



2025

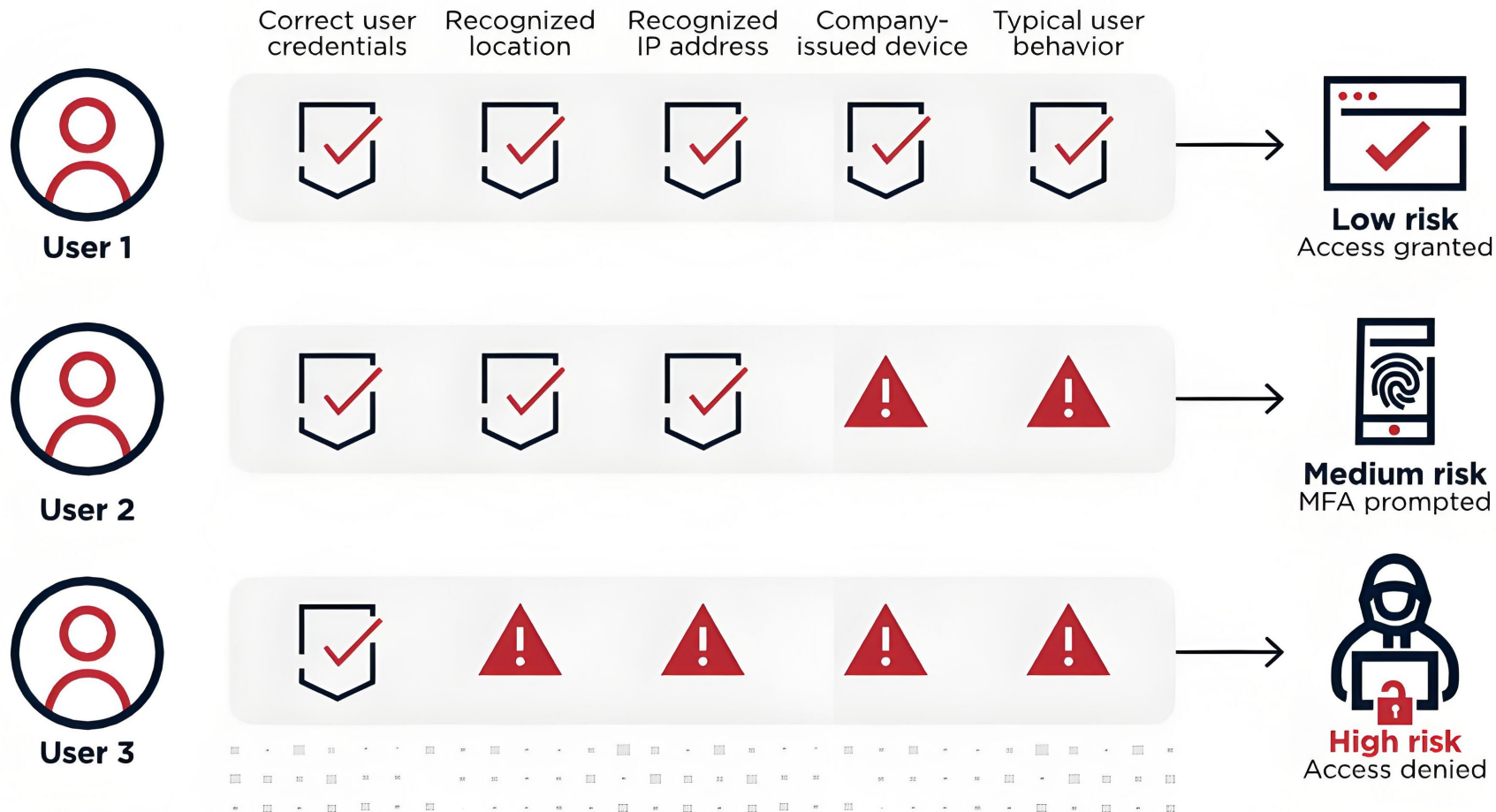


“Who is Trying to Access My Account?” Exploring User Perceptions and Reactions to Risk-based Authentication Notifications

Tongxin Wei, Ding Wang*, Yutong Li and Yuanhuan Wang

College of Cryptology and Cyber Science, Nankai University, Tianjin, China

- Risk-Based Authentication (RBA) boosts security and usability by adjusting authentication based on user behavior and risk.



