Quantifying atypicality in affective facial expressions of children with Autism Spectrum Disorders

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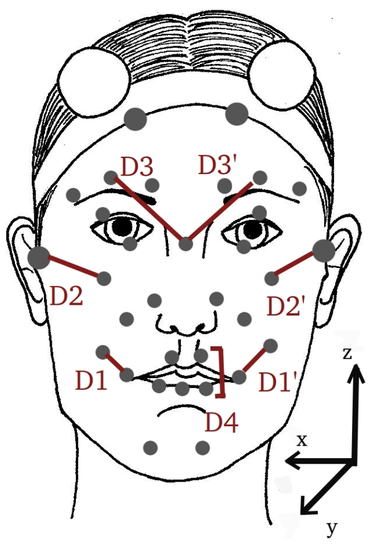
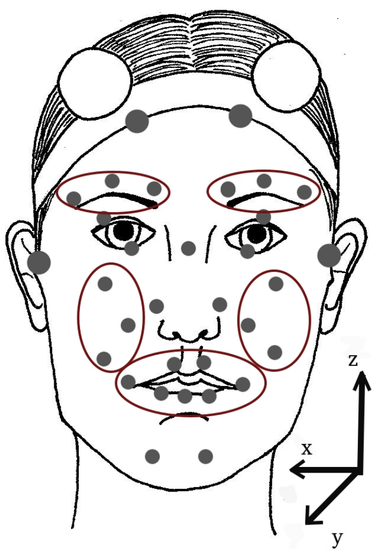
Motivation

- Facial expressions of children with ASD often perceived as 'atypical'
- Quantify atypicality
- Motion Capture (MoCap) and advanced statistical analysis
  - Capture, analyze, visualize
- Computational approaches for new insights for autism





Database

- 37 children, ages 9-14
  - 21 ASD, 16 TD
- Detailed facial MoCap
  - 28 markers
- Emotion Mimicry Tasks
  - 18 emotional expressions

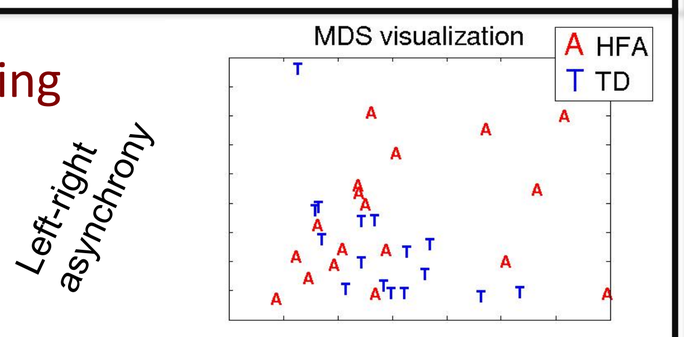
Functional Data Analysis (FDA)

- FDA: a collection of statistical methods [1]
  - Representation, analysis, exploring patterns
  - Time series data represented as functions
- From facial marker data to functional data

$$x_1, x_2, \ldots, x_T \rightarrow \bar{x}(t) = \sum_{k=1}^{K} c_k \varphi_k(t)$$

  - φ_k basis functions, c_k expansion coefficients
- Smoothing, better derivative calculation, fPCA etc.

- Multidimensional Scaling
  - Subject behavior visualization



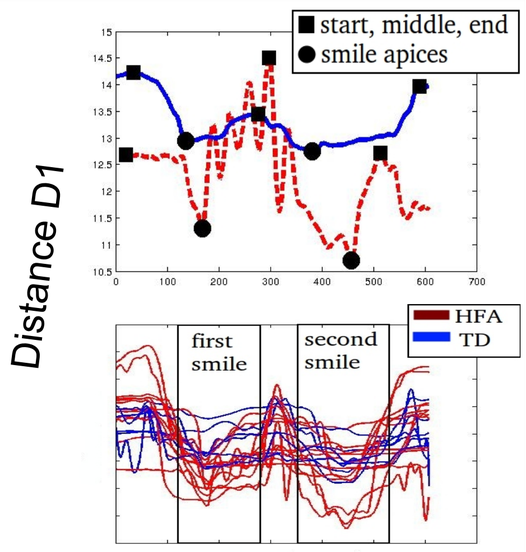
Global Expression Properties

- Facial Movement Synchrony
  - Left-right and upper-lower face correlations
- Face and Head Motion Roughness
  - Higher order derivatives $M_j = 1/T \sum_{i=1}^{T} |D^j \bar{x}_c(t_i)|, j = 1,2,3$

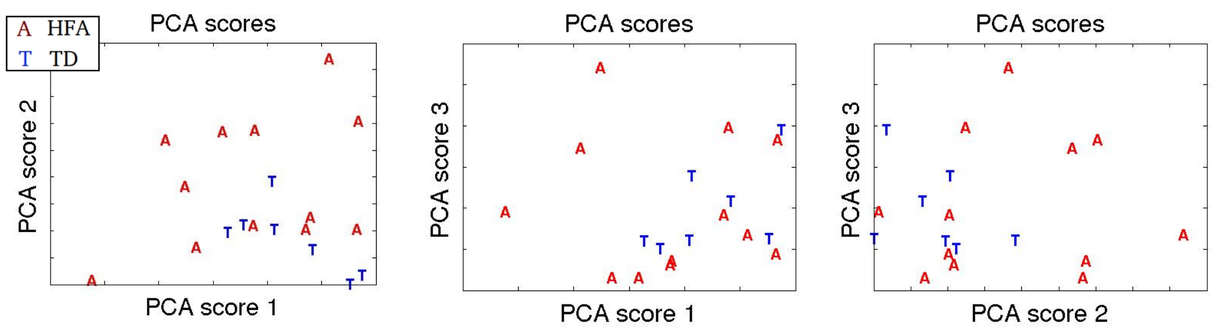
Left-Right Face Synchrony	
Left-right mouth corner correlations	Lower corr. for ASD (p=0.02)
Left-right cheek correlations	Lower corr. for ASD (p=0.07)
Left-right eyebrow correlations	Lower corr. for ASD (p=0.01)
Upper-Lower Face Synchrony	
Right eyebrow and mouth opening corr.	Lower corr. for ASD (p=0.05)
Left eyebrow and mouth opening corr.	Lower corr. for ASD (p=0.03)
Face and Head Motion Roughness (order 2)	
Mouth roughness measure	Higher roughness for ASD (p=0.02)
Right cheek roughness measure	Higher roughness for ASD (p=0.01)
Right eyebrow roughness measure	Higher roughness for ASD (p=0.07)
Head roughness measure	Higher roughness for ASD (p≈0)

Functional Principal Component Analysis (fPCA)

- Analysis of dynamic evolution of two smiles
- Expression alignment via landmark registration
- Functional PCA (extension of PCA)
  - Input: functional curves, e.g., D1
  - Output: eigenfunctions maximizing data variance
  - Decomposition into principal variability harmonics



- Greater variation of expressive choices for ASD group



Conclusions

- Expression differences
  - More asynchrony for ASD group
  - More motion roughness for ASD group
  - More variability in expressive choices/behaviors for ASD group
- Such differences may account for atypicality impression
- New quantitative insights

1. Ramsay etal, Functional Data Analysis, 2005