Boredom, engagement and anxiety as indicators for adaptation to difficulty in games

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Agenda

Objectives

Methods

- Acquisition protocol
- Physiological signals recording
- Questionnaires

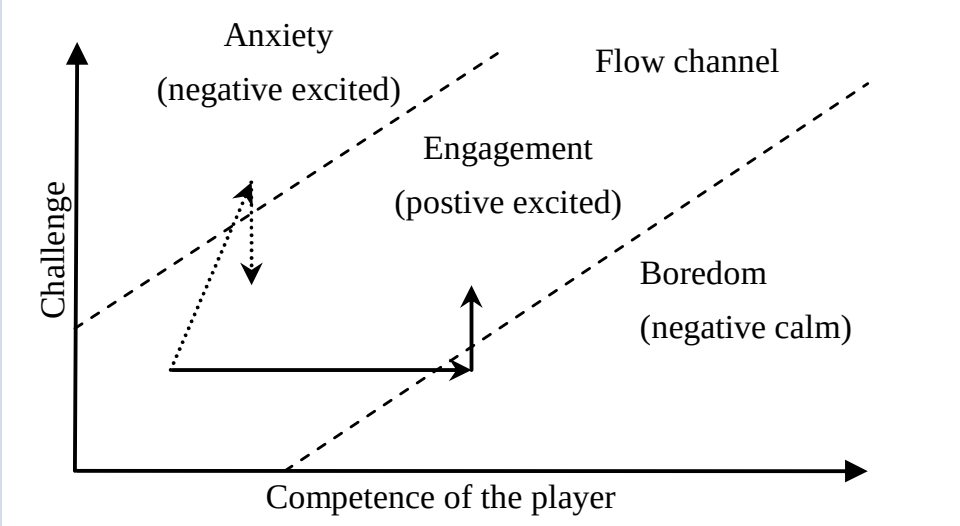
Results

- Validation of the protocol
- Emotion assessment
- Decrease of engagement

Conclusion and future work

Objectives

Challenge and competence relation:



Maintain the level of involvement and pleasure in a task by:

- assessing emotional state of the player by monitoring physiological signals;
- controlling the difficulty of the task to influence challenge.

Objectives

A Tetris video game as the task to be performed:

- possibility to easily control the difficulty of the task;
- well known game ⇨ participants with different skill levels;
- playable with one hand (to wear physiological sensors).

Hypotheses

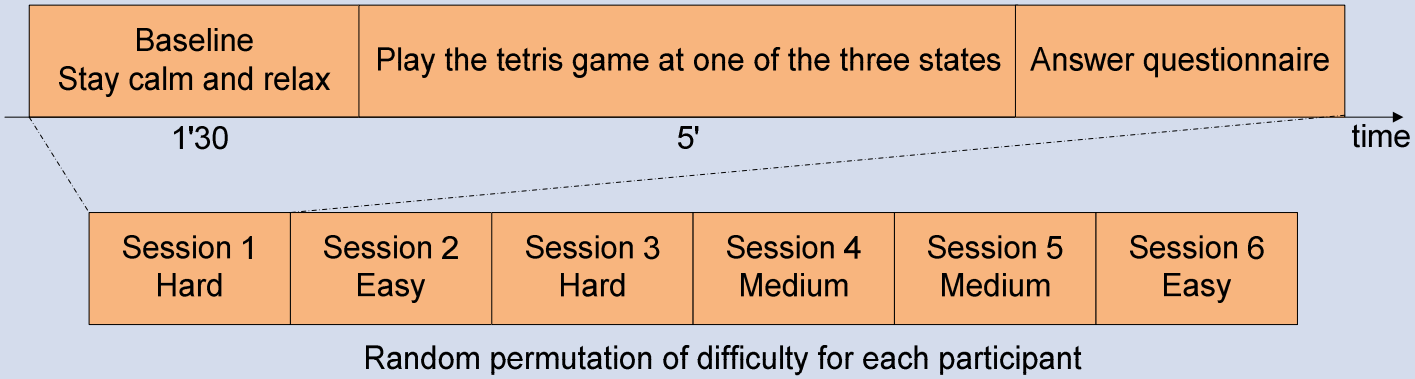
- H1 : playing at different levels of difficulty will give rise to the expected states (boredom, engagement, anxiety);
- H2 : these emotional states can be assessed using central and peripheral signaling;
- H3 : as the skill increases, the player will switch from the engagement state to the boredom state.

