

Measuring Emotions Using EEG While Playing Serious Games

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Outline

- Serious Games for Cognitive Assessment and Intervention
- UniCog/VibrantMinds
- Engagement-Analysis Study
 - Materials
 - Participants
 - Procedure
- Results
- Conclusion

Serious Games for Cognitive Assessment and Intervention (state-of-the-art)

- The brain of older people is able to retain considerable plasticity that can be fostered by playing computing games (Toril, Reales, & Ballesteros, 2014)
- Training older adults using video games can improve their cognition (Anguera, Boccanfuso, Rintoul, Al-Hashimi, & Faraji, 2013; Nouchi, et al., 2012)
- Brain-training games are expected to improve executive function, memory, attention and processing speed, not only during the performance of the computing games but also during skills or performance that have not been trained (e.g. ADL) (Nouchi, et al., 2012)

Computerized Cognitive Training (CCT) Improves Cognitive Function in Healthy Adults

Outcomes

- Training with video games and CCT improves several cognitive functions in older adults that decline with aging (Toril et al., 2014).
- Significant effects were observed on nonverbal memory, verbal memory, working memory, processing speed, and visuospatial skills; no effects were found for executive functions and attention (Lampit, Hallock and Valenzuela, 2014)

Participants

- Older participants (>71 years) improved more in their cognitive functions after training than younger participants (60–70 years) (Toril et al., 2014).

Interventions

- Training for 6 weeks or less resulted in greater improvement than longer training (Toril et al., 2014).
- Three or fewer CCT sessions per week was effective; more sessions were ineffective (Lampit, Hallock and Valenzuela, 2014)
- Sessions shorter than 30 minutes resulted showed weak evidence for cognitive functions (Lampit, Hallock and Valenzuela, 2014)
- Group-based training was more effective than training administered at home (Lampit, Hallock and Valenzuela, 2014)

UniCog/VibrantMinds

A platform for cognitive assessment and training, including

1. a family of mobile games, e.g., Whack-a-Mole, designed to offer sequence of levels of systematically increasing difficulty;
2. a family of traditional cognitive-assessment tests, e.g., clock-drawing;
3. a cloud-based back-end managing experiments, participants and their game-playing data;
4. physiological-monitoring services, e.g., EEG and EOG, collecting data through wearable sensors during game-play; and
5. analytics.



Monitoring Moderate Dementia with a “Whack-a-Mole” Game

- Few rules
- Test cognitive function using two factors:
hitting a mole (action) and
not hitting a bunny (inhibition)
- 12 patients with moderate dementia played the “whack-a-mole” game on a tablet, once a week, for 10 weeks.
- Patients with moderate dementia were able to play the game successfully.
- Participants’ performance improves within the sessions, and performance gains in one session carried to the next, a week later. Once the initial learning curve reached a plateau in the first 3-5 weeks, all participants showed stable game performance for the duration of the study as measured by the maximum level they reached during each session.



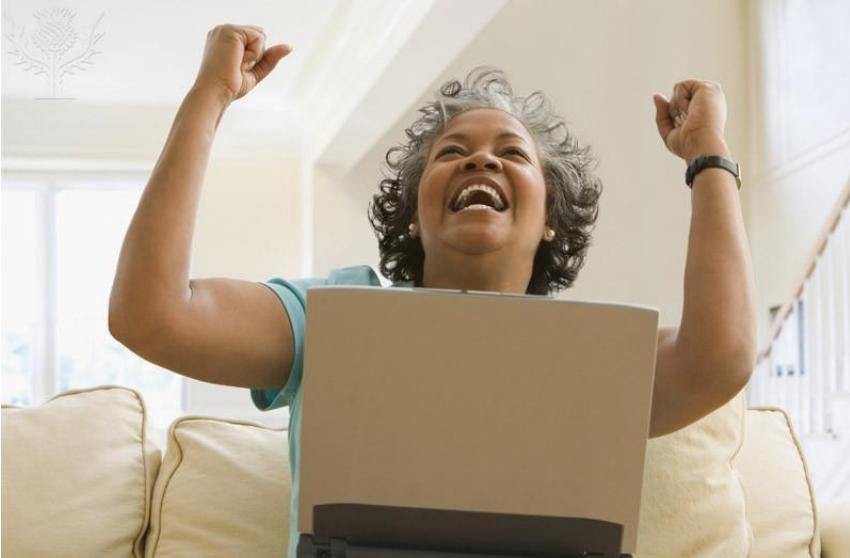
The participants in the study showed an ongoing desire to play the game including asking the Adult Day program staff “Do I get to hit moles today?”

