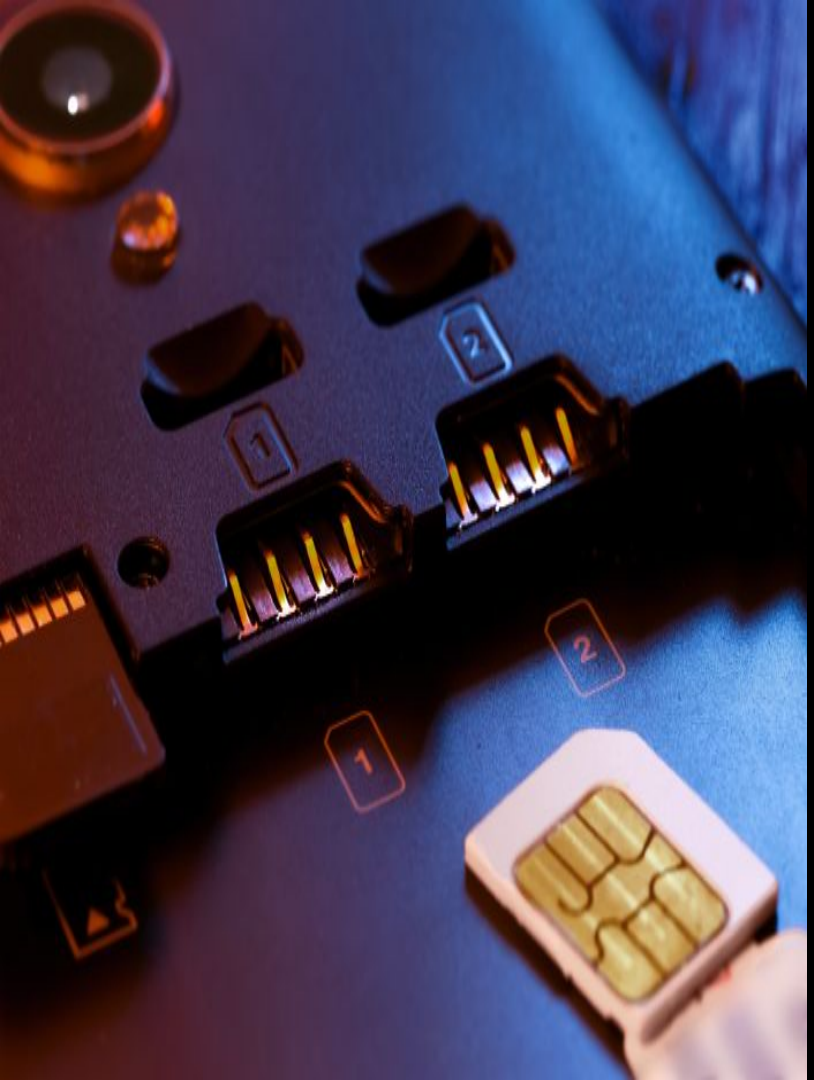


Mind the SIM: Awareness and Mental Models in a South Korean Case Study

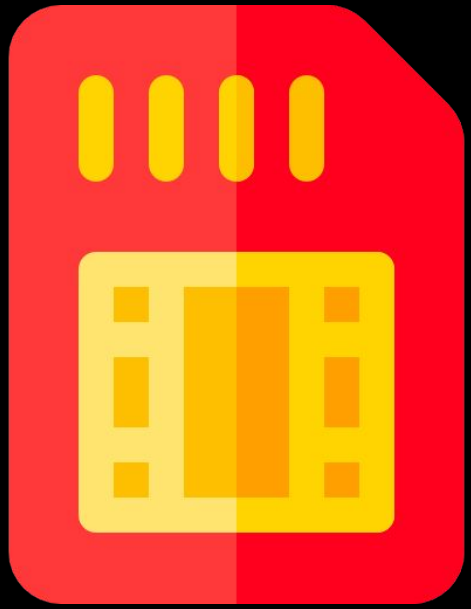
Hyunsoo Lee, Seyoung Jin
Hyoungshick Kim, Uichin Lee

Background: The SIM may be a tiny chip, but it is a critical security backbone

SIM (Subscriber Identity Module)

