

Verbal Tone and Proximity in Virtual Police Encounters Affect Arousal and Defensive Behavior

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1 Introduction

The way individuals verbally address each other plays a central role in de-escalating conflict situations and is closely linked to nonverbal cues such as interpersonal distance. Violations of personal space can elicit discomfort, defensive behavior, and physiological arousal.

In authority encounters such as police-citizen interactions, verbal tone and spatial proximity jointly shape perceived threat. Using virtual reality, we examine how speech (friendly vs. unfriendly) and distance (respect vs. violation) influence physiological arousal and defensive behavior.

2 Methods

Participants

- **Sample:** N = 91 healthy adults (58 female; mean age = 36.8 years), two groups based on **migration background** (19 persons)

Data Acquisition

- **Physiology:** Electrodermal activity (EDA) and photoplethysmography (PPG) recorded from the index finger of the non-dominant hand via a wearable EmotiBit sensor (Montgomery et al. 2024)
- **Behavior:** **Position** and **distance** tracked via VR headset (Meta Quest Pro, non-tethered), **defensive gestures** captured by external ZED & Triton cameras.

Experimental Design

- **Within-subject factors:** **Verbal Behavior** (Friendly vs. Unfriendly) and **Interpersonal Distance** (Far vs. Near, i.e. Respecting vs. Violating personal space)
- **Between-subject factors:** **Avatar Gender** (Female vs. Male) and **Skin Color** (Dark vs. Light)

Procedure

- **Scenario:** A realistic passport-control interaction in VR with a police avatar
- Participants first completed a demographic questionnaire in the reception room, then performed the VR task in the experimental room (ending with a stop-distance procedure) and finally returned to the reception room to complete the post-experiment questionnaire.

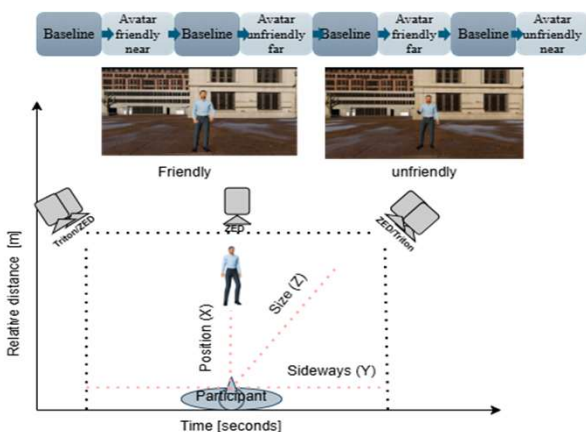


Figure 1. Experimental design. The task consisted of alternating **Baseline** and **Interaction** blocks (4 of each). Baseline trials (20s) included viewing of neutral landscape images; in Interaction trials (20–30s), the avatar approached the participant and delivered a scripted speech. After each interaction, participants rated perceived **stress, escalation, and threat**.

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3 Results

Physiological Arousal (EDA & PPG)

Linear mixed-effects models predicting **skin conductance response (SCR)** amplitude:

- significant main effect of **Behavior** ($\beta = 0.3, p < 0.001$) – unfriendly behavior elicited significantly higher arousal than friendly behavior
- significant **interaction between Behavior and Distance** ($\beta = -0.318, p < 0.01$) – the impact of unfriendly behavior was significantly stronger at **Far distances**, contrary to typical proxemic effects
- significant effects of **Avatar Skin** ($\beta = -0.408, p < 0.05$) and **Avatar Gender** ($\beta = -0.383, p < 0.05$) – **Dark-skinned** avatars and **Female** avatars induced higher SCR amplitudes, especially under unfriendly Behavior

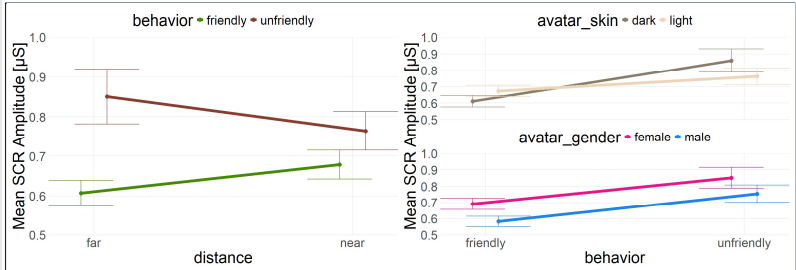


Figure 2. Interaction effects on SCR Amplitude. (A) Distance × Behavior interaction. (B) Behavior × Avatar Skin interaction. (C) Behavior × Avatar Gender interaction.

Linear mixed-effect models predicting **heart rate change (Δ HR)** from baseline to experimental trial:

- significant main effect of **Avatar Skin** ($\beta = 1.717, p < 0.05$) – light-skinned avatars induced higher (Δ HR)

Behavioral Response (Distance)

- **Approach Inhibition:** significantly **reduced forward movement towards Unfriendly** avatars ($\beta = -0.007, p < 0.01$) – indicates social hesitation
- **Space Regulation:** significantly **larger backward movement in the Near condition** ($\beta = -0.024, p < 0.001$) – attempt to restore personal space
- **Defensive Reactions:** despite no significant main effect of behavior on retreat distance, the distribution reveals a **“long tail”** of extreme retreat responses specific to the **Unfriendly** condition.

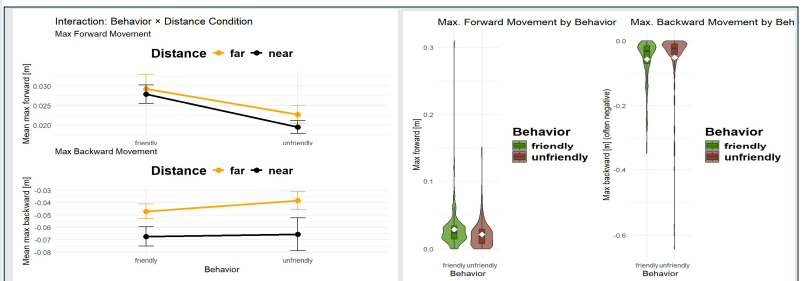


Figure 3: (A) Interaction effects: Reduced approach towards unfriendly avatars and increased retreat in Near conditions. **(B) Distribution:** Violin plots reveal an **extended lower tail** of extreme defensive retreat specifically in the Unfriendly condition.

4 Discussion

Multimodal Consistency: Unfriendly behavior elicited a robust stress response, confirmed by the alignment of physiological arousal (EDA) and subjective stress ratings.

Distance Regulation: High arousal persisted even at greater distances. Participants' active backward movement likely served as a behavioral strategy to regulate this physiological threat. **Social Biases:** The significant effects of avatar gender and skin tone suggest that officer characteristics modulate perceived threat, highlighting the importance of respectful communication in policing.

References

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- Montgomery et al. (2024) ist eine Validationsstudie zum EmotiBit.