Methods - Acquisition protocol

Tetris difficulties calibration:

- medium (engagement) : threshold method, ranged from 11 to 20;
- hard (anxiety) : medium + 8, max 25;
- easy (boredom) : medium – 8, min 5.

Schedule of the protocol :

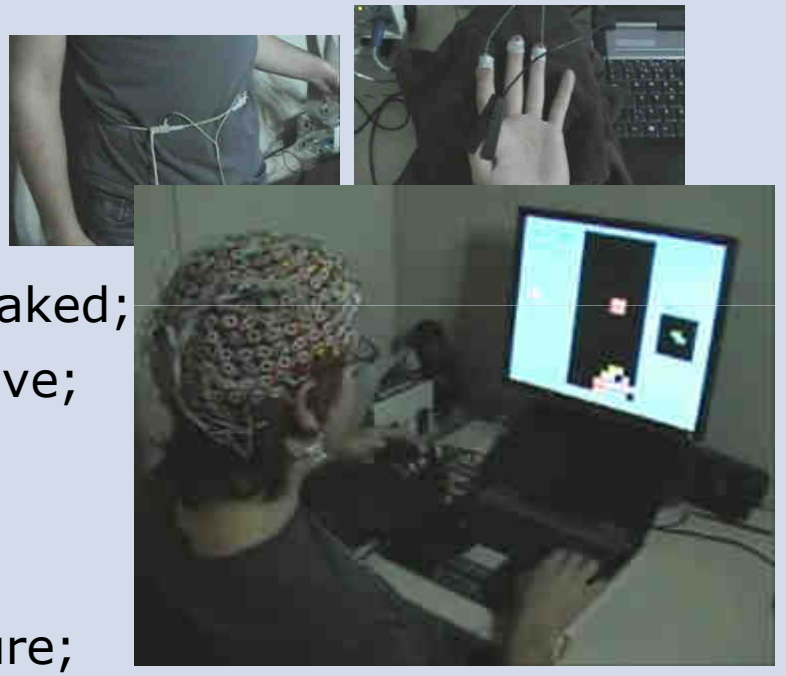


20 participants were recorded (6 peripheral, 14 peripheral + EEG)

Methods - Physiological signals recording

Recording of signals from:

- the peripheral nervous system (GSR, blood pressure, respiration, temperature);
- the central nervous system (EEG).



Why ?

- physiological signals cannot be easily faked;
- part of emotional processes are cognitive;
- fusion of modalities improves results.

Features extraction

- Heart rate extracted from blood pressure;
- Extracted fatures : Mean, standard deviation or mean of derivative;
- Baseline substraction.

Methods - Questionnaires

Description:

- 30 questions, with scales ranging from 1 to 7;
- related to emotions : “I was stressed”, “I had pleasure”,…
- related to involvment : “I was focused on the game”, “I was motivated”, …

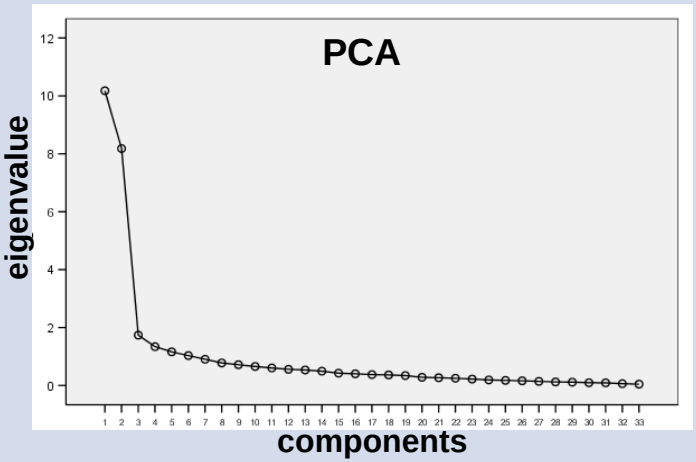
PCA and factor analysis on the 30 dimensions to obtain axes with maximum variance:

- First component is correlated with pleasure, interest, motivation, focus;

⇨ Valence

- Second component is correlated with excitation, pressure, - calm, - control;

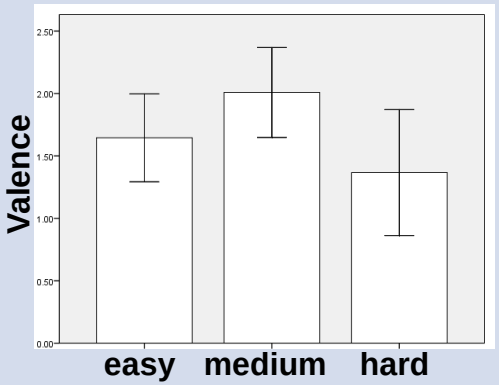
⇨ Arousal

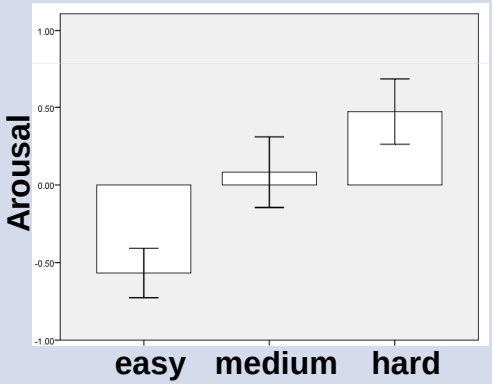


Results – validation of the protocol (H1)

Questionnaires:

- ANOVA on valence (pleasure, focus) → $F=46$, $p<0.01$;
- ANOVA on arousal → $F=232$, $p<0.01$.





Physiological analysis:

- As the level increases:

  decrease in average GSR and temperature;

  increase in average heart rate.

⇨ Increase of arousal.

⇨H1 validated by self-assements and physiological analysis

Results – Emotion assessment (H2)

Classification

- Selection of nine relevant features (ANOVA);
- ground truth: the three difficulties (easy, medium, hard) corresponding to three emotional states;
- cross validation: using each participant in turn as the test set and the remaining ones as the learning set;
- SVM with radial basis functions.

Results

Classified / True	Easy (Boredom)	Medium (Engagement)	Hard (Anxiety)
Easy (Bored.)	72.5%	20.0%	7.5%
Medium (Eng.)	37.5%	20.0%	42.5%
Hard (Anxiety)	29.0%	2.6%	68.4%

53.3% of accuracy

⇨Higher than random classification

Results - Decrease of engagement (H3)

T-test between first and second session at medium level

Questionnaire

- "I had pleasure to play" (t=-1.8, p<0.09);
- "I had to adapt to the interface" (t=-3, p<0.06).

Physiological

- Average GSR (t=3, p<0.01) ;
- average derivative of temperature (t=2.3, p<0.04);
- average heart rate (t=-1.9, p<0.08).

⇨ **Decrease of arousal and pleasure**

Is it due to learning and change in competence ?

Conclusion

To some extent the three hypothesis are validated but:

- H2 : accuracy is low for emotion assessment;
- H3 : is the change of emotional state due to an increase of competence ?

Future work:

- Improve accuracy of emotion assessment
  - ⇨ Fusion with EEG signals
  - ⇨ Reduce the number of classes
- Solve the problem of disengagement in hard difficulties
  - ⇨ Make use of contextual informations
- Emotion analysis on a smaller time scale to better account for the different events in the game
- Creation of an adaptive tetris game