Motivations

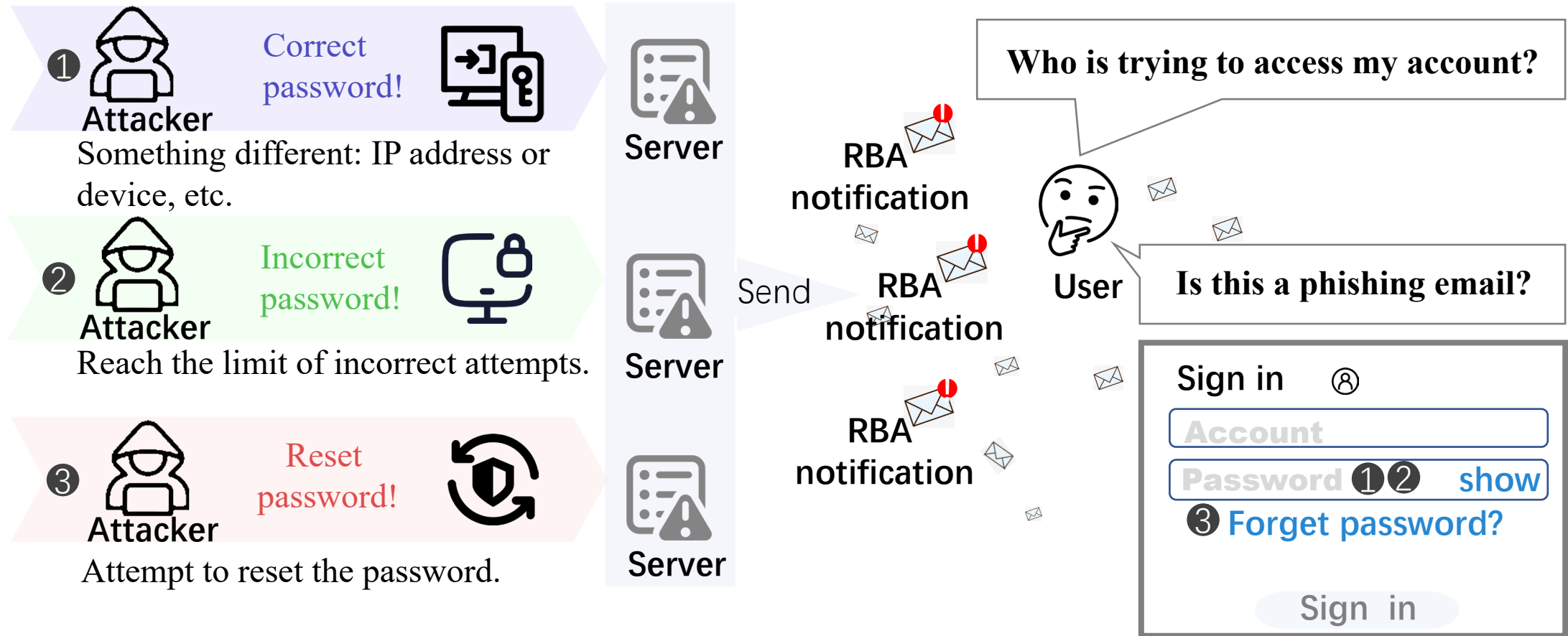
- Users prefer RBA over 2FA, find it more secure than password-only authentication, and perceive its security as comparable to 2FA [1].
- When users attempt suspicious logins, they receive notifications but are not prevented from logging in [2].
- Users often receive identity verification codes that may not be triggered by their actions, causing confusion [3].

[1] Wiefeling, Stephan, Markus Dürmuth, and Luigi Lo Iacono. "More than just good passwords? A study on usability and security perceptions of risk-based authentication." In Proc. ACSAC. 2020.

[2] Markert, Philipp, et al. "Understanding Users' Interaction with Login Notifications." In Proc. CHI. 2024.

