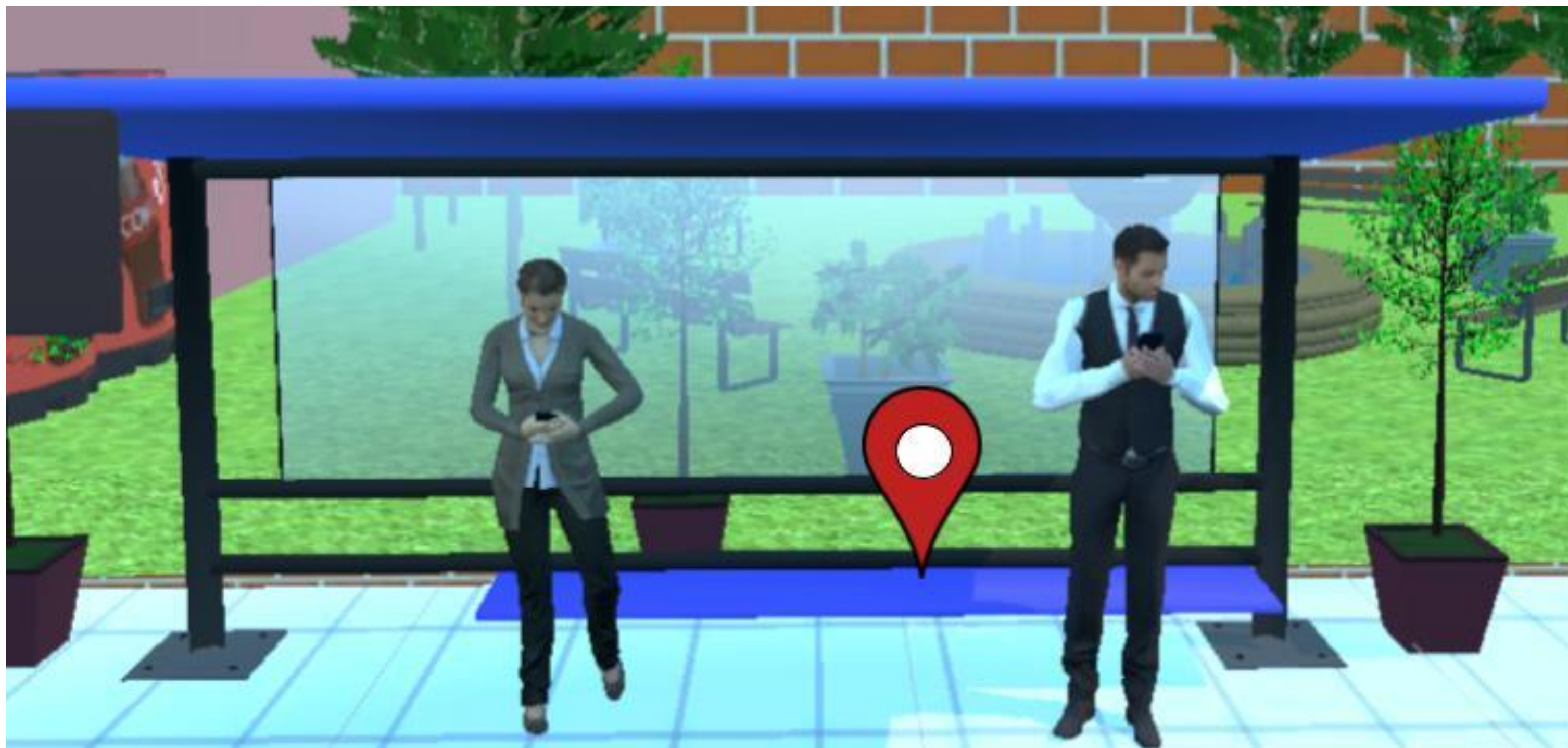


Understanding Shoulder Surfer Behavior and Attack Patterns Using Virtual Reality

Yasmeen Abdrabou, Radiah Rivu, Tarek Ammar, Jonathan Liebers, Alia Saad, Carina Liebers, Uwe Gruenefeld, Pascal Knierim, Mohamed Khamis, Ville Mäkelä, Stefan Schneegass, Florian Alt

ABSTRACT. In this work, we explore attacker behavior during shoulder surfing. As such behavior is often opportunistic and difficult to observe in real world settings, we leverage the capabilities of virtual reality (VR). We recruited 24 participants and observed their behavior in two virtual waiting scenarios: at a bus stop and in an open office space. In both scenarios, participants shoulder surfed private screens displaying different types of content. From the results we derive an understanding of factors influencing shoulder surfing behavior, reveal common attack patterns, and sketch a behavioral shoulder surfing model.



STUDY DESIGN

Independent Variables:

- Environment (office, bus stop)
- Avatar gender (male, female)
- Screen content (news article / video vs. chat / email vs. game)

Dependent Variables

- Gaze direction (x,y,z)
- User position in the environment and head rotation
- Euclidean distance between participant and screen

RESULTS

- Gaze contact considered shoulder surfing beyond 1s.
- Males and females attacked equally often, but female screens observed longer (18s vs. 13s).
- Immersive content (games, videos) attacked for long periods of time (avg. > 6s), as opposed to text.
- Frequent attacks during typing, but for short amounts of time.
- The closer attackers are to the screen, the longer attacks last.