1. Identity
   - Identifies you on the network
   - Links phone number to device
2. Authentication
   - Stores secure credentials
   - Enables OTP verification
3. Connectivity
   - Connects to mobile network
   - Enables communication

SIM CARD CONNECTS:



IDENTITY

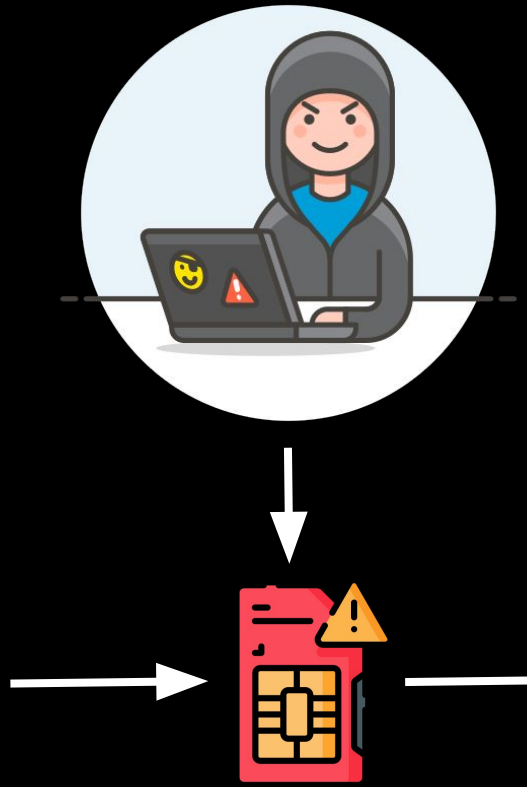
DEVICE

SERVICES (Bank, Apps)

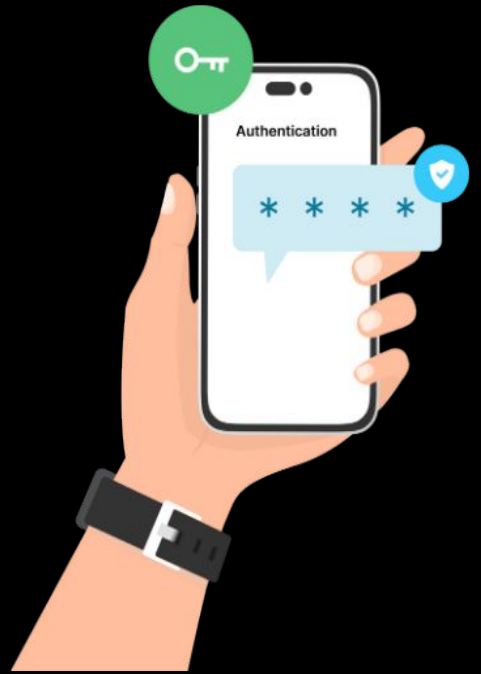
Background: What happens when the SIM is compromised?

SIM Swapping

NO SERVICE



MOBILE CARRIER



Motivation: SKT SIM Data Breach (2025)

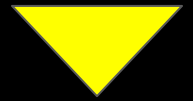
SK Telecom users' USIM data leaked in cyberattack

- South Korea’s largest telecom provider, SK Telecom (SKT), was breached
- Exposure of SIM authentication data affecting ~23 million users (~50% of the population)
- Leaked data included SIM identifiers (IMSI) and authentication keys (Ki)
- Carrier response: SIM replacement and additional security measures

BUT HOW DO USERS ACTUALLY MAKE SENSE OF THIS?