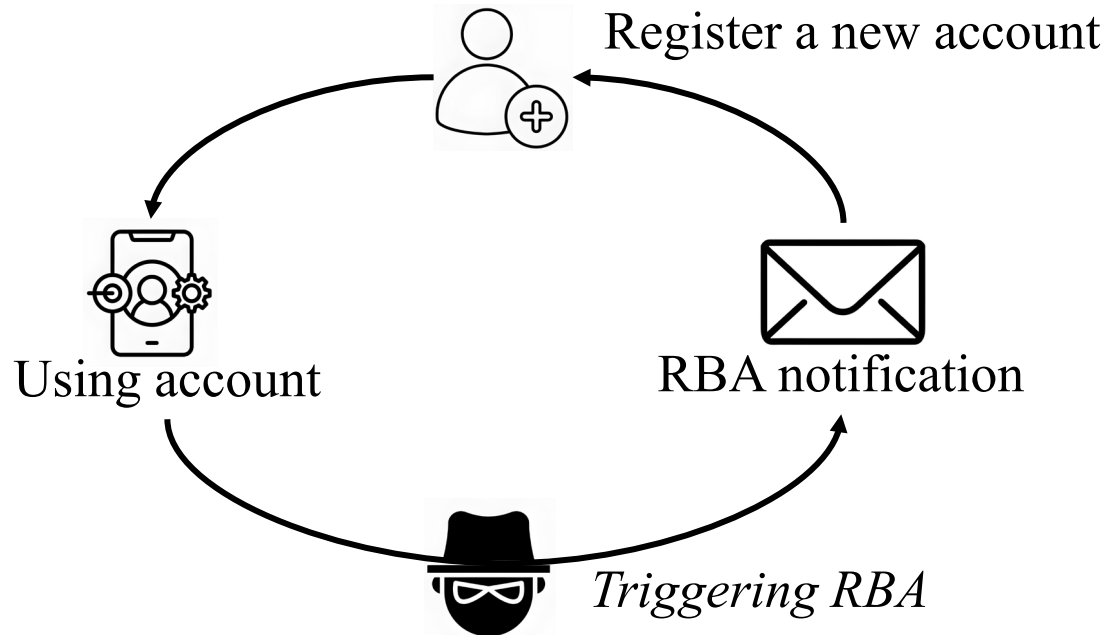
[3] Wu, Tingmin, et al. "What risk? i don't understand. an empirical study on users' understanding of the terms used in security texts." In Proc. Asia CCS. 2020.

- Three types of suspicious access that trigger a Risk-based Authentication (RBA) notification:



Website survey

- To explore the design of RBA notifications, we test websites ranked in the top 5,000 by Tranco as of December 2023. We evaluate 251 websites using three types of suspicious access.



- Create a new account linked to emails and phone numbers to receive RBA notifications.
- Simulate hacker triggered RBA.

Website survey

- RBA notifications alert users to suspicious logins and usually include details like a verification code, time, device, and location.

COMPANY Verification Code

Dear COMPANY Users,

Your COMPANY verification code is: **907749**

Please confirm your sign-in request

We have detected an account sign-in request from a device we don't recognize.

If you did not request this code, it is possible that someone else is trying to access the COMPANY Account rba@gmail.com. **Do not forward or give this code to anyone.**

You received this message because this email address is listed as the recovery email for the COMPANY Account rba@gmail.com. If that is incorrect, please click [here](#) to remove your email address from that COMPANY Account.

Sincerely yours,
The COMPANY Accounts team

COMPANY

Temporary lock out from your COMPANY ID

You are temporarily locked out of your COMPANY ID due to 7 successive login failures. You can attempt to login again in 10 minutes from the time this email was sent.

If you need to reset your password you can request to reset it [here](#).

Any questions about your COMPANY ID, account, organization(s) and subscription(s), can be sent to support.COMPANY.com. We will do our best to reply as soon as possible.

Sincerely,
The COMPANY Accounts team

COMPANY

Reset your password

We have received your password reset requests. Click below to change your ^^ account Password:

[Reset password](#)

Requested from: Chrome browser on
Windows device
Location: Los Angeles, California
IP: 5.34.219.6

User study

➤ Online study and offline interview

Online user study



Users' attitudes

Understandings

Responses

Measures

Offline interview



Users' feelings

Behaviors

Satisfaction scores

Expectations

In this paper, we invite 258 online participants and 15 offline participants to explore users' perceptions, reactions, and expectations for three types of RBA notifications.

