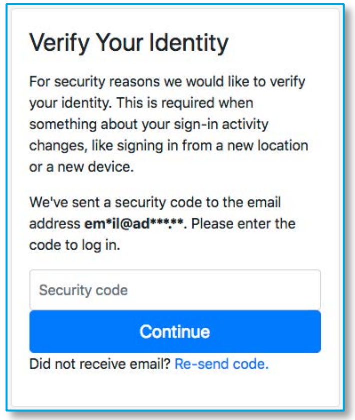
Get a verification code at ••••• •••••35
Standard rates apply

Call your phone on file ••••• •••••35

Use your phone or tablet to get a security code (even if it's offline)

Get help

Deadlock Problem



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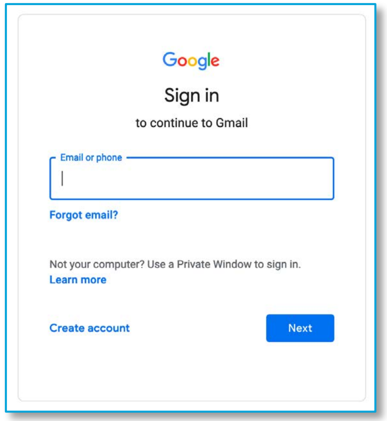
Security code

Continue

Did not receive email? Re-send code.

→



Google

Sign in

to continue to Gmail

Email or phone

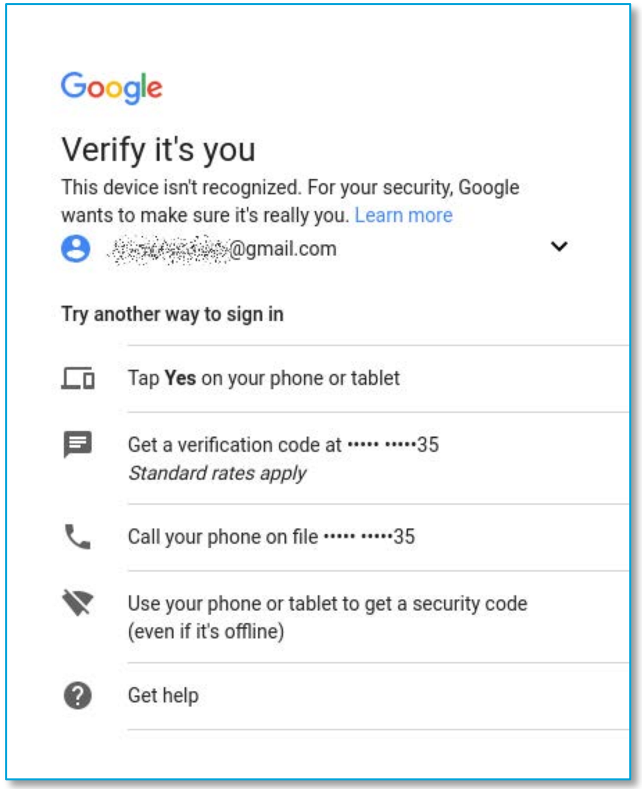
Forgot email?

Not your computer? Use a Private Window to sign in.
Learn more

Create account

Next

→



Google

Verify it's you

This device isn't recognized. For your security, Google wants to make sure it's really you. Learn more

[redacted]@gmail.com

Try another way to sign in

Tap **Yes** on your phone or tablet

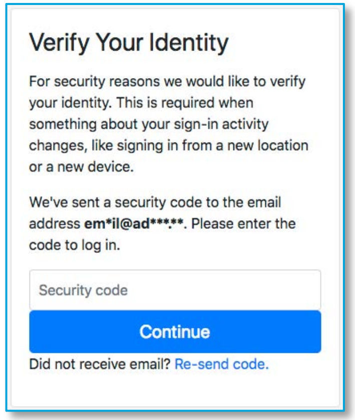
Get a verification code at •••• ••••35
Standard rates apply

Call your phone on file •••• ••••35

Use your phone or tablet to get a security code (even if it's offline)

Get help

Deadlock Problem



Verify Your Identity

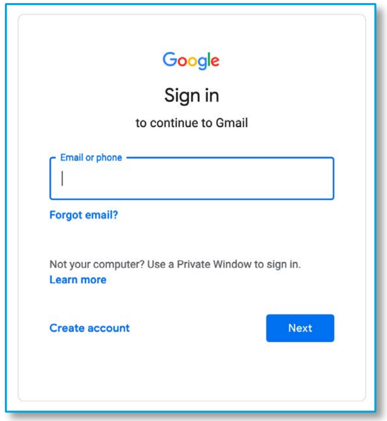
For security reasons we would like to verify your identity. This is required when something about your sign-in activity changes, like signing in from a new location or a new device.