Large-scale breach

Critical security risk



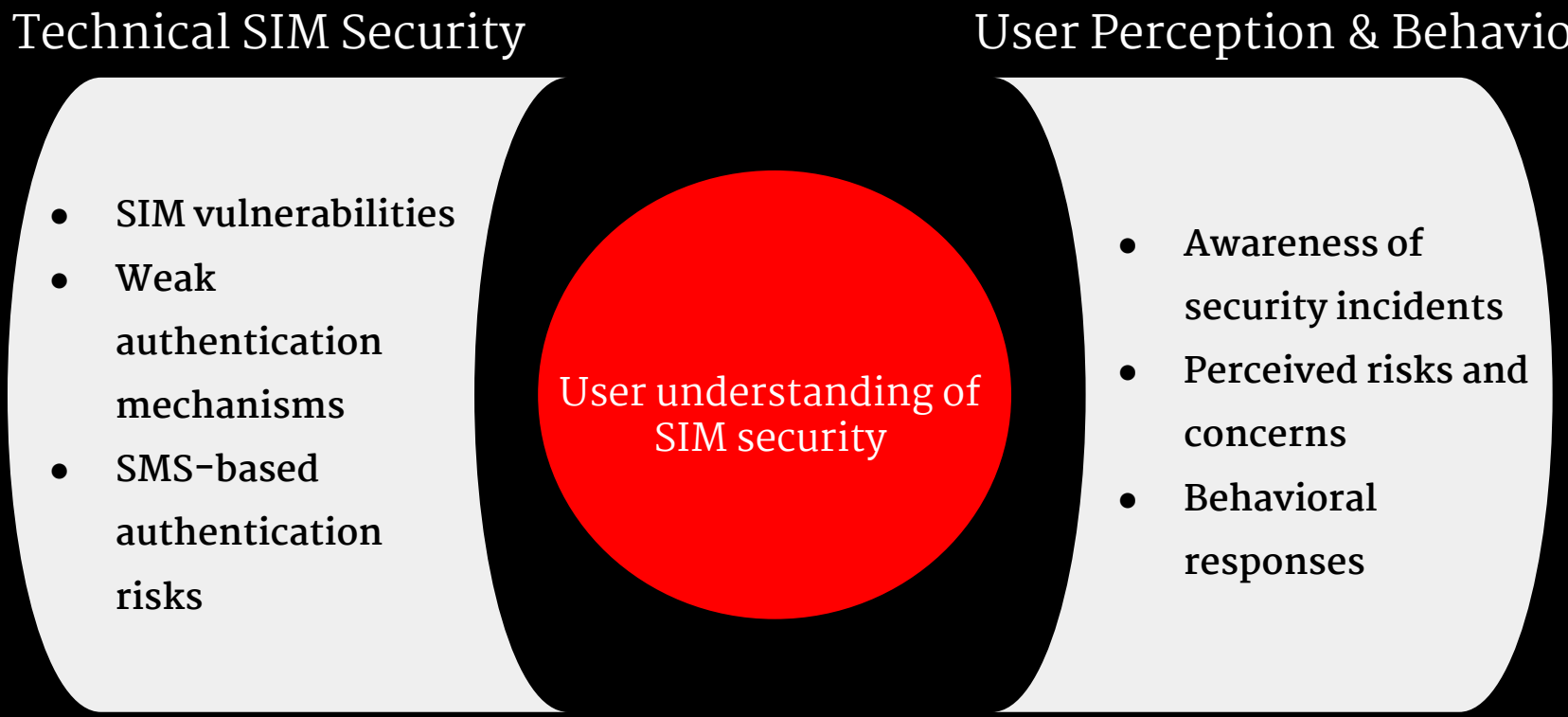
Do users understand what was exposed?

Do they realize the risks?

Do they take action?

A highly visible breach, rooted in an invisible infrastructure

Motivation: The missing piece – User Mental Model



SIM operates as a “black box” for users

Research Questions

Understand how users perceive, interpret, and respond to SIM security incidents

RQ1: **[Awareness]** How do users perceive the SKT SIM authentication key breach and understand the associated risks and impacts?

RQ2: **[Response]** How do users respond emotionally and behaviorally to the SIM security incident, and how do these responses differ between directly affected and unaffected individuals?

RQ3: **[Mental Model]** How do users conceptualize the operation of SIM cards and SIM-based authentication in everyday smartphone use?

Research Overview

Participants

- N = 33
- SKT / non-SKT
- Age: 20s–60s

Method

- Semi-structured interviews
- Drawing task
- Post-session reflection

Analysis

- Thematic analysis
- Mental models: Low / Mid / High

Participant Details

- **N = 33 participants**
- **Carriers**: SKT (17), non-SKT (16)
- **Age**: 20s–60+
- **SIM replacement (SKT users)**: 9 / 17

Demographics

- Gender-balanced
- Diverse education levels

Technology background

- Mostly non-CS
- Few with IT/security experience

Devices & SIM

- Android & iOS mix
- Physical SIM + eSIM

Research Questions

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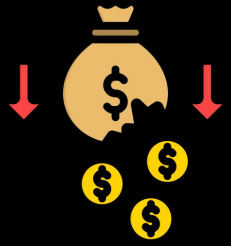
RQ3: **[Mental Model]** How do users conceptualize the operation of SIM cards and SIM-based authentication in everyday smartphone use?

