Automated measurement of expressive prosody in neurodevelopmental disorders

Emily Tucker Prud'hommeaux[1], Jan van Santen[1], Rhea Paul[2,3], Lois Black[1]

[1]Oregon Health and Science University Center for Spoken Language Understanding, [2]Yale University Child Study Center, [3]Southern Connecticut State University

Motivation

- Autism Spectrum Disorders (ASD) are associated with impaired expressive prosody.
- Existing prosodic performance evaluation methods rely on human judgments, which are time-consuming and subjective.

Objective: Establish the validity of automated digital measures of prosody by comparing automated objective measures with human judgments.

Background

Four tasks completed by TD and ASD subjects (age 4-7 yrs) as part of *Expressive & Receptive Prosody in Autism* grant (NIH 1R01DC007129) [1].

1. **Lexical Stress**: Repeat disyllabic word with initial or final stress.
2. **Syntactic Phrasing (PEPS-C Chunking)**:Describe picture indicating the number of items, e.g., "chocolate, cookies, and jam" vs. "chocolate-cookies and jam" [2].
3. **Pragmatic Style:** Talk about a picture using prosody appropriate for a baby vs. an adult.
4. **Pragmatic Focus (PEPS-C Focus):** Correct an inaccurate description of a picture, e.g., if blue cow is described as green, the subject responds "BLUE cow" [2].

Responses scored on a scale from -1 to 1 using automated methods that capture contrastive melodic and temporal speech patterns [1].

Experimental Design

Data and Subjects

- Forty minimal utterance pairs selected for each task: each pair from single speaker with same lexical content but different target prosody.
- Pairs selected randomly from dataset to fully represent the score space.
- Four judges: adult speakers of American English.

Presentation

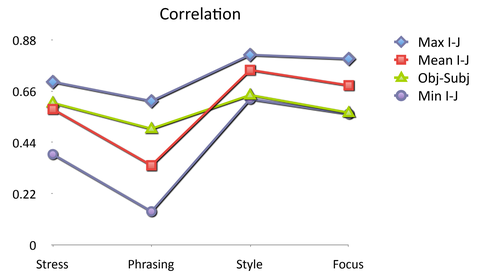
- Test administered via self-directed web interface with one pair per page.
- Pairs and elements of each pair presented in random order.
- Judges asked to indicate which of two utterances corresponded to the target meaning and their certainty about that judgment.

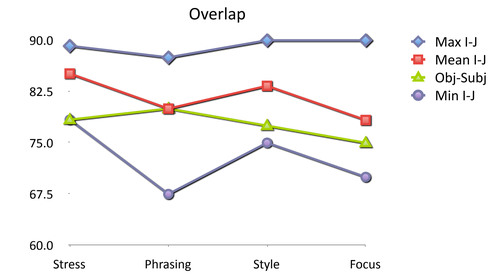
Scoring

- Judges' responses scaled to range from -1 to 1.
- Correlation calculated between judges and between objective automated measure and subjective scores.
- Overlap in polarity counted between judges and between objective automated measure and weighted mean subjective score.

Results

Task Name	Mean Inter-judge		Min Inter-judge		Max Inter-judge		Objective vs. Subjective	
	Correlation	Overlap	Correlation	Overlap	Correlation	Overlap	Correlation	Overlap
Stress	0.58	85.14	0.39	78.38	0.70	89.19	0.61	78.38
Phrasing	0.34	80.00	0.15	67.50	0.62	87.50	0.50	80.00
Style	0.75	83.33	0.63	75.00	0.82	90.00	0.64	77.50
Focus	0.69	78.33	0.56	70.00	0.80	90.00	0.57	75.00





Summary

- All tasks: Correlation between objective and mean subjective scores > minimum inter-judge correlation.
- All tasks: Overlap between objective and mean subjective scores >= minimum inter-judge overlap.
- Lexical Stress and Syntactic Phrasing: Objective-subjective correlation > mean inter-judge correlation.
- Syntactic Phrasing: Objective-subjective overlap = mean inter-judge overlap.

Conclusions

Automated digital measures of prosody:

- require less time than human assessment;
- are comparable in reliability to consensus subjective judgment;
- can identify correct target prosody as reliably as human judges; and
- show potential for identifying new, more specific speech-based markers for ASD.

More data needed to determine if objective measures discriminate better between groups than subjective measures

References

[1] van Santen J., Prud'hommeaux, E.T., Paul, R., Black, L., Shriberg, L. 2008. Expressive prosody in autism: Effects of prosody function and processing demands. Poster presented at *IMFAR 2008.*

[2] Peppé, S. and McCann, J. 2003. Assessing intonation and prosody in children with atypical language development: the PEPS-C test and the revised version. Clinical Linguistics and Phonetics 17(4-5), 345-354.

Sponsors

NIH 1R01DC007129 (PI: van Santen, I: Black, Paul), Autism Speaks Mentor-based Fellowship (Prud'hommeaux)