We've sent a security code to the email address **em*il@ad*****.**. Please enter the code to log in.

Security code

Continue

Did not receive email? Re-send code.



Google

Sign in

to continue to Gmail

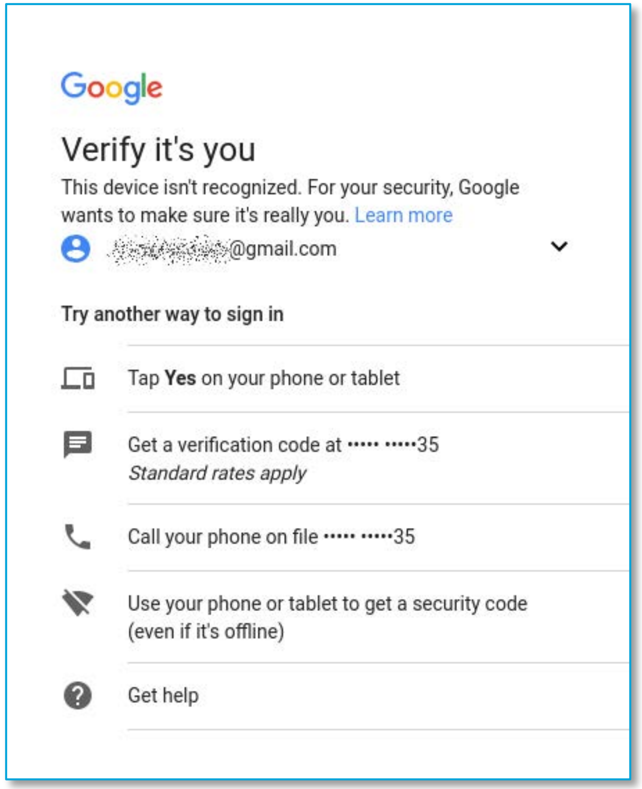
Email or phone

Forgot email?

Not your computer? Use a Private Window to sign in.
Learn more

Create account

Next



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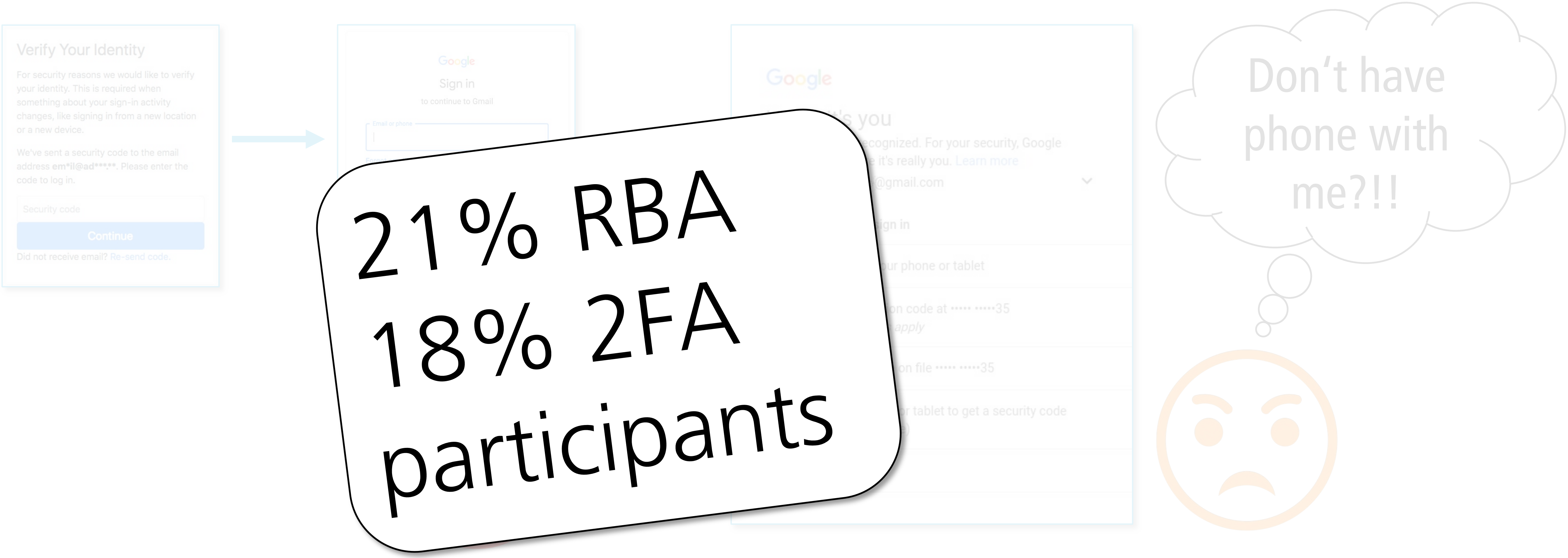

