

Articulation from acoustics: estimating constriction degree from the acoustic signal

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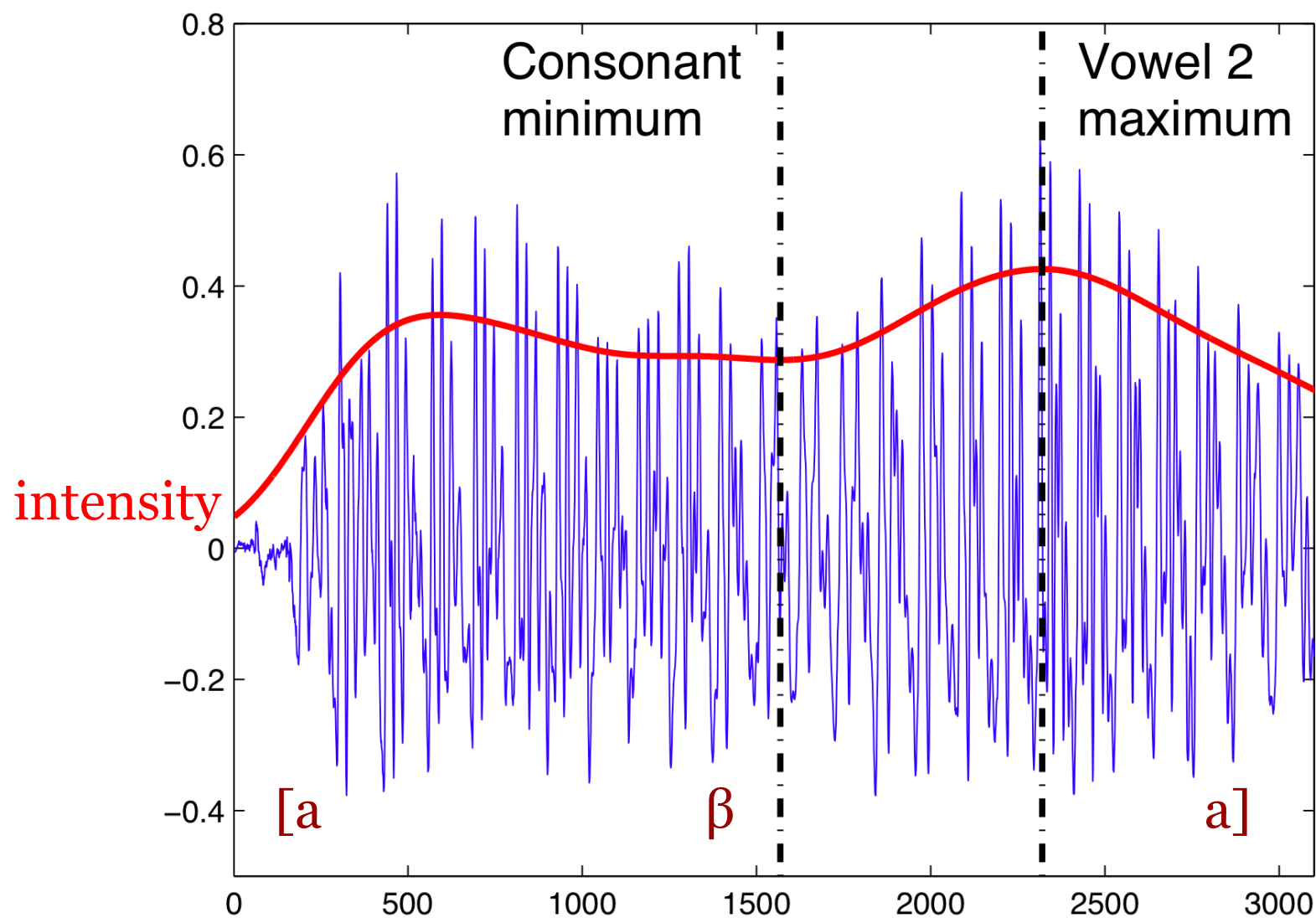
Background

- Many studies on lenition in Spanish have used **acoustic measurements** to estimate constriction degree during a stop closure/approximation
- Studies have used various methods, but all are based on the **intensity** of speech during the consonant constriction
- Up to now: no way to determine accuracy of various acoustic measurements

