Investigating Security Indicators for Hyperlinking Within the Metaverse

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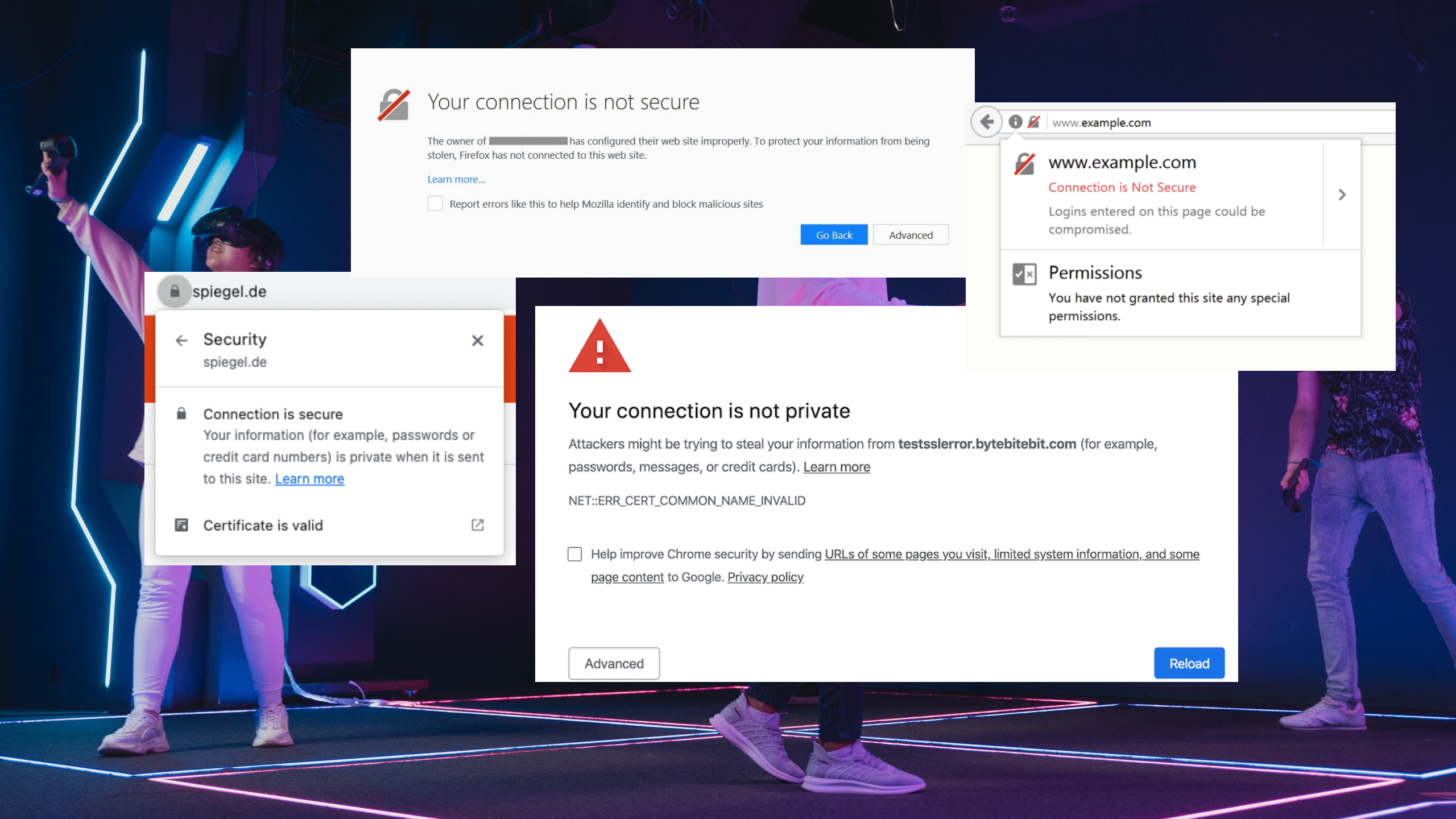
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Research Questions

RQ1	What are the general design dimensions for security indicators in the metaverse?
RQ2-5	Which security indicators are the most **effective**, **usable**, have the best **notification qualities** and which would participants **like to use** in their daily VR experience?