Results (RQ1-1): Users lack understanding, but perceive risks

Understanding	Risk Perception
• “SIM ”= just a hack • Unaware of SIM functions • Could not explain what was exposed	• Financial loss • Identity theft • Personal / work / family risks

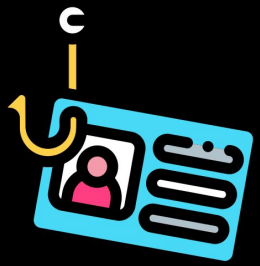
Risks are interpreted through familiar frames, not SIM understanding

Results (RQ1-1): Users lack understanding, but perceive risks



"*If whatever the thing called SIM gets hacked, somebody's going to take my money away.*" - P9 (SKT)

"*Smartphones are basically your identity card across apps… If that gets stolen? I don't even want to think about it.*" - P13 (non-SKT)



"*What if my hacked phone reaches out to my kids?*" - P22 (non-SKT)

Results (RQ1-2): Perceived risk does not lead to high concerns

Helplessness

Low data value

Safety Insensitivity

Trust

Limited Understanding

Research Questions

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RQ3: **[Mental Model]** How do users conceptualize the operation of SIM cards and SIM-based authentication in everyday smartphone use?

Results (RQ2-1): Trust varies, but personal relevance remains low

Low Trust

"*I don't know if just changing the SIM is really a solution. This wasn't some outside attack. It was a backdoor inside the system.*" - P12 (SKT)

"*This didn't happen because something was wrong with my SIM. It happened because the company failed to manage SIMs properly.*" - P16 (non-SKT)

High Trust

"*I trust them a lot. They're a big company. They give more data and discounts because of the accident.*" - P21 (SKT)

"*I'd feel safer with the physical SIM replacement. At least I can see it being done.*" - P27 (non-SKT)

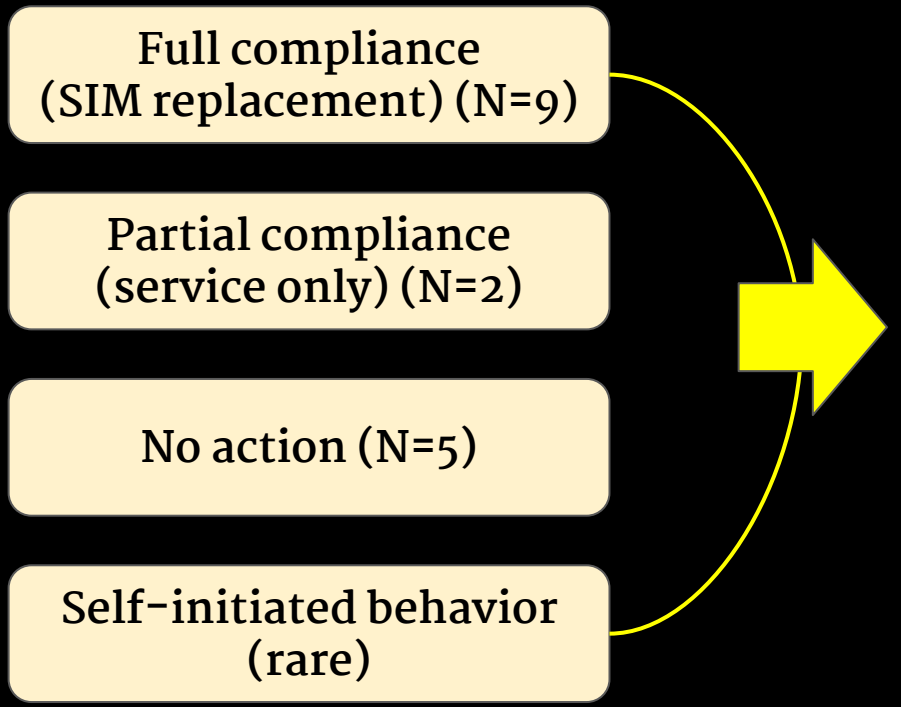
Results (RQ2-1): Trust varies, but personal relevance remains low