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Security code

Continue

Did not receive email? Re-send code.

Google

Sign in

to continue to Gmail

Email or phone

Google

...'s you

...ecognized. For your security, Google ...e it's really you. Learn more

...@gmail.com

...ign in

...ur phone or tablet

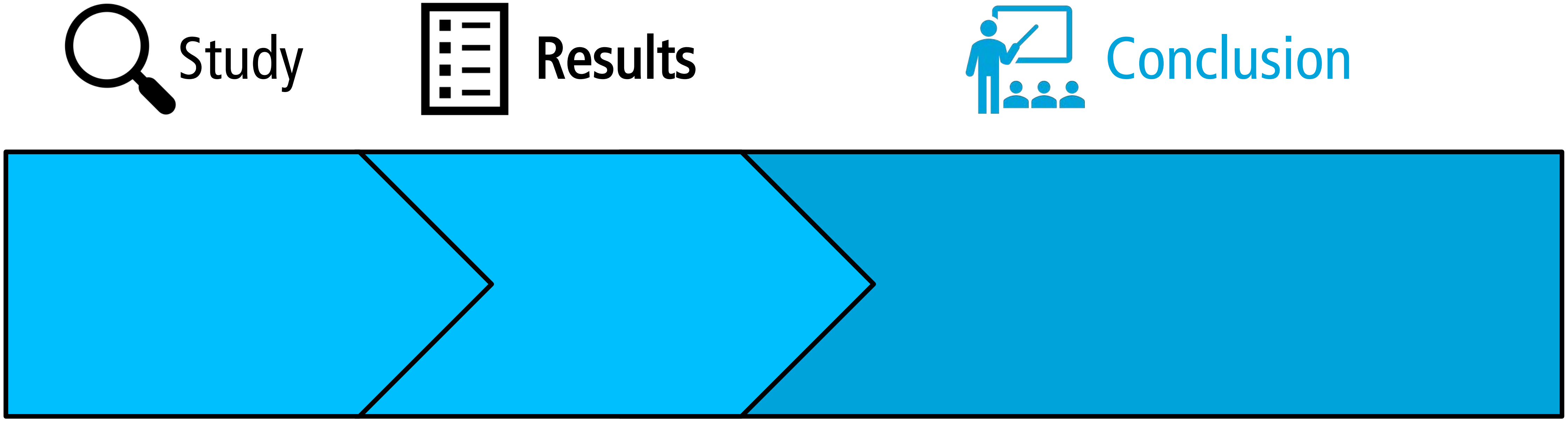
...on code at ••••• •••••35 ... apply

...on file ••••• •••••35