Method

Study I:
Expert Interviews (RQ1)

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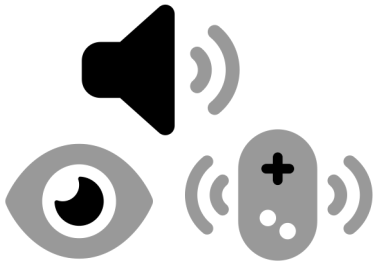
Result I:
Design Dimensions for Indicators



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Study II:
Lab Study with Users (RQ2-5)

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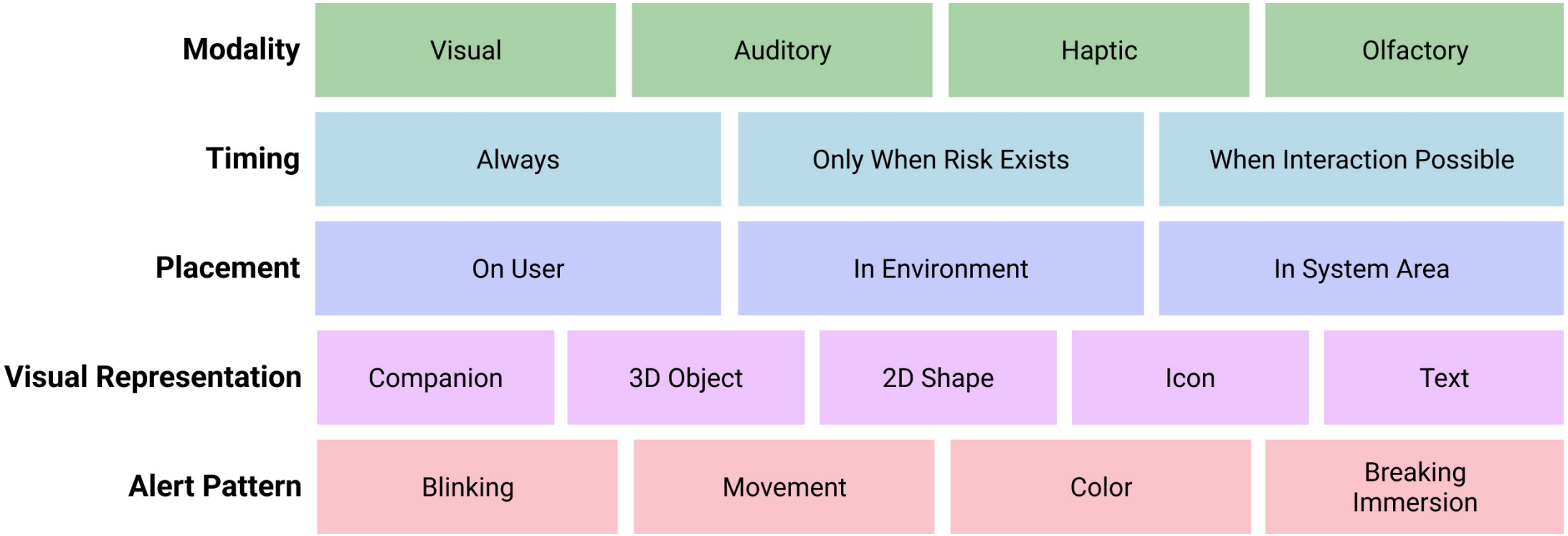
Result II:
Set of Evaluated Security Indicators