Affected users (SKT)	Non-affected users (non-SKT)
• Detached response • "Not me" perspective • Incident normalized	• Mixed attachment & detachment • Often redirected to others (e.g., family)

"*When I first received the message that my data was breached, I thought, 'Oh, okay.' It happens all the time to everyone, and I'm not the one hackers would target.*" - P2 (SKT)

"*I use LG U+, so at first I didn't pay much attention to the news. But my mom uses SKT, so I felt like I had to do something.*"
- P10 (non-SKT)

Results (RQ2-2): Users take action, but rarely take initiative



- Driven by cost, effort, convenience
- Fatigue / indifference
- Lack of visible threat
- Follow carrier guidance

Research Questions

Understand how users perceive, interpret, and respond to SIM security incidents

RQ1: **[Awareness]** How do users perceive the SKT SIM authentication key breach and understand the associated risks and impacts?

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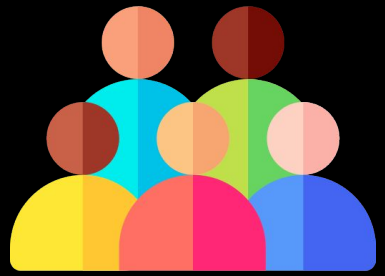
RQ3: **[Mental Model]** How do users conceptualize the operation of SIM cards and SIM-based authentication in everyday smartphone use?

Results (RQ3-1): People know SIM matters, but don't understand it

"It's necessary to activate a mobile phone. I don't really know what information it contains, but I assume it must include some personal information, since it's required for phone activation." – P19 (non-SKT)



Moderate understanding (N = 17) Low comprehension (N = 9) Accurate model (N = 7)

Results (RQ3-2): Diverse mental models of SIMs in practice

Call process

High-Level Understanding (N = 6)

"The signal is delivered to the telecom operator via SIM, then passed through the base station and finally to the recipient's phone." - P1 (SKT)

Mid-Level Understanding (N = 18)

"I don't think any other information is transmitted. Probably just the voice signal." - P10 (non-SKT)

Low-Level Understanding (N = 9)

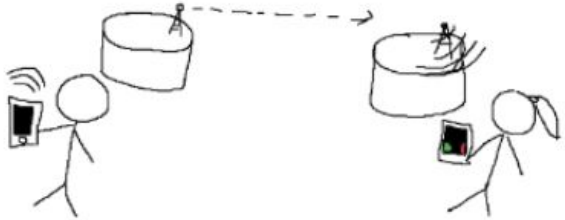
"The SIM in my ear absorbs the signals and delivers them to the brain. That way we communicate." - P21 (SKT)

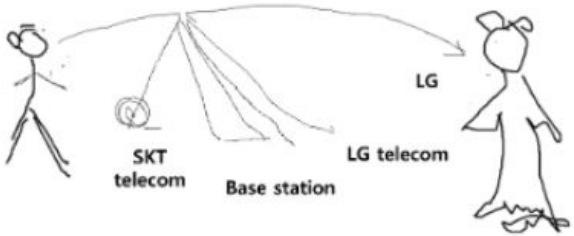
Results (RQ3-2): Diverse mental models of SIMs in practice

Call process

High-Level Understanding (N = 6)

"The signal is delivered to the telecom operator via SIM, then passed through the





(a) High level (P1) (b) Medium level (P10) (c) Low level (P21)

Low-Level Understanding (N = 9)

"The SIM in my ear absorbs the signals and delivers them to the brain. That way we communicate." - P21 (SKT)

Results (RQ3-2): Diverse mental models of SIMs in practice

🔐 Authentication

High-Level Understanding (N = 6)

"I submit my info to the bank, and then they rely on the mobile carrier to send me a one-time code through SMS. That code isn't generated by the bank itself but delivered via my SIM, so when I enter it back, the bank can verify both my identity and that I have access to my registered phone." - P29 (non-SKT)

Mid-Level Understanding (N = 16)

