Identifying Physiological-Emotional Response Patterns During Competitive Tasks

An Unsupervised Learning Analysis of the EmoPairCompete Dataset

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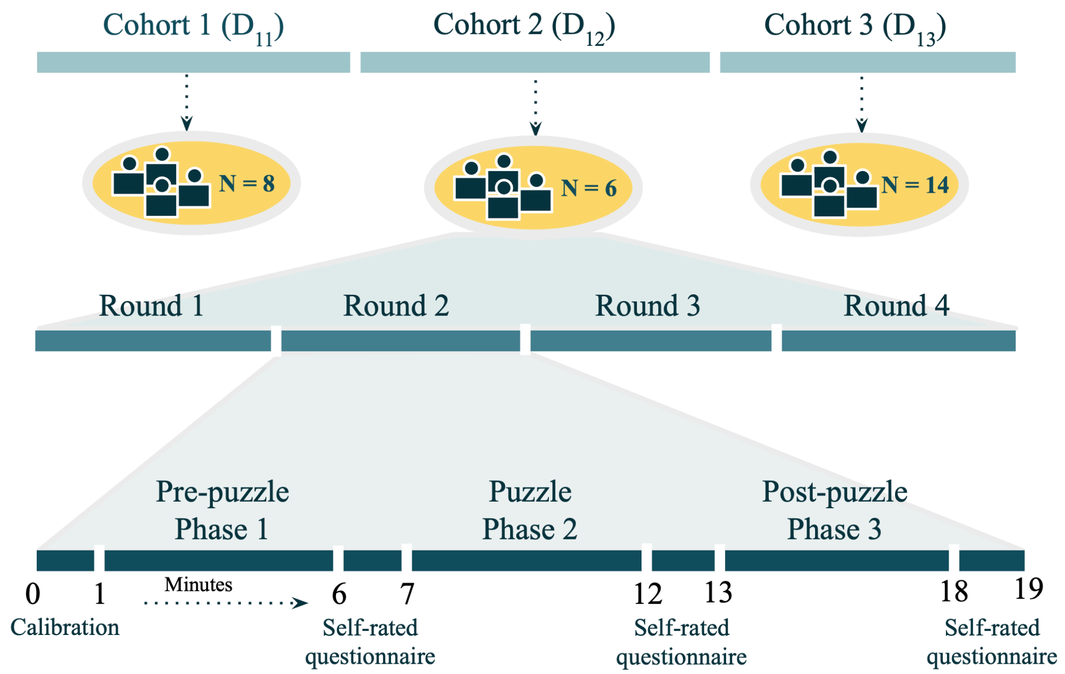
Research Question & Methodology

- Question: "*Do distinct physiological-emotional response patterns exist among participants during competitive puzzle-solving tasks, and what characterizes these different profiles?*"
- Data: EmoPairCompete dataset (26 participants, 4 rounds)
- Signals: HR, EDA (phasic/tonic), Temperature, self-reported emotions
- Method: Hierarchical clustering with Ward's linkage

Experimental Design

- Design: 4 rounds × 3 phases = 12 measurements per participant
- Each Round:
  - 1-min calibration
  - 5-min pre-puzzle rest (Phase 1)
  - 5-min puzzle task (Phase 2) - our focus
  - 5-min post-puzzle recovery (Phase 3)
- Measurements: E4 wristband + I-PANAS-SF questionnaires



