Neural Correlates of Impaired Recognition of Emotion in Speech In Primary Progressive Aphasia

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Introduction

- Primary Progressive Aphasia (PPA) is a clinical syndrome caused by neurodegenerative disease.
- The most prominent clinical feature is a decline in language skills in the earlier stages.
- Emerging research suggests some people with dementia experience aprosodia, which is impaired recognition/expression of prosodic features (e.g., pitch, volume, rate) used to convey emotions in speech.
- Impaired emotional prosody in patients with dementia causes communication breakdowns with severe consequences including depression and increased disruptive behaviors.
- However, few studies have investigated emotional prosody deficits in PPA.

Aims

We aimed to:

1. investigate receptive emotional prosody in PPA
2. examine the processes underlying receptive aprosodia in PPA
3. investigate how atrophy contributed to specific impairments

Methods

- **Participants:**
  - 33 participants with PPA (17 women, 16 men; mean age = 69.2 years; mean education = 16.5 years)
    - 17 with logopenic variant PPA (lvPPA)
    - 8 with nonfluent variant PPA (nfvPPA)
    - 8 with semantic variant PPA (svPPA)
  - 19 age-matched healthy controls (8 women; 11 men; mean age = 61.0 years; mean education = 16.8 years)
- **Procedure:** MPRAGE scans were acquired in a subset of 23 patients. The whole brain was automatically segmented into regions of interest (ROIs). ROI volumes were calculated using MRICloud.
- **Prosody Testing:** Participants were given six behavioral assessments. Impaired performance was defined as 2 or more standard deviations below the mean of controls.
  - Emotional prosody recognition was assessed by asking participants to choose the emotion of the speaker based on their tone of voice in 25 pseudoword sentences.
  - Each stage of the three-stage model of receptive prosody of prosodic processing
  - Recognition of emotional facial expressions

Methods

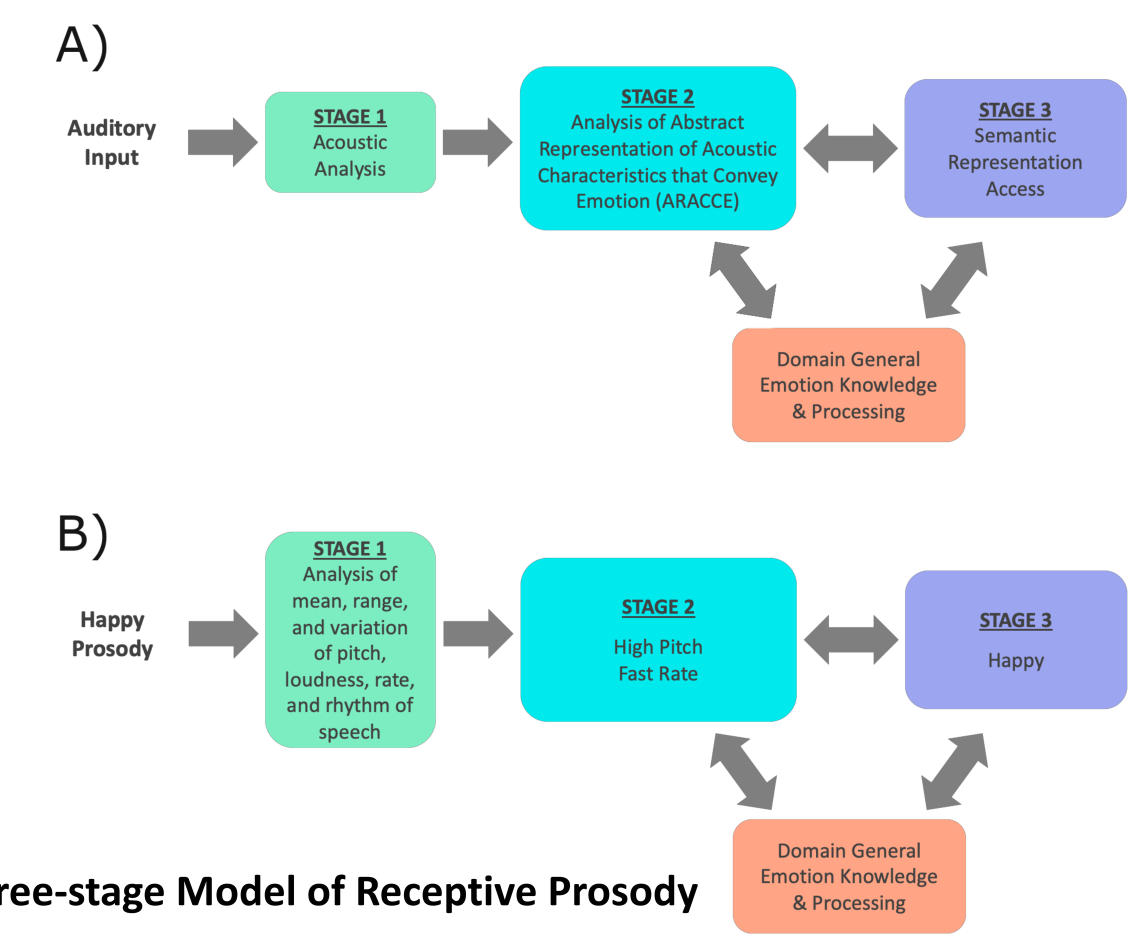

Figure 1. Three-stage Model of Receptive Prosody

- **Analysis:**
  - The relationship between ROIs involved in receptive emotional prosody, and accuracy on each test was modelled using Least Absolute Shrinkage and Selection Operator (LASSO) regression.
  - Volumes of seven RH ROIs, and seven LH homologues (normalized by cerebral volume) were entered into LASSO models, with the ratio of cerebral to intracranial volume (to control for inter-individual differences in brain size) and age.
  - K-medoids analysis was used to identify different performance profiles.