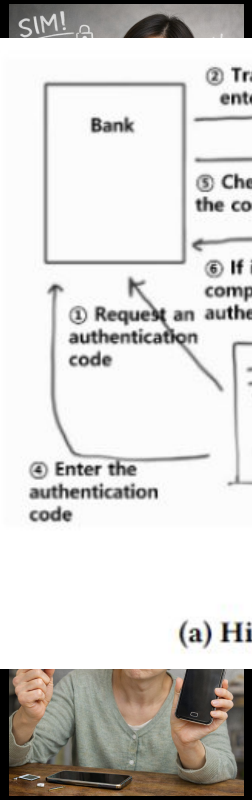
"I think there's a department at a bank fully dedicated to authentication. . . they issue and verify the code." - P2 (SKT)

Low-Level Understanding (N = 11)

"This is authentication done on the site, so it is possible without a SIM" - P26 (non-SKT)

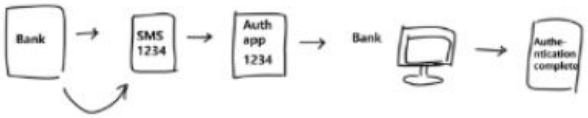
Results (RQ3-2): Diverse mental models of SIMs in practice

🔐 Authentication



High-Level Understanding (N = 6)

(a) High level (P29)



(b) Medium level (P2)

(c) Low level (P26)

"*This is authentication done on the site, so it is possible without a SIM*" - P26 (non-SKT)

Results (RQ3-3): Understanding SIM security without behavioral change

Upon seeing instruction video on SIM functionality…

Learning (Understanding)

What changed?

- 20 / 33 learned new information
- Misconceptions corrected
- Risk perceived as more serious

Action (Behavior)

What didn't change?

- 8 / 20 → no intention to act
- Limited behavior change overall
- Responsibility shifted to carriers

Learning ↑ ≠ Action ↑

Discussion: Phone Number as Digital Identity, but Limited Protection Awareness

Finding

- Phone number = **digital identity** (banking, authentication)
- Users aware of **financial / identity risks**

BUT

- “SIM = just hacked”
- **Shallow understanding**
- **Low personal action**

Low personal relevance, Reliance on carriers, Limited action

Discussion: Connect identity use to concrete security risks

Implication

#1. Focus on specific knowledge gaps and real-world relevance for education

#2. Use everyday scenarios (banking, messaging, OTP)

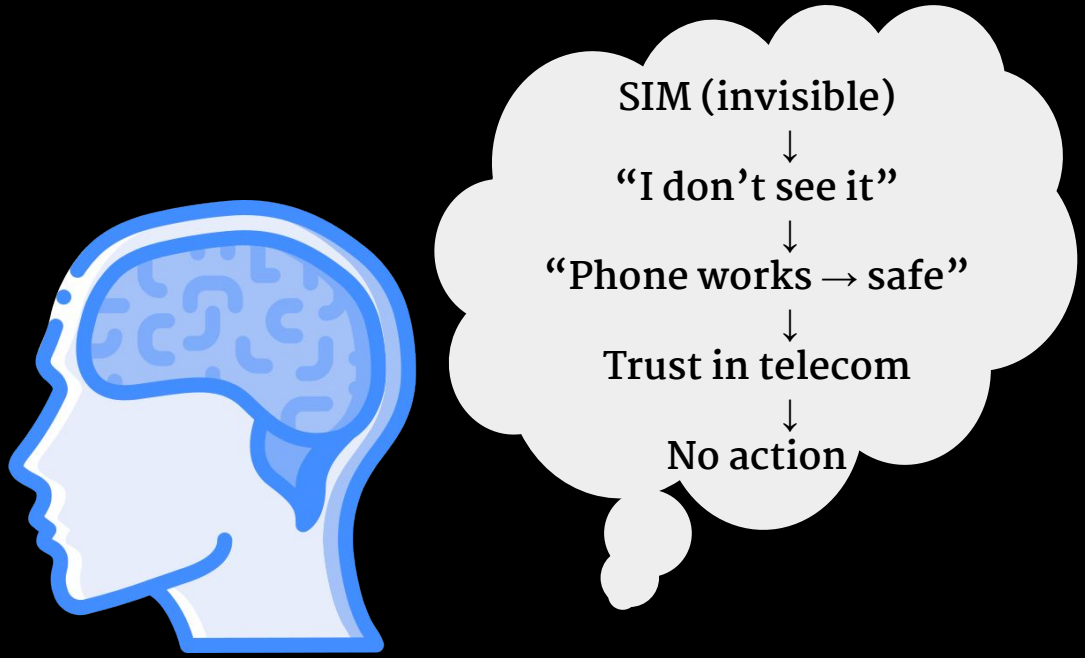
#3. Reflective framing + just-in-time nudges