User study

➤ Online study and offline interview

Online user study



Users' attitudes

Understandings

Responses

Measures

RQ1: [Feelings and Awareness] What are users' attitudes and feelings towards receiving RBA notifications that are not triggered by themselves? Do these RBA notifications raise users' awareness of potential security risks?

RQ2: [Reactions and Understanding] Is addressing these notifications a priority for them? What actions do users take upon receiving RBA notifications? What do users perceive as the sources of these notifications?

RQ3: [Perceptions and Expectations] What factors can influence users' perceptions and reactions? What key information do participants expect to be included in an RBA notification? Do current RBA notifications meet users' expectations?

User study

➤ Online study and offline interview

Offline interview



Users' feelings

Behaviors

Satisfaction scores

Expectations

Fake email

10 AM

12 PM in the noon

8 PM in the evening

Score

The scores for each component are calculated separately in three different scenarios.

User study

➤ Data analysis

Online user study

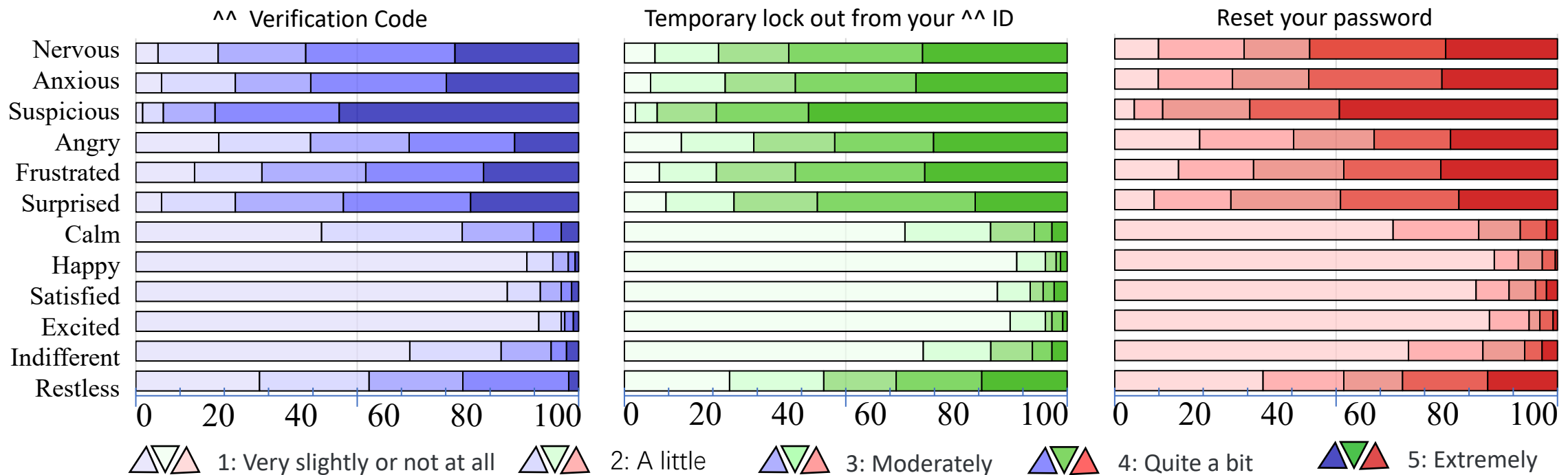
● ○ ○ ○ ○ Likert-scale tests
● ● ○ ○ ○
● ● ● ○ ○ Fisher's exact test
● ● ● ● ○ Pearson's chi-square test
● ● ● ● ●