...r tablet to get a security code

21% RBA
18% 2FA
participants

Overview

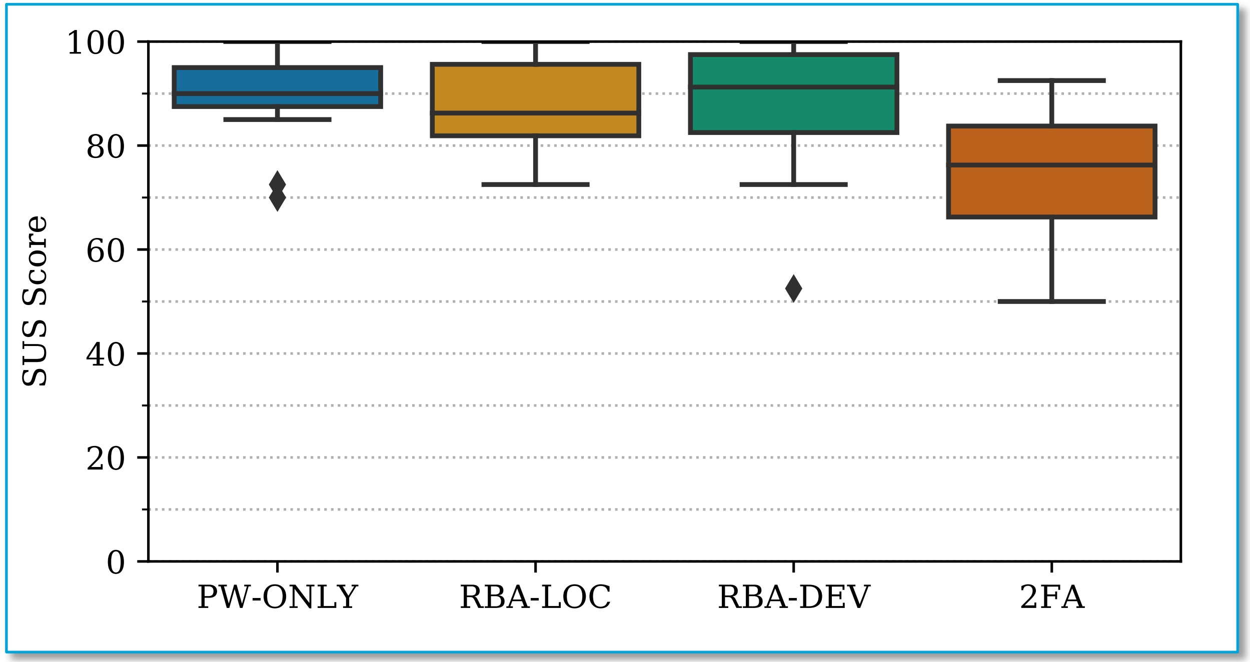


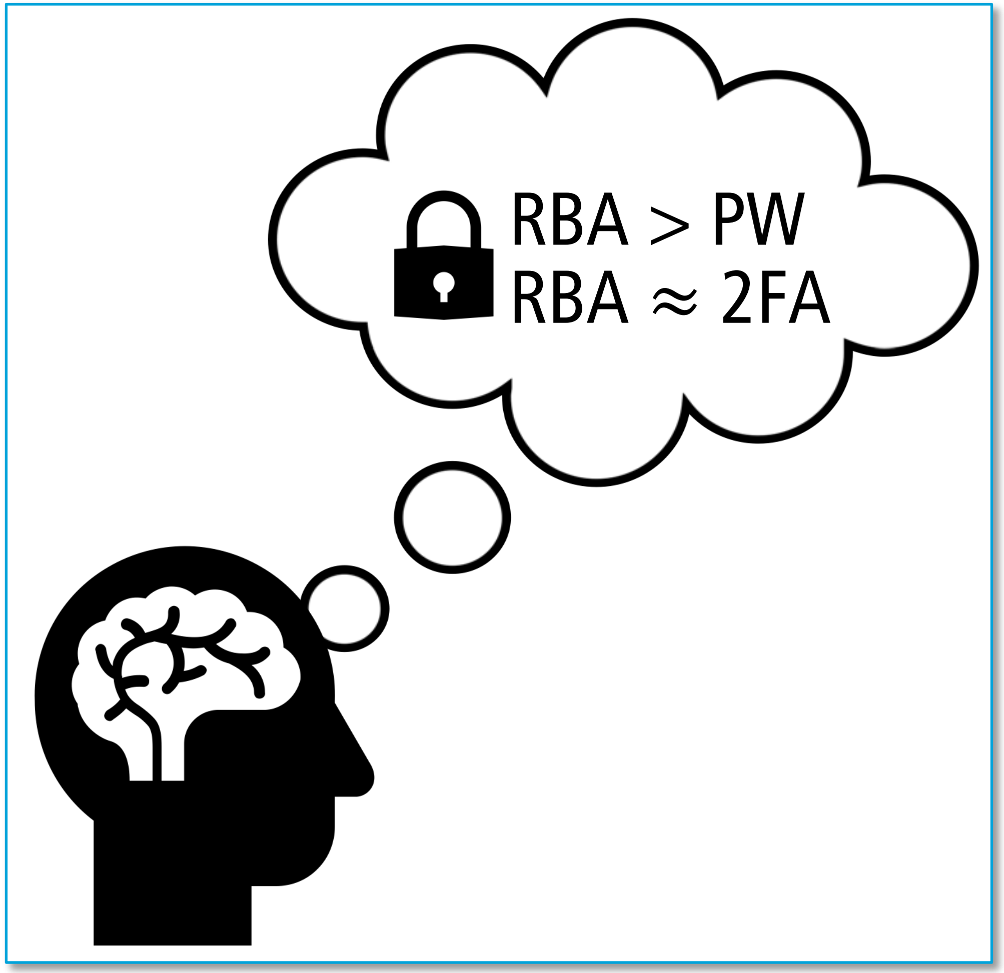
Study

Results

Conclusion

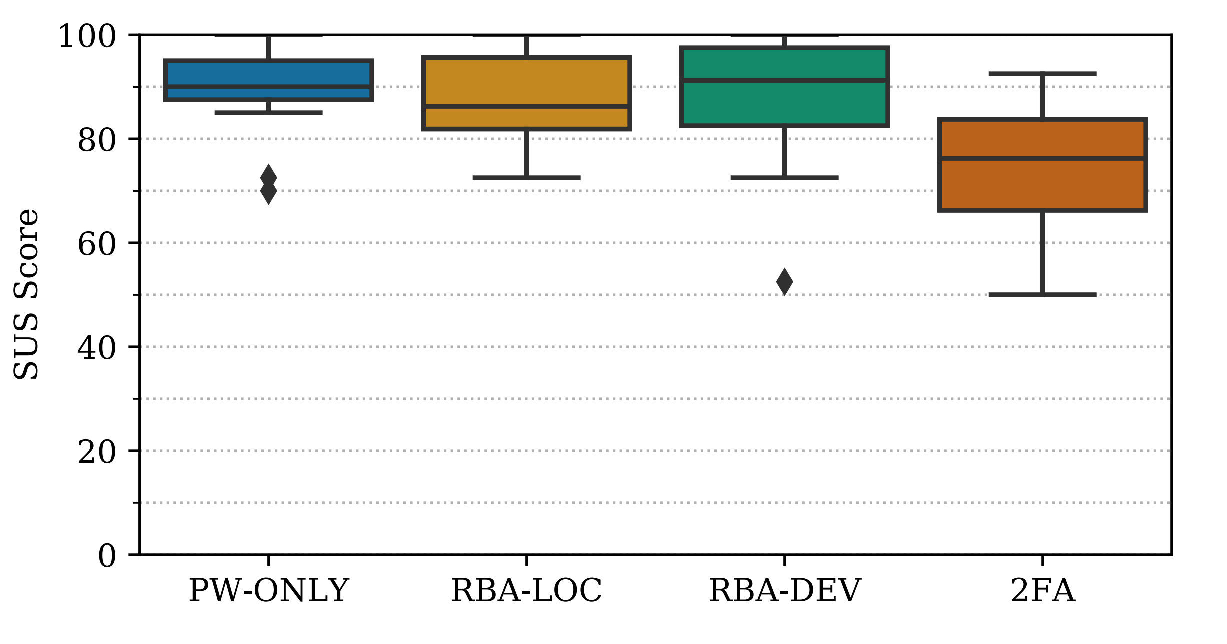