Study I: Expert Interviews

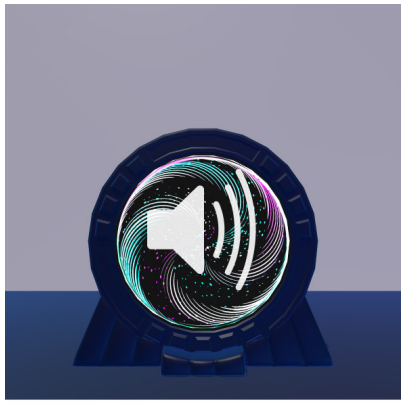
- 8 participants with 3+ years of experience with VR and security
- Presentation of established indicators and methods of attracting attention in VR
- Discussion of novel indicators for VR focusing on the different parameters, form factors, and functionalities
- Analyzed with thematic analysis

Results I: Design Space



Results I: Indicator Selection

Selection Criteria: Only one modality (i.e., sense) at a time and each modality at least once



Auditory | When Interaction Possible

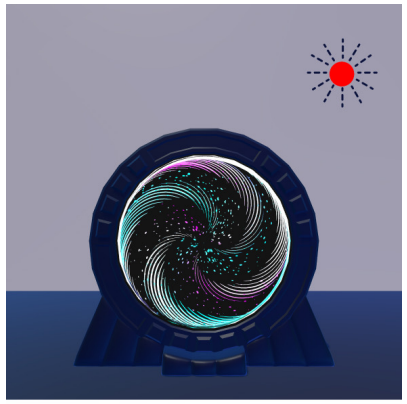
Breaking Immersion

Audio

Haptic | When Interaction Possible