Offline interview

< / >
Scores
Coding

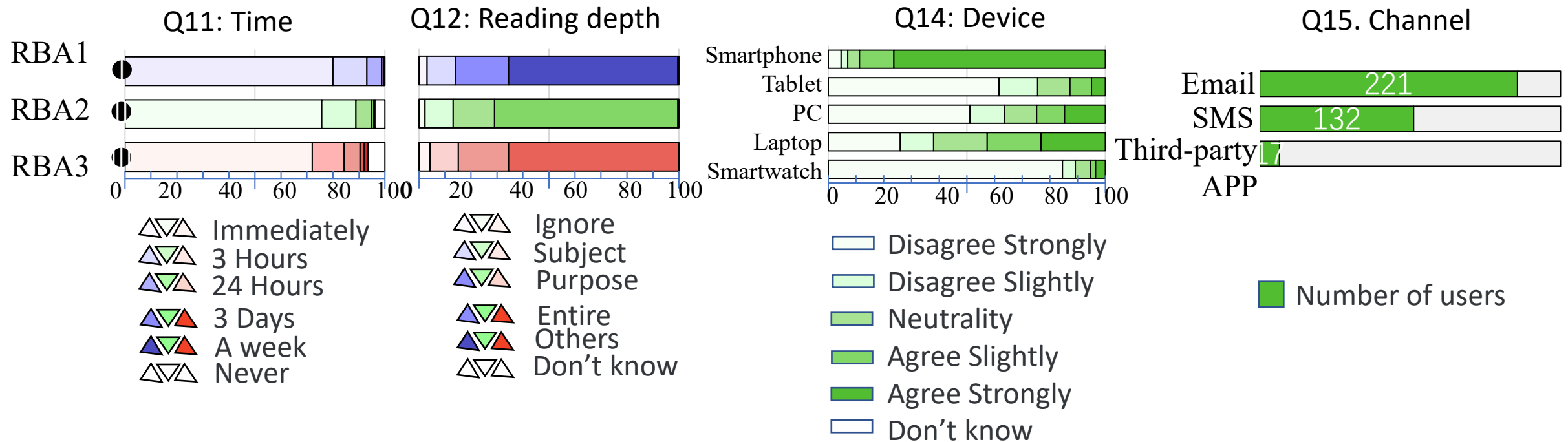
RQ1: Feelings and Awareness

- RBA notifications not triggered by users often elicit negative emotions (e.g., suspicion (81.8%), anxiety (60.5), nervousness (61.6%), and surprise (53.1%)), with no significant differences in feelings toward the three types.



RQ2: Reactions and Understanding

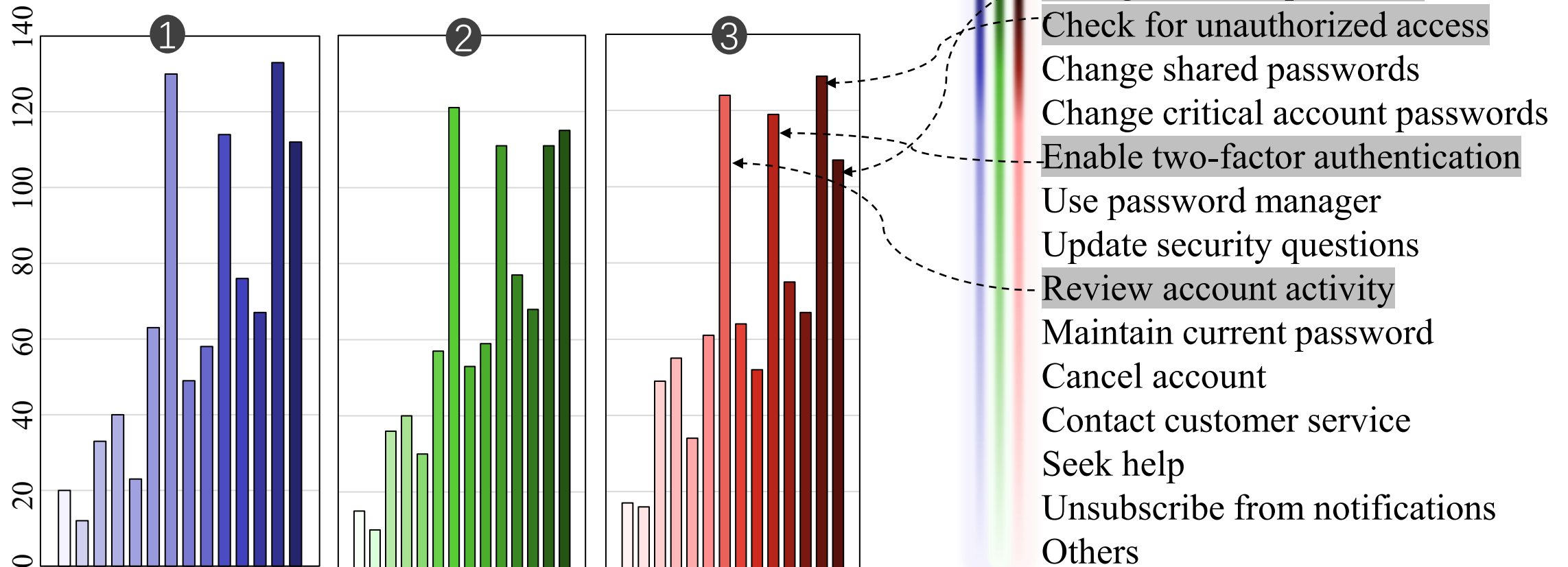
- Most participants immediately read RBA notifications in full, especially if they view RBA notifications as beneficial.