#4. Cultural and social context adaptation

Explain SIM in ways that connect directly to everyday risks

Discussion: SIM as invisible infrastructure, default trust

Finding



Invisible systems lead to passive trust, not active protection

Discussion: Perceptible security touchpoints

Implication

#1. Make security perceptible at key interaction moments, not continuously

#2. Support functional understanding, not technical transparency

#3. Surface invisible authentication events to recalibrate user expectations

Make invisible authentication processes perceptible at the moment they happen

Mind the SIM: Key Takeaways

- **Awareness ≠ Action**

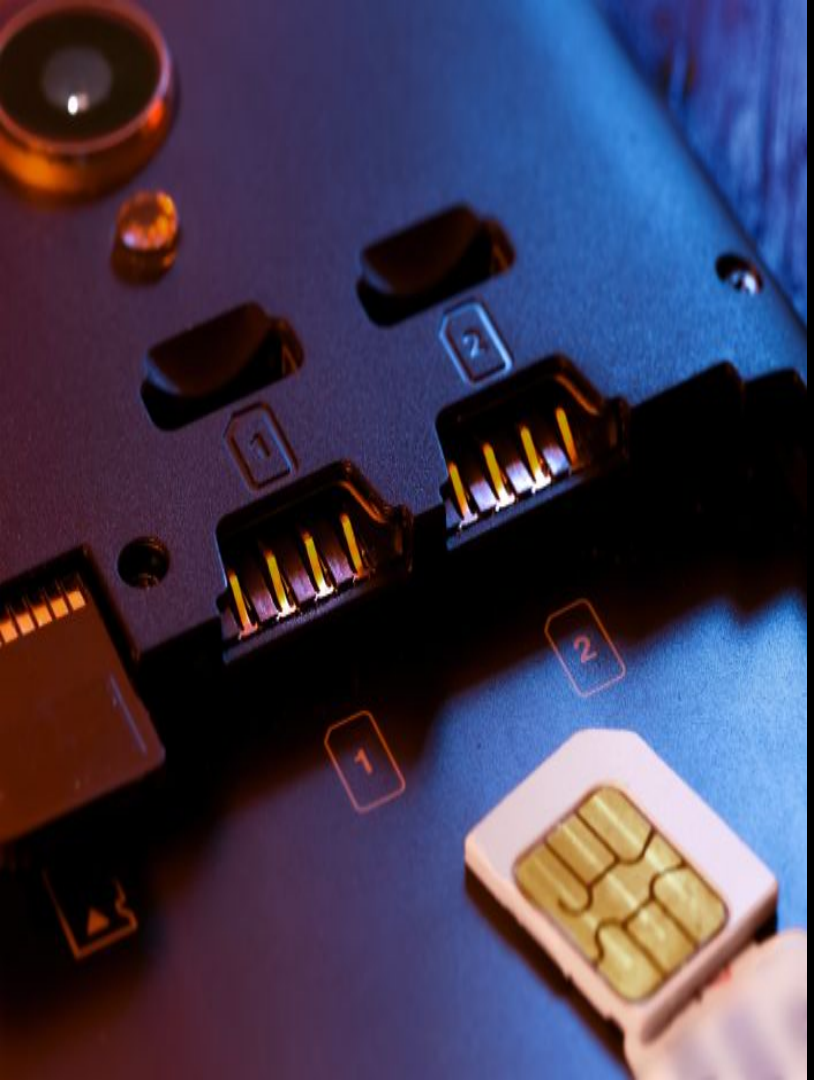
  → Users recognize risk, but rarely act
- **Shallow mental models**

  → SIM = “black box”, misunderstood or invisible
- **Perceived low personal relevance**

  → “Not me”, reliance on carriers
- **Invisible security → passive behavior**

  → “Phone works = safe” illusion

Make invisible security perceptible at the right moments



CHI'26

Mind the SIM: Awareness and Mental Models in a South Korean Case Study

Paper

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