Breaking Immersion

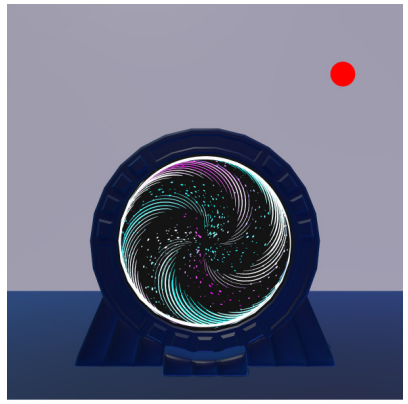
Haptic



Visual | When Interaction Possible

On User | 2D Shape | Blinking | Color

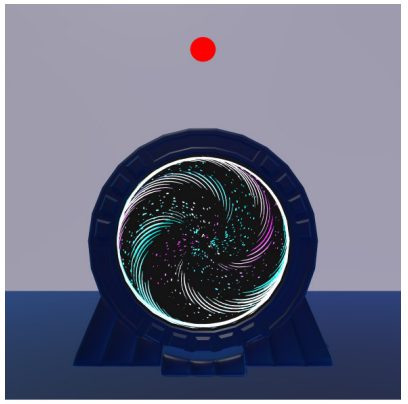
Blinking



Visual | When Interaction Possible

On User | 2D Shape | Color

Peripheral



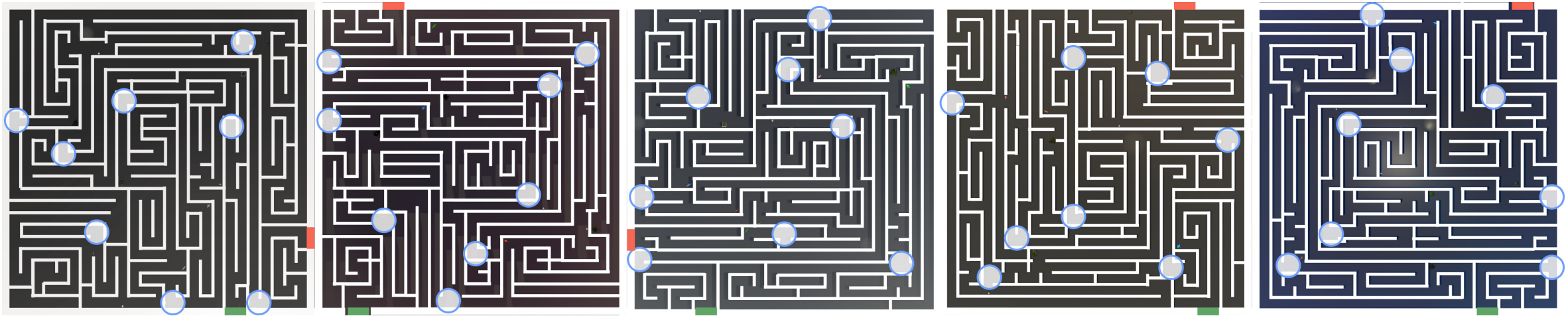
Visual | When Interaction Possible

2D Shape | In Environment | Color

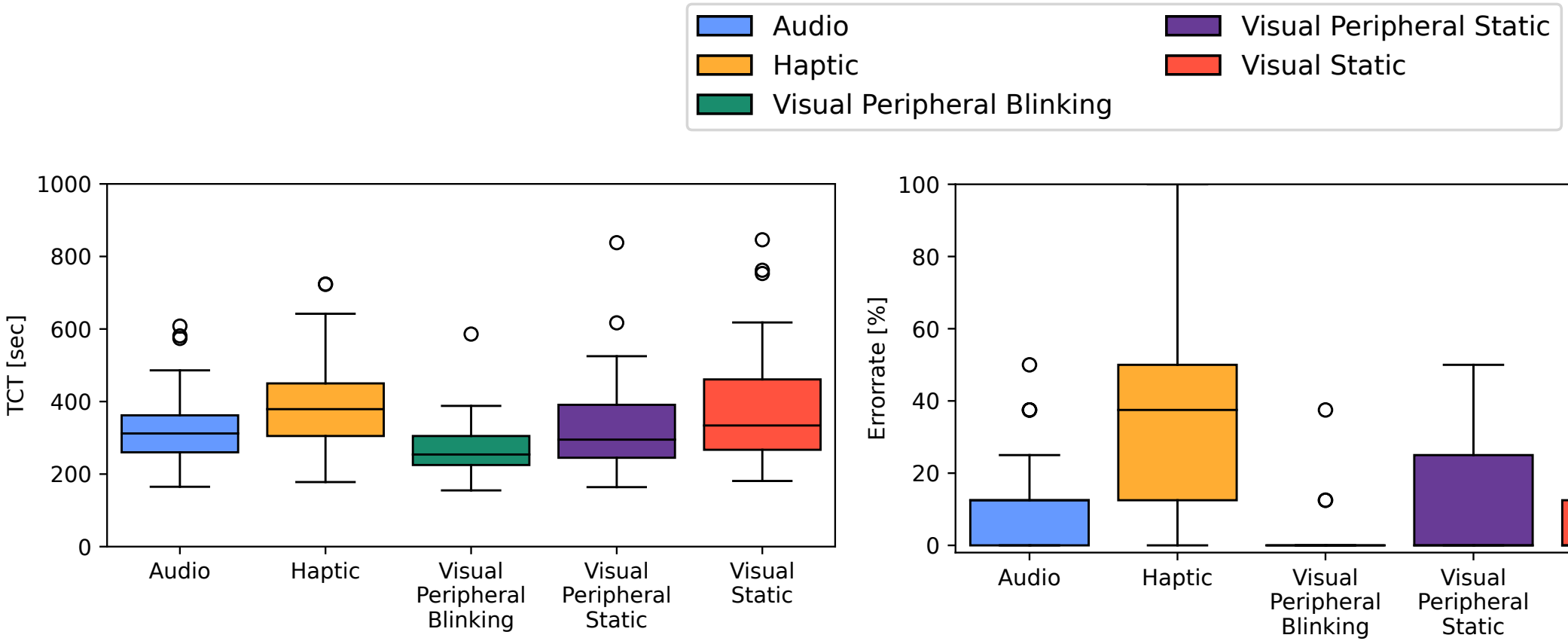
Static

Study II: Lab Study

- Maze VR game (N=25) to simulate security-relevant decisions in VR
- Goal: Finding the exit as quickly and with as many points as possible
- 4 secure (+10 points) and 4 insecure (-10 points) optional portals