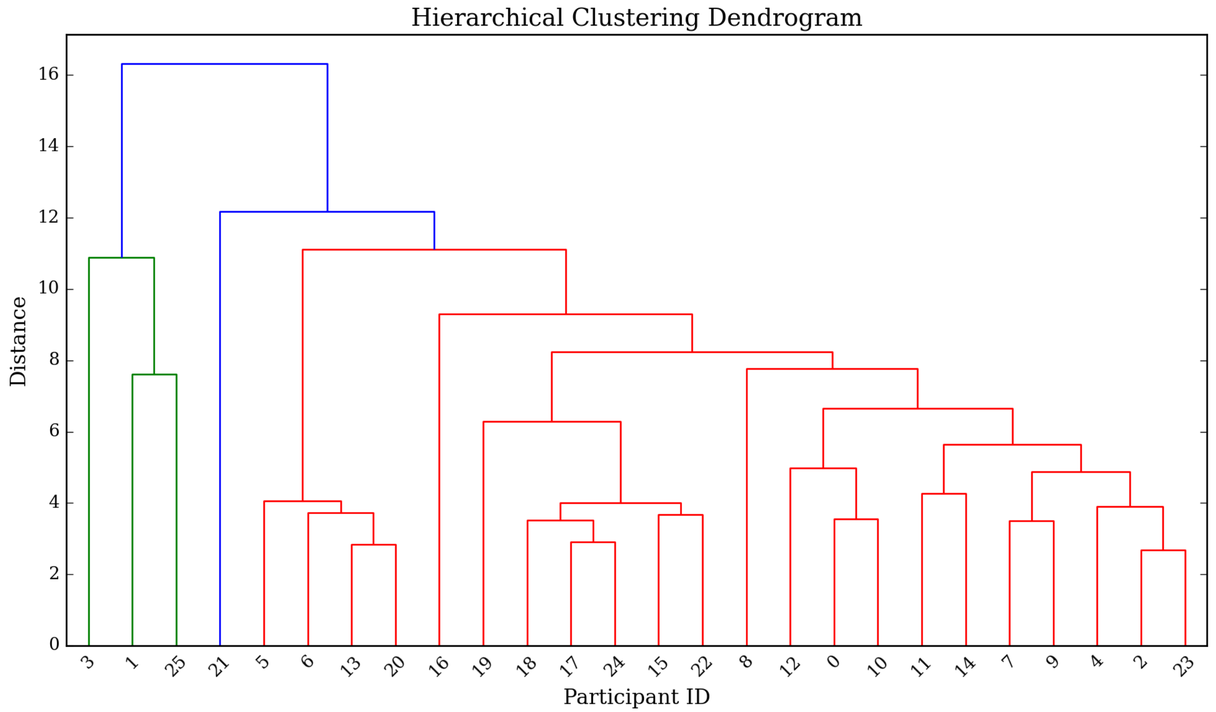
Data Processing

- Standardisation of physiological signals (z-scores)
- Composite emotional scores: Positive Affect (PA) & Negative Affect (NA)
- Delta calculations: changes from baseline
- Feature selection: 24 key variables used for clustering

Physiological Measures			
Heart Rate	**EDA (Phasic)**	**EDA (Tonic)**	**Temperature**
z_d_P2R1_HR_TD_Median	z_d_P2R1_EDA_TD_P_AUC	z_d_P2R1_EDA_TD_T_AUC	z_d_P2R1_TEMP_TD_Mean
z_d_P2R2_HR_TD_Median	z_d_P2R2_EDA_TD_P_AUC	z_d_P2R2_EDA_TD_T_AUC	z_d_P2R2_TEMP_TD_Mean
z_d_P2R3_HR_TD_Median	z_d_P2R3_EDA_TD_P_AUC	z_d_P2R3_EDA_TD_T_AUC	z_d_P2R3_TEMP_TD_Mean
z_d_P2R4_HR_TD_Median	z_d_P2R4_EDA_TD_P_AUC	z_d_P2R4_EDA_TD_T_AUC	z_d_P2R4_TEMP_TD_Mean
Self-Report Measures			
Positive Affect		**Negative Affect**	
z_d_P2R1_PA		z_d_P2R1_NA	
z_d_P2R2_PA		z_d_P2R2_NA	
z_d_P2R3_PA		z_d_P2R3_NA	
z_d_P2R4_PA		z_d_P2R4_NA	