The Overall Research Problem

- Assessing engagement is difficult in people with dementia.
- A systematic, objective method for measuring engagement would lay important groundwork for recognizing the levels of engagement, the emotional states, and the cognitive effort in people with dementia. These measures, in turn, could be used to improve cognitive function through serious gameplay.

The Study Objectives

- The study will lead to an understanding of the patterns of engagement, emotional states and cognitive difficulty of healthy individuals while performing game computing tasks.
- The software system may help health practitioners objectively examine arousal and valence, while older adults engage in serious games.



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Source Britannica Image Quest™

Methods - Participant

- EEG data was collected from one healthy 33-year-old participant, recruited by the UoA Computing Science Department.
- The player played four different sessions, each one lasting around 13 minutes.



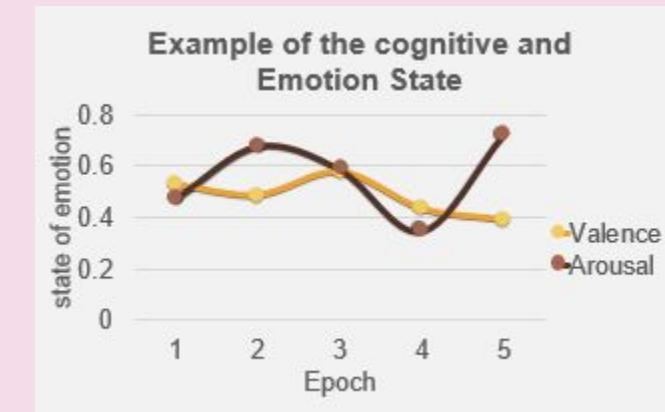
Methods - Procedure

CASES	1	2	3	4
Visibility	1s			
Target latency	0.8s			
Level duration	10 s			
Level progression	6 %	8%	13%	5%

Table 1. Configuration player's session

Methods - Materials

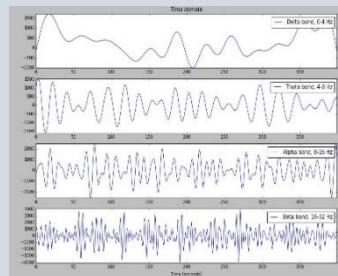
Emotion events



Emotiv EPOC+



Signal Pre-processing



Feature Extraction

$$\text{Arousal} \quad \left(\frac{\beta_{f3} + \beta_{f4}}{\alpha_{f3} + \alpha_{f4}} \right)$$

Arousal & Valence

$$\text{Valence} \quad \left(\frac{\beta_{f4} - \beta_{f3}}{\alpha_{f4} - \alpha_{f3}} \right)$$