ATTACK PATTERNS

CONTINUOUS ATTACK

Behavior. Shoulder surfers look at screen for extended period of time with few or no gaze shifts.

Content. Video, game (immersive).

Interpretation. Chances of being noticed rather low for shoulder surfers.

CAUTIOUS ATTACK

Behavior. Attackers continuously monitor victims' gaze behavior.

Content. Short text messages, social media (micro interactions).

Interpretation. Victims monitor environment when interacting with sensitive content; attackers try to reduce chance of being caught.

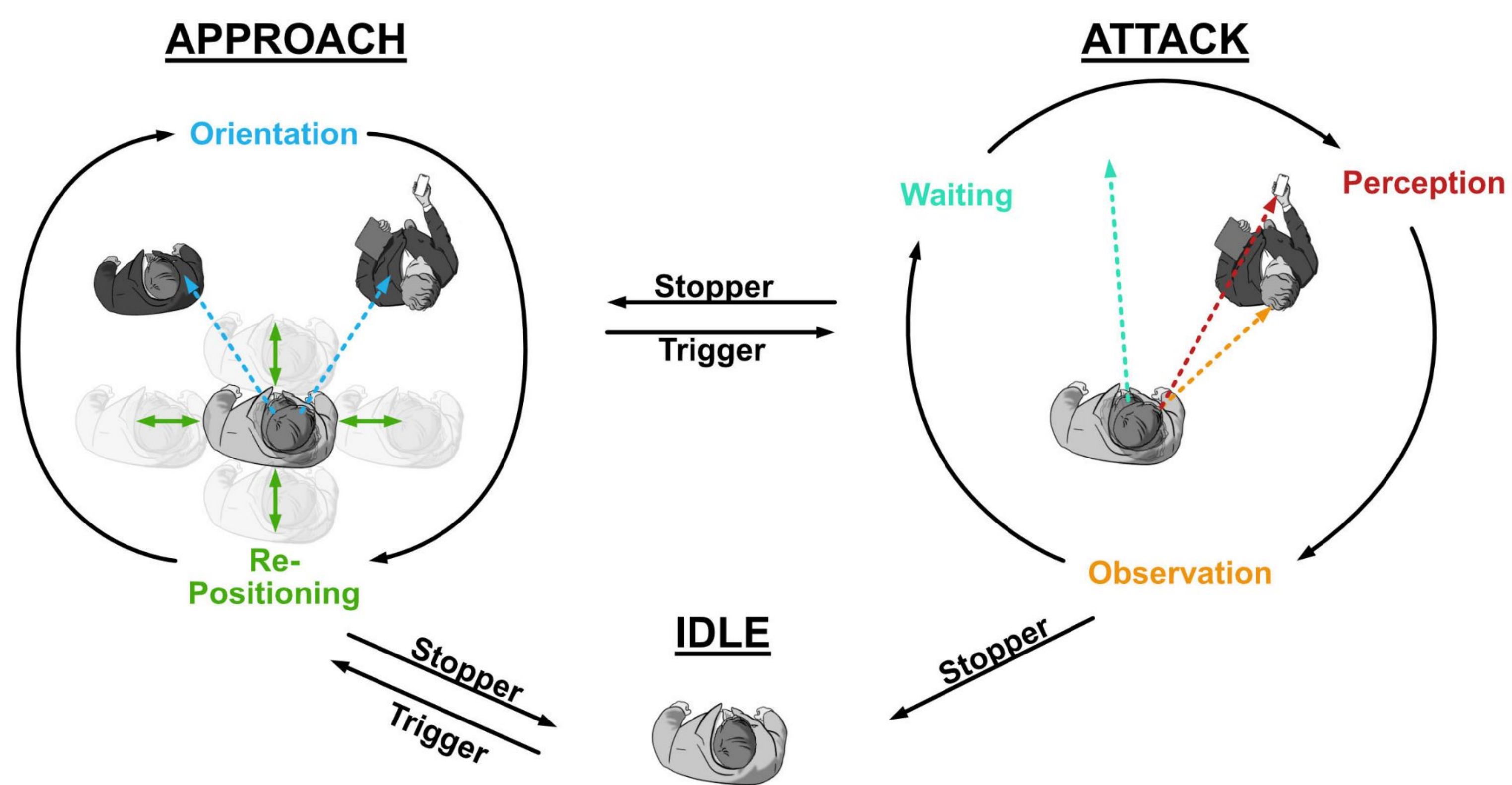
REPEATED ATTACK

Behavior. Attackers look at screen for several seconds, avert their gaze, and look back after some time.

Content. Emails, real-time chat conversations.

Interpretation. Attackers check and quickly perceive new content; minimized chance of being caught.

SHOULDER SURFING ATTACK CYCLE



INSIGHTS AND DISCUSSION

- Acceptability of shoulder surfing varies across contexts and depending on content.
- Salient areas in line of sight trigger shoulder surfing attacks.
- Attackers approach a shoulder surfer's sweet spot.
- Ability to recall depends on personal interest as well as on the degree of distraction.
- Generalizability to real world settings to be explored.

TAKE HOME MESSAGES

1. VR as a method to investigate shoulder surfers' behavior
2. Empirical insights on factors influencing shoulder surfing
3. Attack patterns and stage-based behavioral model

which of them did you encounter before?