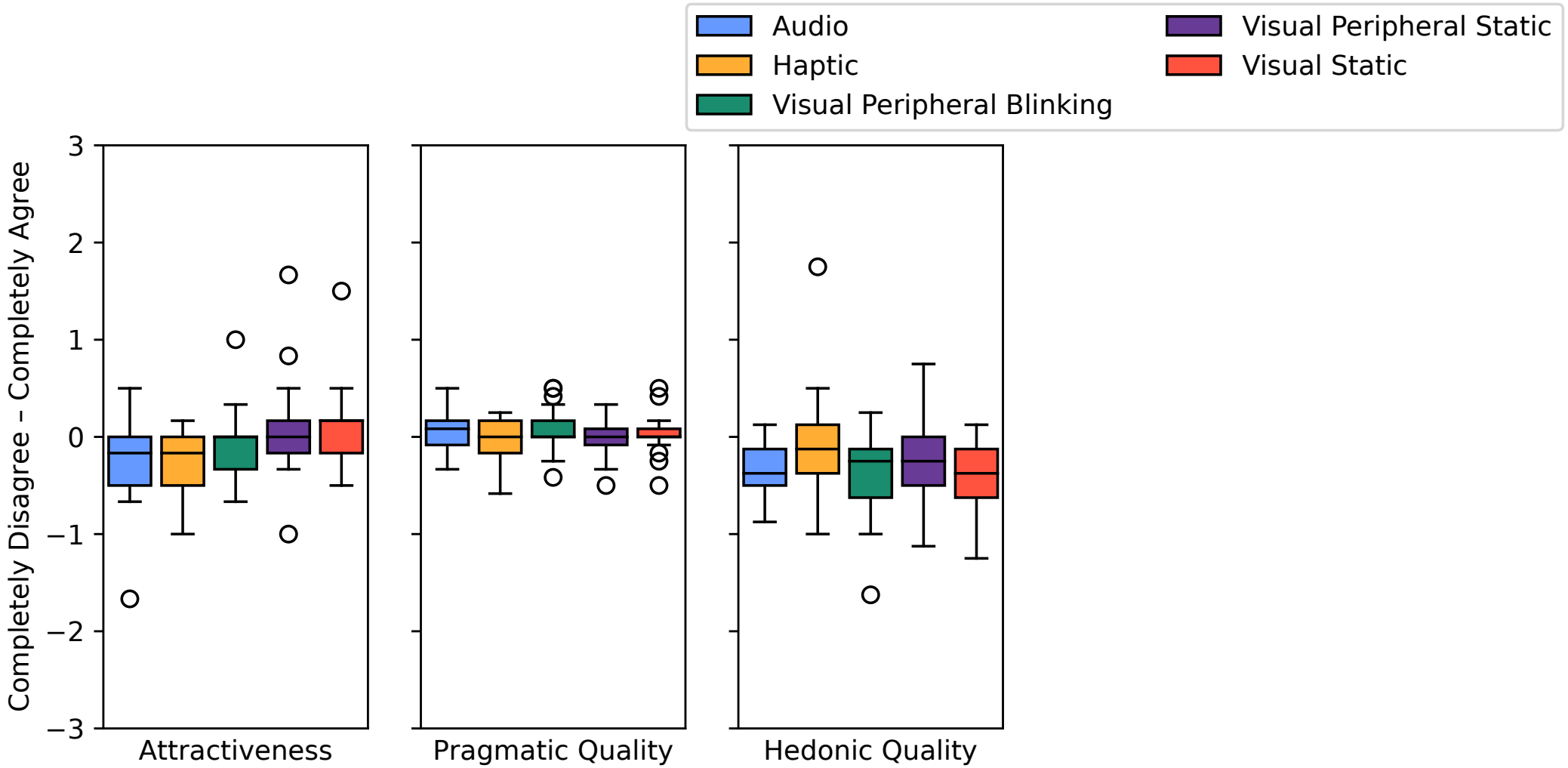
Results II: Effectiveness