Emotion Recognition

Synchronization

Unicog DB

Timestamp events

Event Recognition

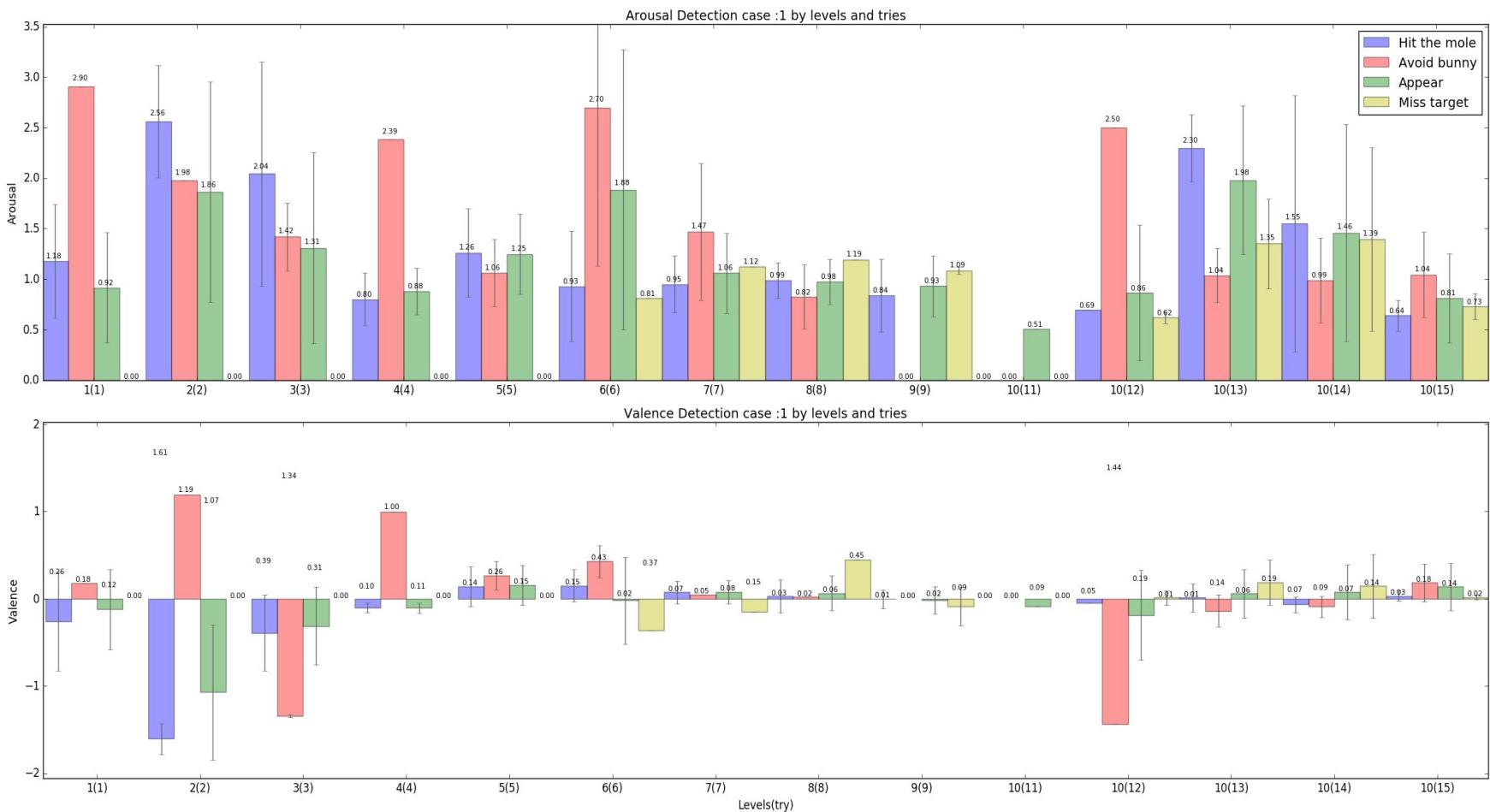
Activity-related Event Recognition



Cognitive events

Data – Arousal and valence

“Status” of emotions during play



Findings

- The application enabled us to observe and analyze the user's brain activity related to emotional states during play.
 - Arousal higher → avoiding a bunny (inhibition)
 - Valence → No clear pattern
- More standardized conditions are needed.

Contributions and Future Work

- A better EEG sensor is needed in order to avoid over-noisy signal. Future analysis could also involve experiments for each EEG channel separately, in order to identify the most effective features per channel.
- In addition to electroencephalography (EEG), , we plan to consider electrooculography (EOG), kinematic motion, and self-reported measures.
- This method will be used in the context of other games to assess its validity and potential as an intervention and assessment in rehabilitation with older adults with cognitive impairment.

Monitoring Moderate Dementia with a “Whack-a-Mole” Game

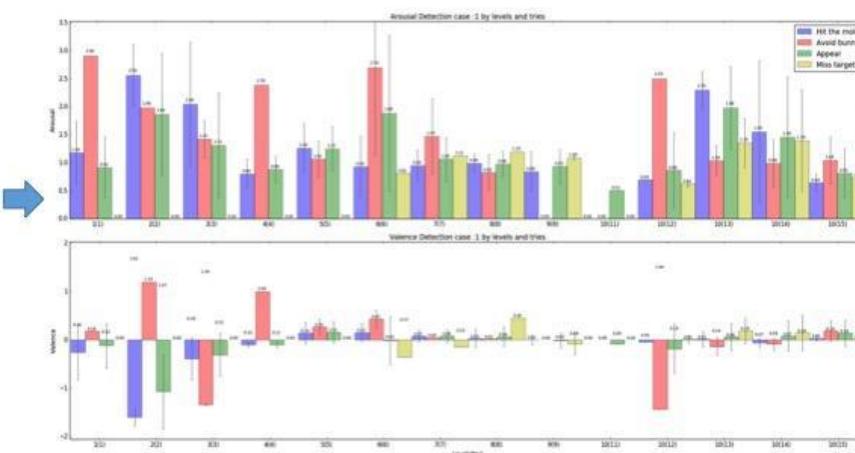
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Wallace et. al 2017: Detecting Cognitive Ability Changes in Patients with Moderate Dementia Using a Modified “Whack-a-Mole” Game
IFEE Transactions on Instrumentation and Measurement

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