Estimating Attentional States of Older Adults for Remote Caregiving

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- Remote caregiving robots can support older adults aging in place, but **caregivers often have limited awareness of users' attentional states**.
- **Challenge: Existing attentiveness cues** are primarily derived from **younger adults** and may not generalize well due to **age-related changes** in facial appearance and behavior.
- **Finding: Eye blinks and lower-face movements,** particularly lip parting and chin raising, show promise as **facial indicators of attentiveness in older adults**.

Introduction

- Remote caregiving robots can help older adults age safely and independently at home.
- Caregivers often have limited awareness of older adults' attentiveness due to the limited camera view available in teleoperation systems
- **Main challenge: Existing attentiveness cues have been identified using younger adults.**
- Aging changes facial appearance and behavior, which may reduce the reliability of conventional attentiveness indicators.
- We investigate **which facial cues are associated with attentiveness in older adults** to support future remote caregiving systems.

Which facial cues can be used to estimate older adults' attentiveness for remote caregiving?

Methodology

- **Participants:** Conducted a pilot study with 4 older adults (69.5 ± 5.1 years, 2 males & 2 females)
- **Experiment:** Participants performed a Sustained Attention to Response Task (SART), responding to all digits except the target digit "3".
- A hidden camera recorded participants' facial behavior during the task.
- **Data Processing:** OpenFace 2.0 was used to extract Action Units (AUs) from the video recordings.
- **Data Analysis:** Logistic & linear mixed-effects models were used to identify AUs associated with attentional states.

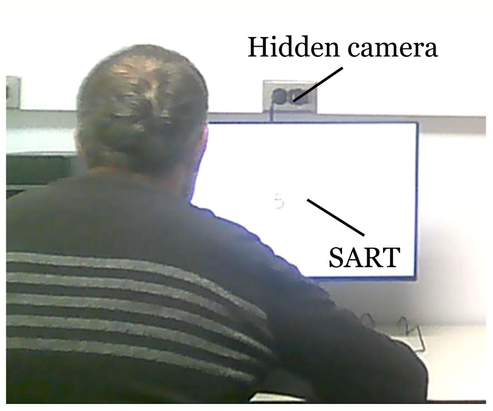
Results & Discussion

- **Results: Eye blinks (AU45), lip parting (AU25), and chin raising (AU17) showed strong and consistent associations with attentiveness.**
- **Potential Impact: Attentiveness estimation could support more effective remote caregiving.**
- **Future Work:** Larger participant cohorts, integration of gaze and head movement features, and real-time deployment in remote caregiving robots.

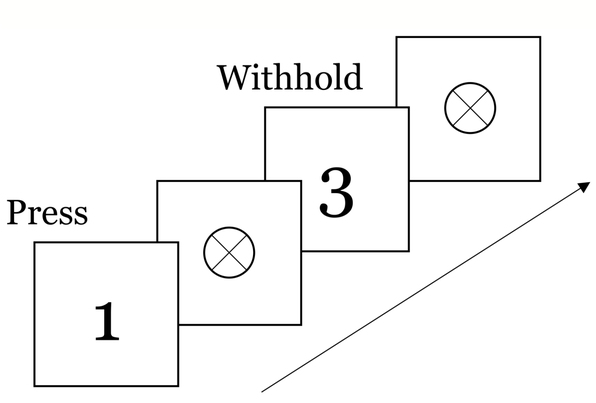
SIGNIFICANT ACTION UNITS ASSOCIATED WITH ATTENTIONAL STATE.

AU*	Estimate	Statistic	p-value#
$AU12_c$ (Lip Corner Puller)	4.83	OR = 125.28	< 0.001
$AU25_c$ (Lips Part)	4.44	OR = 84.66	< 0.001
$AU45_c$ (Blink)	4.09	OR = 59.88	< 0.001
$AU17_c$ (Chin Raiser)	1.29	OR = 3.64	< 0.01
$AU14_c$ (Dimpler)	-7.34	OR = 0.001	< 0.001
$AU45_r$ (Blink)	0.07	$t = 4.98$	< 0.001
$AU26_r$ (Jaw Drop)	0.09	$t = 4.32$	< 0.001
$AU25_r$ (Lips Part)	0.06	$t = 3.81$	< 0.01
$AU15_r$ (Lip Corner Depressor)	0.02	$t = 3.63$	< 0.01
$AU01_r$ (Inner Brow Raiser)	0.04	$t = 3.50$	< 0.01
$AU17_r$ (Chin Raiser)	0.05	$t = 3.26$	< 0.01
$AU09_r$ (Nose wrinkler)	0.008	$t = 2.84$	< 0.05
$AU20_r$ (Lip Stretcher)	0.02	$t = 2.60$	< 0.05
$AU23_r$ (Lip Tightener)	0.02	$t = 2.52$	< 0.05

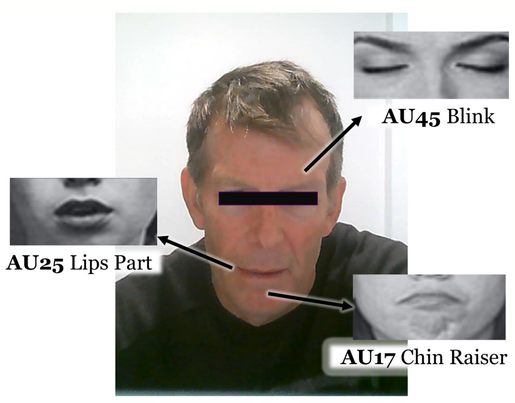
* AU_c denotes Action Unit occurrence, and AU_r denotes Action Unit intensity, analyzed with logistic and linear mixed models, respectively.
# p-values were adjusted using false discovery rate (FDR).



Experiment setup



Sustained Attention to Response Task (SART)



Video frame of hidden camera

Feel free to connect with **Thomas** on LinkedIn!

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