RQ2: Behaviors



- Most participants follow the instructions in RBA notifications, but distrust and skepticism still persist.



RQ3: Perceptions and Expectations

- The design of RBA notification content and the presentation of metadata significantly influence users' perception of a crisis.

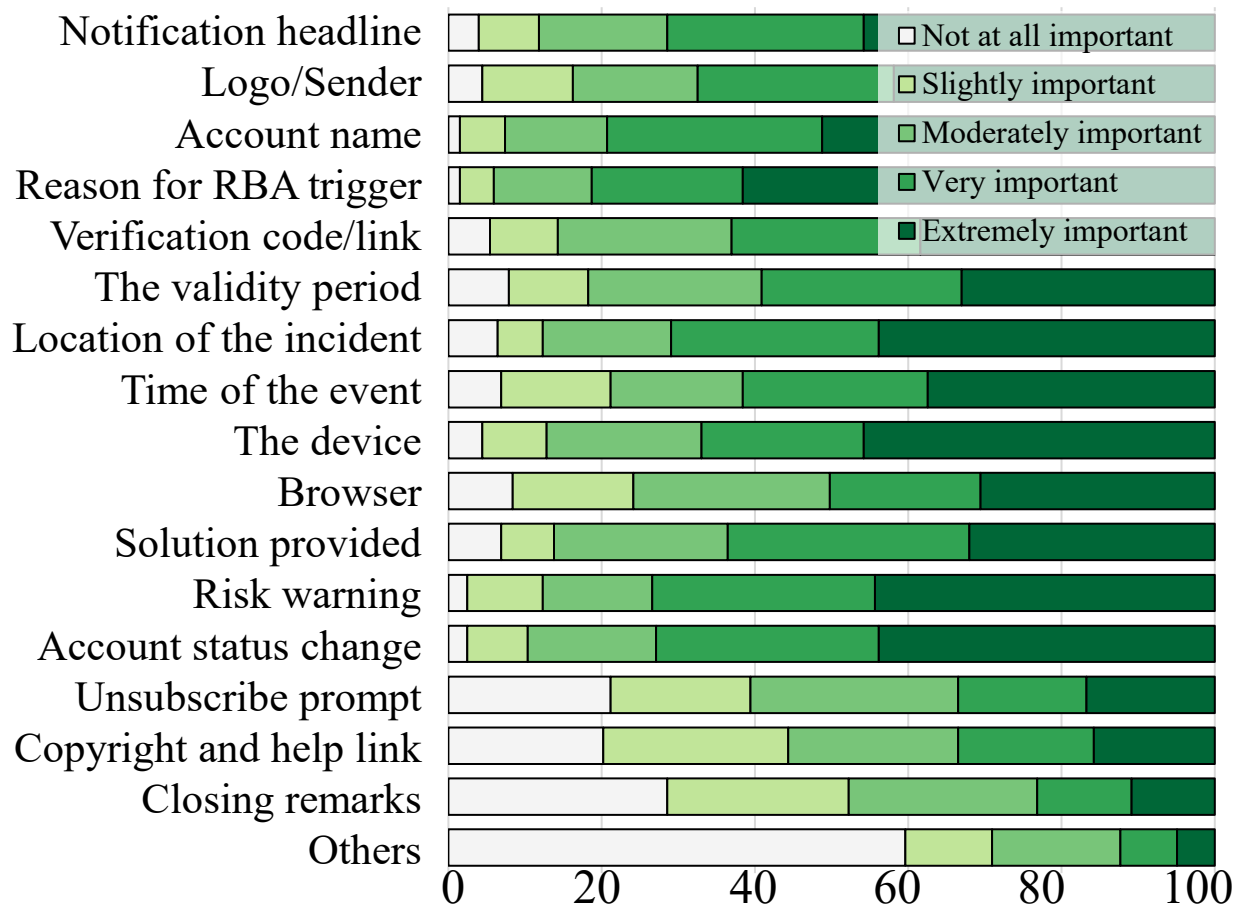


TABLE IV. SATISFACTION SCORES FOR RBA NOTIFICATIONS.*

Types	Rank	Website	Score I	Rank	Website	Score II
Correct password	16	Cloudflare	3.66	1	Google	4.7
	53	Adobe	3.14			
	128	Namecheap	4.75			
	645	Samsung	4.5	14	LinkedIn	4.67
	1054	Constantcontact	4.4	53	Adobe	3.1
	1075	Expedia	3.5			
	2170	GoG	4			
Incorrect password	144	Unity3D	4.25	2497	LastPass	4.55
	2098	Espncdn	3.38			
	2170	GoG	3.86	144	Unity3D	3.98
	2333	Instacart	3.8			
	2497	LastPass	4.33	2333	Instacart	3.3
	2763	Newegg	3.67			
Forget password	16	Cloudflare	3.2	191	Elsevier	3.2
	48	UI	4.11			
	53	Adobe	3.75	144	Unity3D	3.5
	63	Zoom	4.33			
	191	Sciencedirect	4.25	48	UI	4.3
	214	Cisco	3.6			

*The score is the average rating, with 5 being the highest score. A value shaded in light grey indicates the top three scores from the first evaluation. **Bold values** highlight the top scores from the second evaluation.

RQ3: Perceptions and Expectations

- Most users ignore RBA notifications triggered by someone other than themselves.

TABLE V. OFFLINE INTERVIEWEE'S RESULTS.*

No.	Feelings	Time	Read	Behaviors	Device
010	😊	🕒	☑	⌂	📱
012	😞	🕒	☑	✅	📱
020	😊	🕒	☑	⌂	📱
021	😞	🕒	☑	⌂	📱
022	😊	🕒	☑	✅	📱