Conclusion





RBA > PW
RBA ≈ 2FA

Conclusion



RBA > PW
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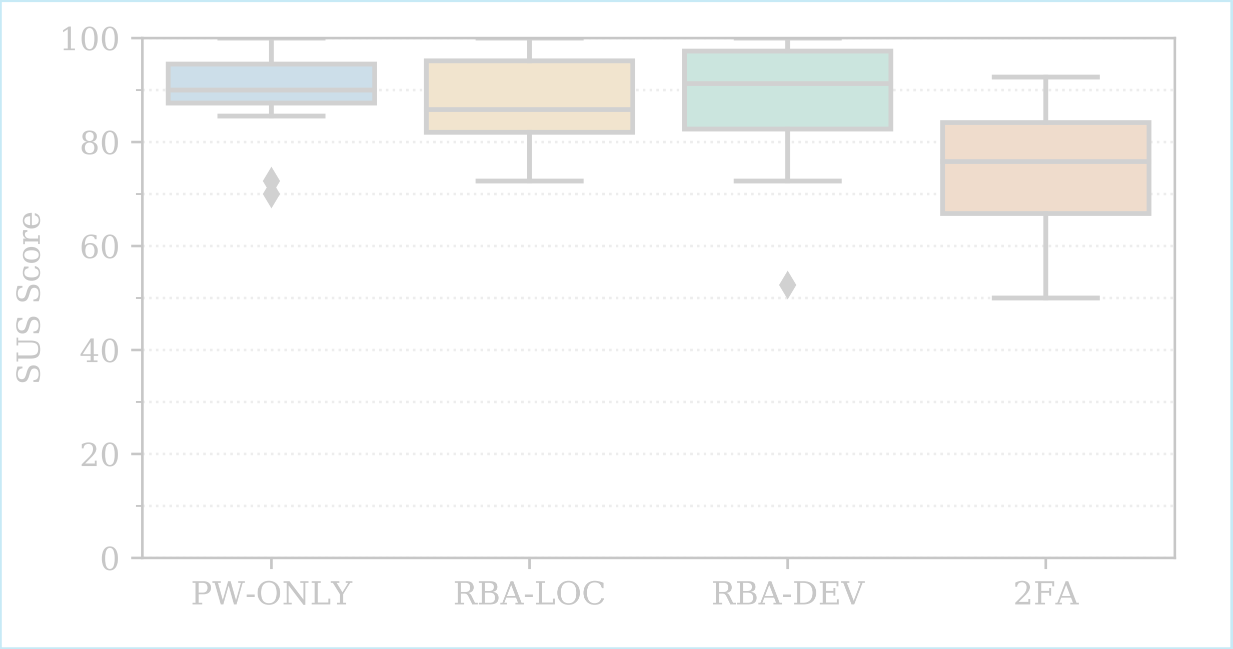
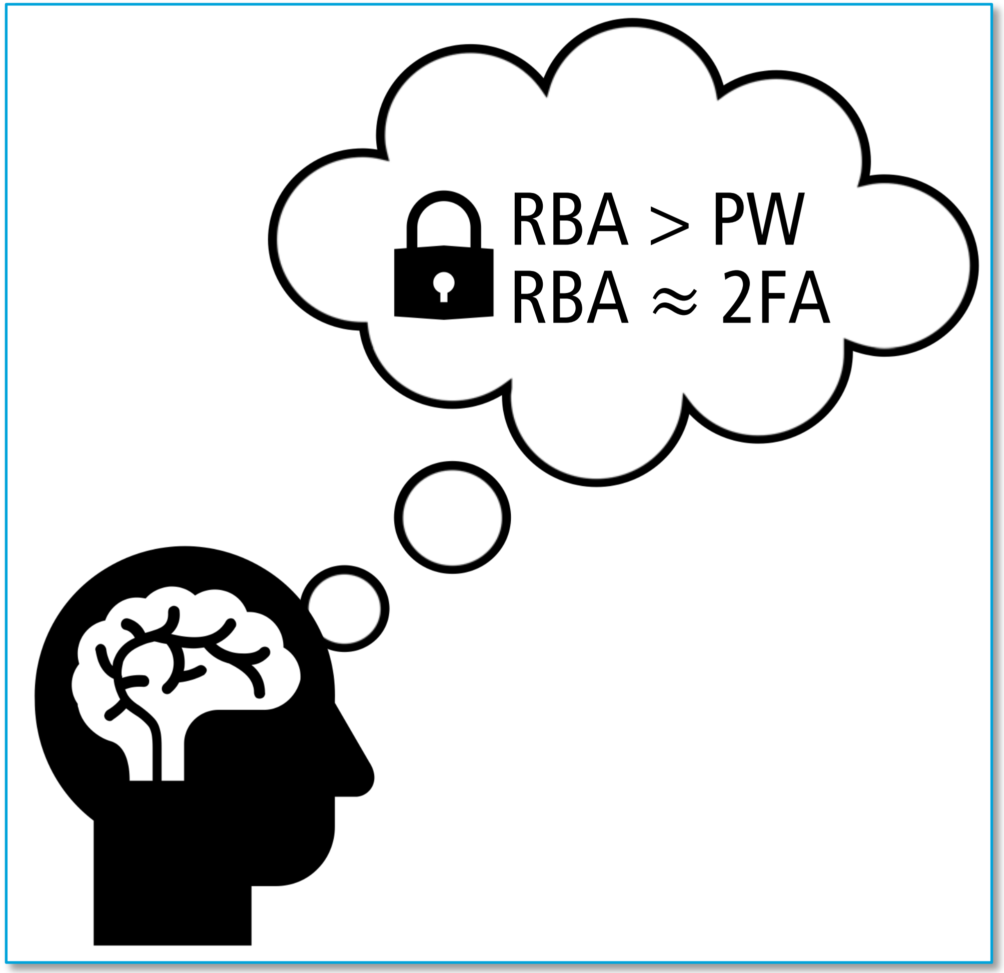
Conclusion





