Field Evaluation with Cognitively-Impaired Older Adults of Attention Management in the Embodied Conversational Agent *Louise*


4th IEEE International Conference on Serious Games and Applications for Health (SeGAH), Orlando, USA – May 13th 2016
• Over 100 millions people with dementia by 2050
• Dementia = loss of cognitive functions due to brain diseases in older adults
• High care costs
• Caregivers shortage
Outline

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Project overview

• Challenge: Building an adapted user interface for older adults with cognitive impairment (and low computer literacy)

• Proposed solution: embodied conversational agents (ECAs)

• Design methodology: user-centered “living-lab” approach

• Place: Broca Hospital (Paris, France)
Why ECAs?

- Good task performance
- Attention and engagement
- Natural interaction
- Trust
- Better understanding
- Non-verbal behaviors
- Personalization
The Louise ECA (1/2)

Attention estimator

Interaction manager

Game engine

Voice synthesizer

Behavior realizer

Kinect data

Dialog script

Keyboard input
The Louise ECA (2/2)

Figure 1 – ECA’s embodiment

Figure 2 – ECA’s behavior
Attention estimation method (1/2)

• *A priori* assumptions:
  o Attention = looking towards the display
  o Sensor placed on top of the display in the middle

• 3 features:
  o \( \varphi \) = divergence from direct orientation of the body towards the sensor
  o Yaw = the head’s rotation around the vertical axis
  o Pitch = face up/face down rotation of the head

*Figure 3 – Angles used for attention estimation*
• Features $f_j$ averaged over 1-second sampling
• Features normalized as: $f_j = \frac{\cos(f_j) - \cos(Max_j)}{1 - \cos(Max_j)}$
• $Max_j = 60^\circ$ for $\phi$, $30^\circ$ for yaw and $20^\circ$ for pitch
• Attention value $A$ computed as: $A = \sum_{j=1}^{n} \omega_j \overline{f_j}$
• Sum of the weights $\omega_j$ is 10; features in [0; 1]
• $\omega_\phi = 3; \omega_{\text{yaw}} = 4; \omega_{\text{pitch}} = 3; n = 3$
• Decision: empirical hysteresis threshold
Evaluation

• Phase 1: Healthy younger adults
  o 14 participants: 10 men, 4 women
  o Assistive technology experts
  o 22 < age < 62 (mean = 37)

• Phase 2: Older adults
  o 8 participants: 6 women, 2 men
  o 3 MCI, 3 Alzheimer’s disease
  o 17 < MMSE < 29 (mean = 23)
  o 63 < age < 91 (mean = 78)
Results

• 6/8 participants successfully interacted (1 could not hear; 1 lost track of context)
• Correct estimations:
  – 83% in Phase 1
  – 76% in Phase 2
• No statistically significant differences between groups
• Effective attention recapture strategy

Figure 4 – Receiver Operating Characteristics (ROC) curve of the attention estimator
Anthropological interaction analysis

- **Goal:** gain insights for future work on interaction management automation
- **Method:** interaction videos annotation and interviews with Louise’s designers
- **Observations:**
  - People with dementia (PWD) utter more words
  - PWD develop more topic expansion
  - PWD are slower to answer
  - Multi-party interaction (bi-party was intended)
  - PWD talked more to the experimenter

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Conclusion

• Simple, fast, cheap and acceptably accurate attention estimation monitoring capabilities
• Little influence of age or cognitive impairment on performance
• Effective attention recapture strategy
• Louise is quite engaging 😊
Ongoing and future work

• Fully automatic system featuring:
  o Attention management
  o Context reminders
  o Keyword-spotting automatic speech recognition
  o Images and example videos display
  o High-quality animation, based on SmartBody
  o Interaction scenario edition in XML

• 2 types of tasks: multiple-option choice and guided task

• 14 participants with MCI or Alzheimer’s disease
Louise 2.0
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