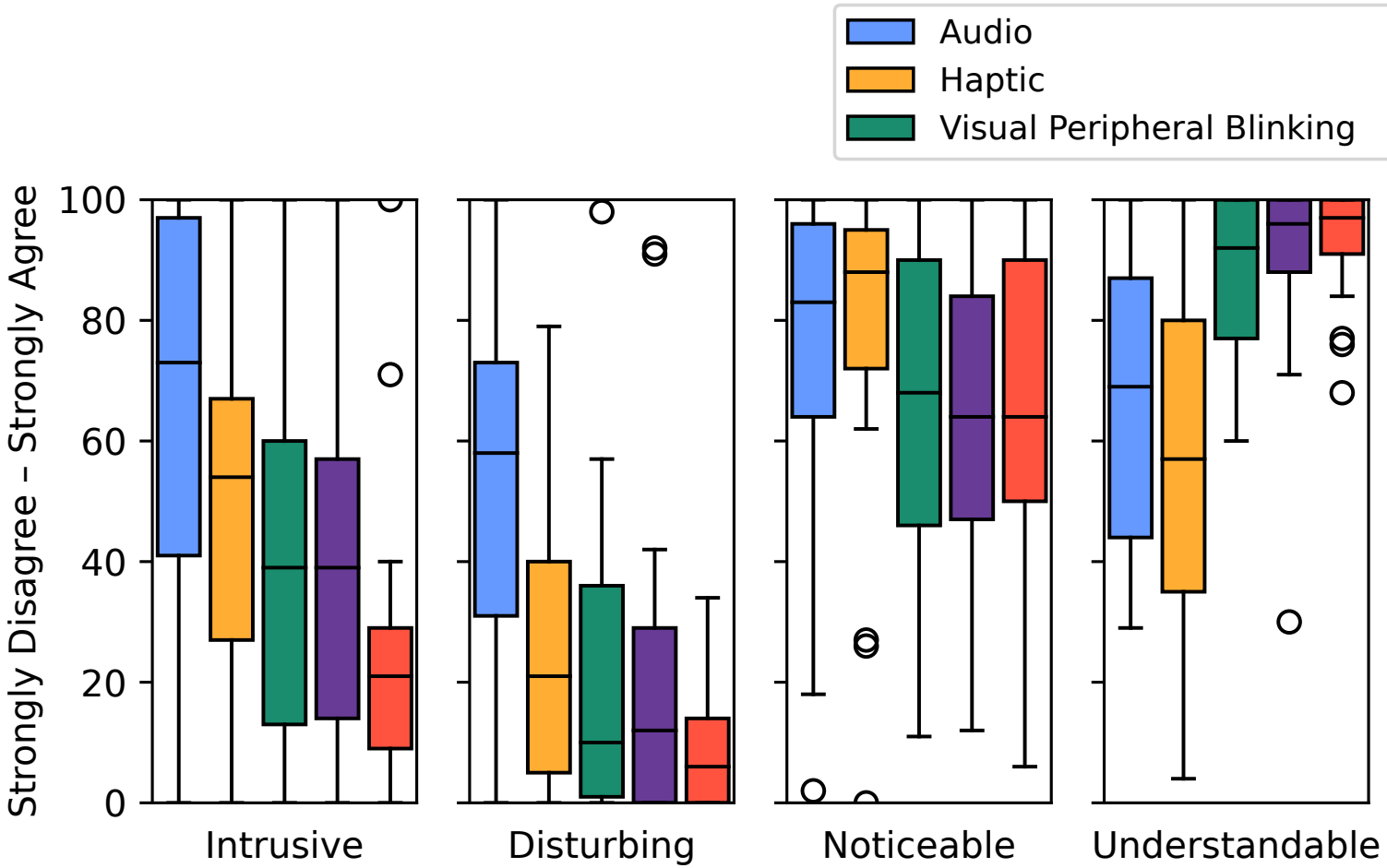
Time taken to complete the maze.

Ratio of insecure portals taken.