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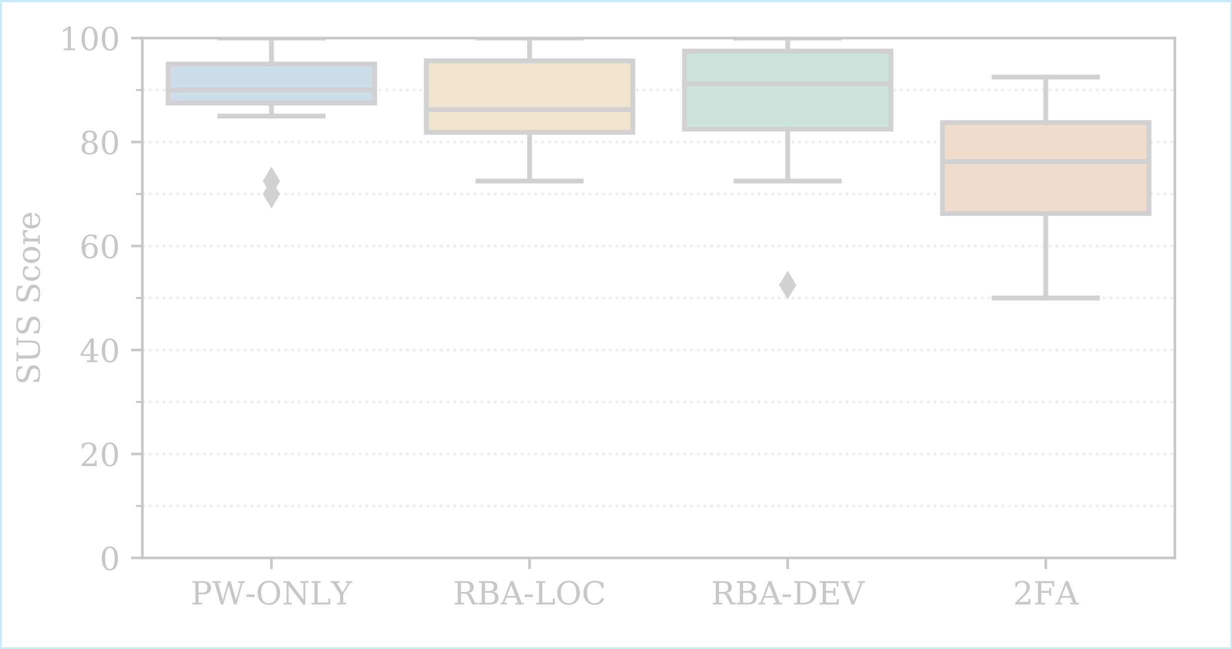
Conclusion



RBA > PW
RBA ≈ 2FA

Conclusion

- Consider RBA on websites with sensitive data involved
  - Exception: Online banking

- RBA using email mostly accepted

- Beware of deadlocks

Thank you

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