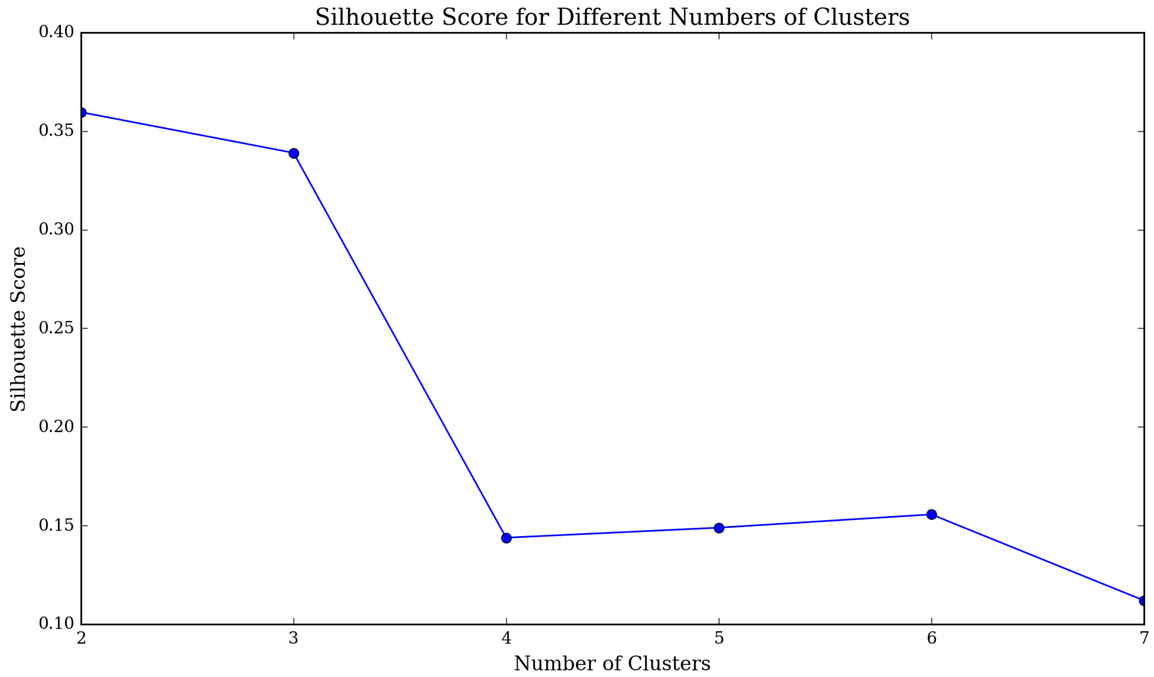
Dendrogram Visualisation

- Clear separation between small cluster (n=3) and main group (n=23)
- Moderate height difference between clusters suggests meaningful distinction
- Evidence of natural groupings in the data



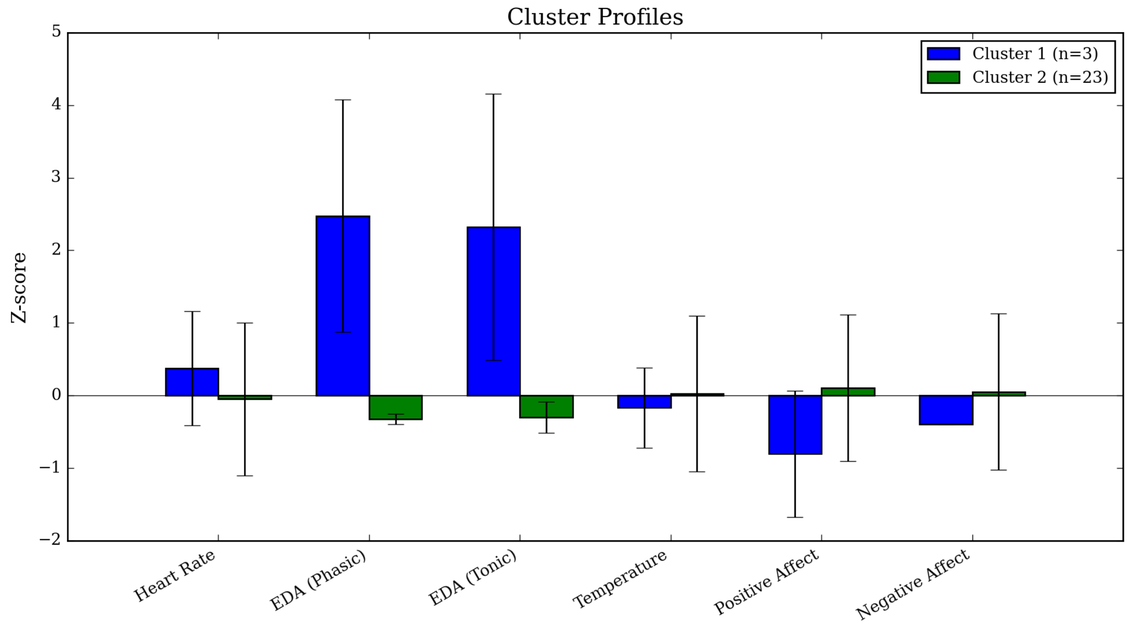
Optimal Number of Clusters

- Two-cluster solution maximizes silhouette score (0.36)
- Sharp decline for solutions with more clusters
- Moderate score indicates some structure with overlap



Clustering Results

- Cluster 1 (n=3): High physiological arousal (especially EDA) + lower emotional self-reports
- Cluster 2 (n=23): Minimal changes from baseline in all measures
- Suggests different stress response patterns



Limitations & Conclusion

- Small sample size (especially in Cluster 1)
- Possible interpretations:
  - Distinct stress response profiles
  - Outlier group vs. typical responders
- Future work: Temporal analysis across rounds to identify adaptation patterns
- Potential applications: Personalised stress management interventions