023	😞	🕒	☑	✅	📱
024	😞	🕒	☑	✅	📱
025	😞	🕒	☒	⌂	📱
026	😊	🕒	☒	⌂	📱
027	😞	🕒	☑	⌂	📱
028	😊	🕒	☑	⌂	📱
029	😞	🕒	☑	✅	📱
030	😞	🕒	☑	✅	📱
031	😞	🕒	☑	⌂	📱
032	😞	🕒	☑	⌂	📱

Four participants show indifference towards RBA notifications. **Six** participants feel confused. **Three** participants feel nervous. **One** participant feels sad about reset password notifications.

Regarding how they check RBA notifications:

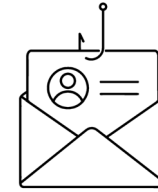
Nine out of fifteen participants check notifications after a long delay. **Six** participants scan the email briefly and mark it as spam. **Two** participants have email filters that automatically block these notifications. **Two** participants ignore the email, thinking it wasn't triggered by their actions. **One** participant deletes the email, suspecting phishing.

Regarding devices:

Thirteen participants use mobile phones to check the notifications. **Two** participants use a computer.

New sights

- RBA notifications or phishing emails



Participants prefer viewing RBA notifications sent via email on their smartphones.

- The time, location, and device used to receive RBA notifications may affect how users respond to them.



2025



Thank you!

Tongxin Wei, Ding Wang*, Yutong Li and Yuanhuan Wang
College of Cryptology and Cyber Science, Nankai University, Tianjin, China



Homepage



email



Ding Wang



Full paper



Homepage



WeChat



email



Tongxin Wei

Feel free to contact us!



wangding@nankai.edu.cn



weitongxin@mail.nankai.edu.cn