Results

Table 1. Lesion Symptom Mapping LASSO Regression Results

	Receptive Emotional Prosody		Acoustic Discrimination in Tones		Matching Features to Emotions		Emotion Synonyms		Emotional Facial Expression Recognition	
	Adjusted Coefficient	p value	Adjusted Coefficient	p value	Adjusted Coefficient	p value	Adjusted Coefficient	p value	Adjusted Coefficient	p value
Model Intercept	-1.28×10^{-16}		-4.37×10^{-16}		4.30×10^{-16}		5.79×10^{-16}		4.37×10^{-16}	
Age	0.317	**0.030***								
Ratio: Cerebral to Intracranial Volume	0.314	0.100	0.377	0.123			0.266	0.738		
Regional Volumes (normalized by cerebral volume):										
Left IFG			0.050	0.882						
Right IFG	0.025	0.958							0.272	0.460
Left STG			0.198	0.237						
Right STG										
Left MTG										
Right MTG										
Left AG			0.223	0.290	0.180	0.825				
Right AG					0.310	0.176				
Left SMG										
Right SMG										
Left BG										
Right BG	0.084	0.132								
Left Amygdala	0.348	**0.018***								
Right Amygdala							0.472	0.080	0.351	0.245

Note. * denotes significance at $p \leq 0.05$.

Results

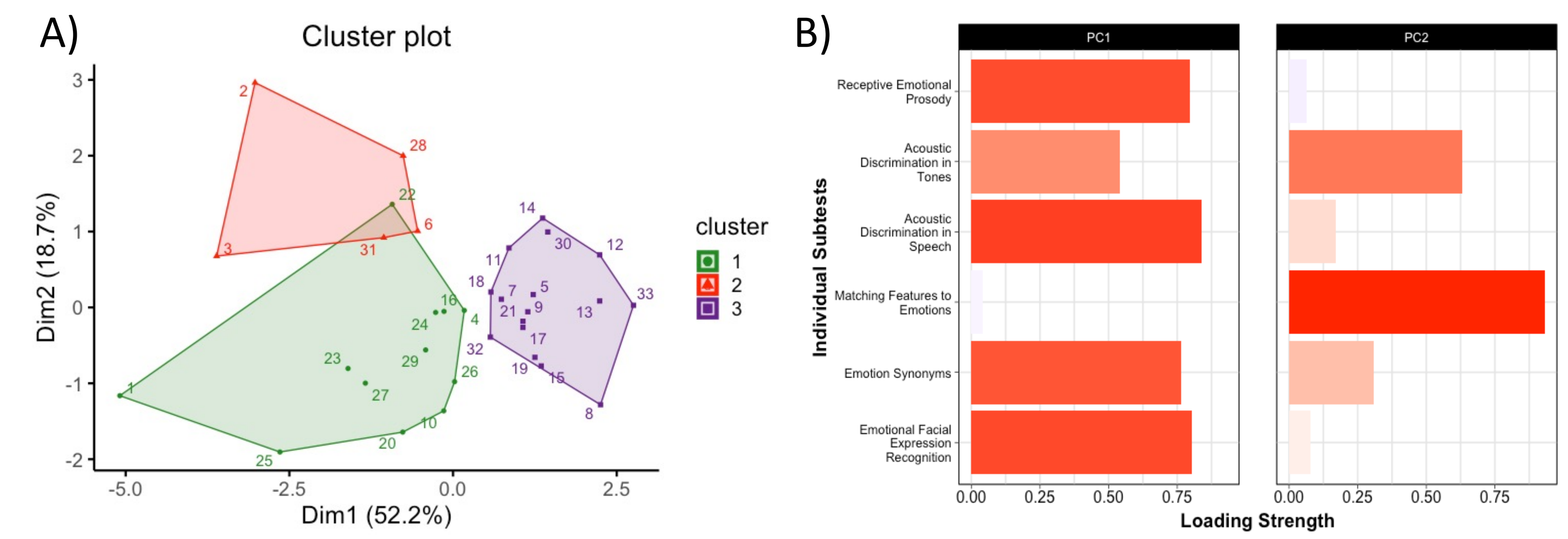

Figure 2. *K*-medoids Cluster Analysis Results. A) results of the *K*-medoids cluster analysis using performance on all six assessments. B) Factor loadings for Principal Components (PC) 1-2, which correspond to clustering dimensions 1-2 in the *K*-medoid analysis, for each of the six behavioral subtests

- Three patient clusters were identified:
  - Cluster 1: Impaired emotion recognition in speech and faces, with stage 2 deficits
    - 7 with lvPPA, 2 with nfvPPA, 3 with svPPA
  - Cluster 2: The most severely impaired emotion recognition in speech and faces, with stage 3 deficits
    - 2 with nfvPPA, 3 with svPPA
  - Cluster 3: Most participants in cluster 3 did not have impaired emotion recognition in either speech or faces
    - 10 with lvPPA, 4 with nfvPPA, 2 with svPPA
- The six assessments loaded onto two dimensions
  - Dimension 1 explained 52.2% of the variance.
  - Dimension 2 explained 18.7% of the variance.

Discussion

- Many participants with PPA had impaired recognition of emotion in speech and faces.
- LASSO analyses indicated that several LH and RH regions were important for emotion recognition, and each prosodic stage
- Important regions for receptive prosody included right inferior frontal gyrus and basal ganglia.
- Impaired emotion recognition was characterized by different patterns of deficits of the three-stage model of receptive prosody.
- Patients in clusters 1 and 2 would likely benefit from different receptive aprosodia treatment approaches.

Acknowledgements

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