Results II: User Experience



Results II: Notification Quality



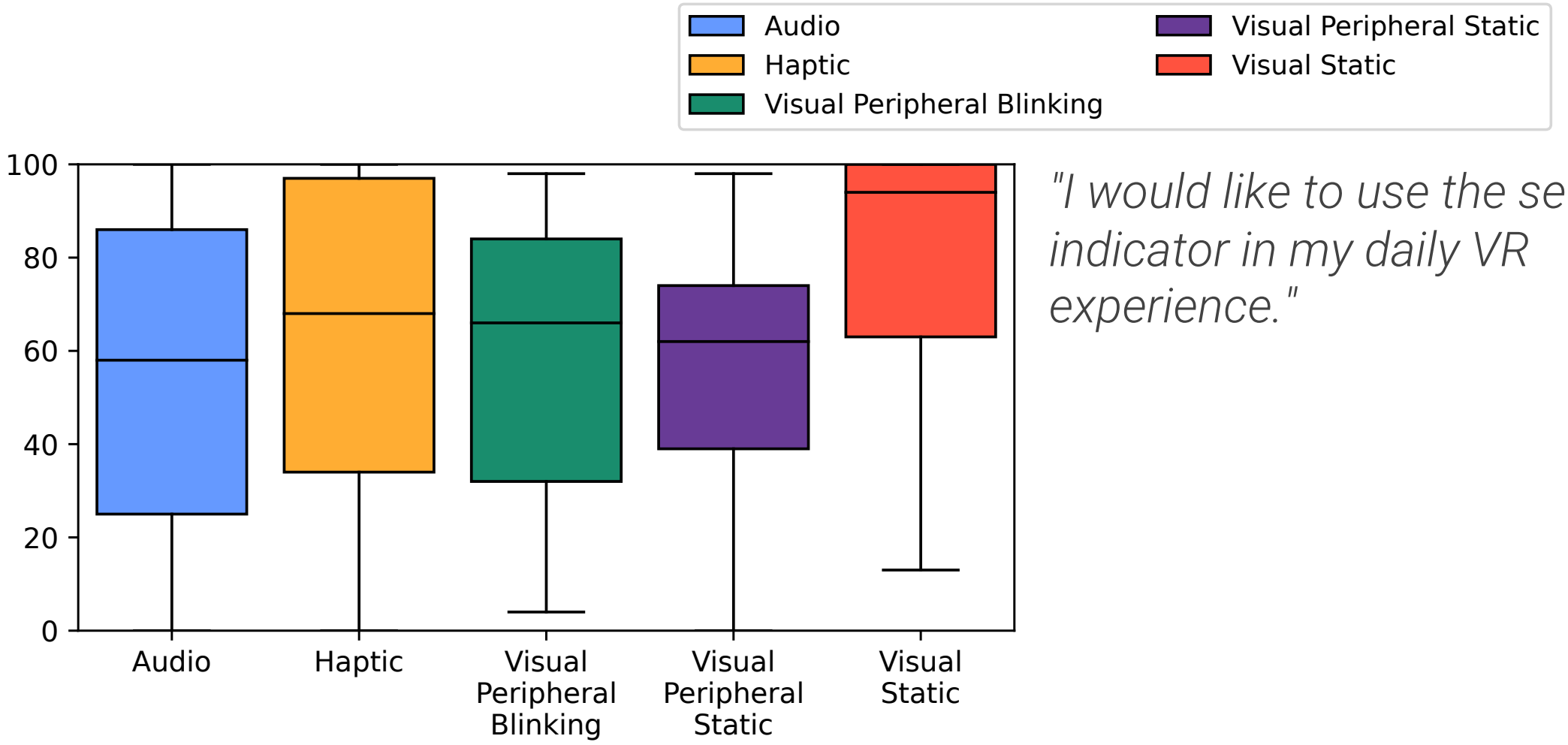
“This indicator is very intrusive.”

“This indicator is very disturbing.”

“This indicator is very noticeable.”

“This indicator is very understandable.”

Results II: User Preference



"I would like to use the security indicator in my daily VR experience."

Takeaways

Use visual indicators for frequent messages/interactions.

Use haptic security indicators to alert users.

The right indicator can help balance the users' attention.

Use audio indicators as a complementary modality.

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