Possible Measurements

- Intensity Ratio (IntRatio)
 - intensity @ C minimum
intensity @ V2 maximum
(e.g. Romero et al 2007)
- Intensity Difference (IntDiff)
 - intensity @ V2 maximum – intensity @ C minimum
(e.g. Cole et al. 1999, Hualde et al. 2010, Martínez Celdrán & Rgueira 2008, Ortega-Llebaria 2004, Soler & Romero 1999)
- Maximum Rising Velocity (MaxVel)
 - Maximum velocity of intensity curve between location of C minimum and V2 maximum
(Hualde et al. 2010, Kingston 2008)

Measurement locations



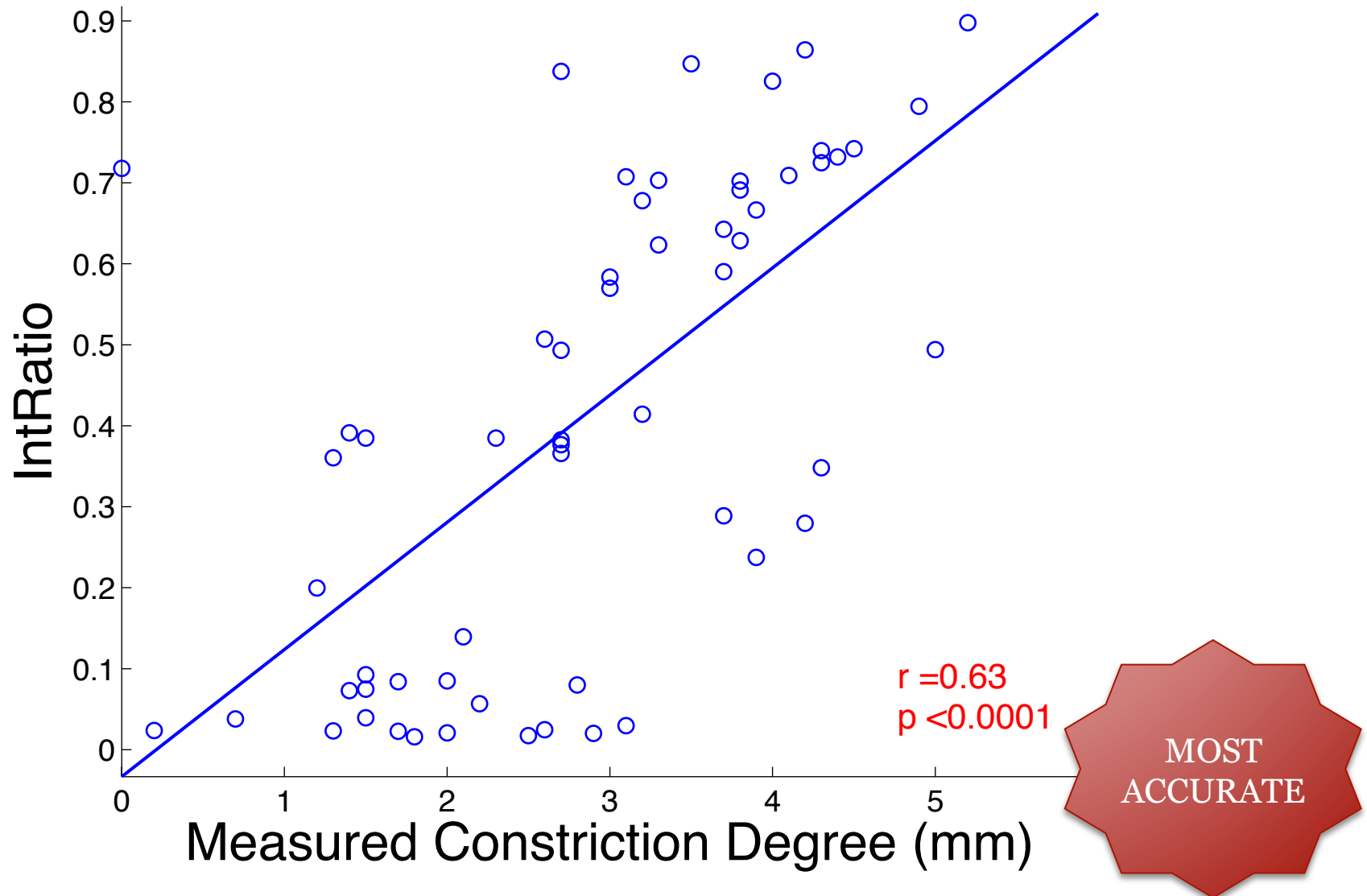
Study questions

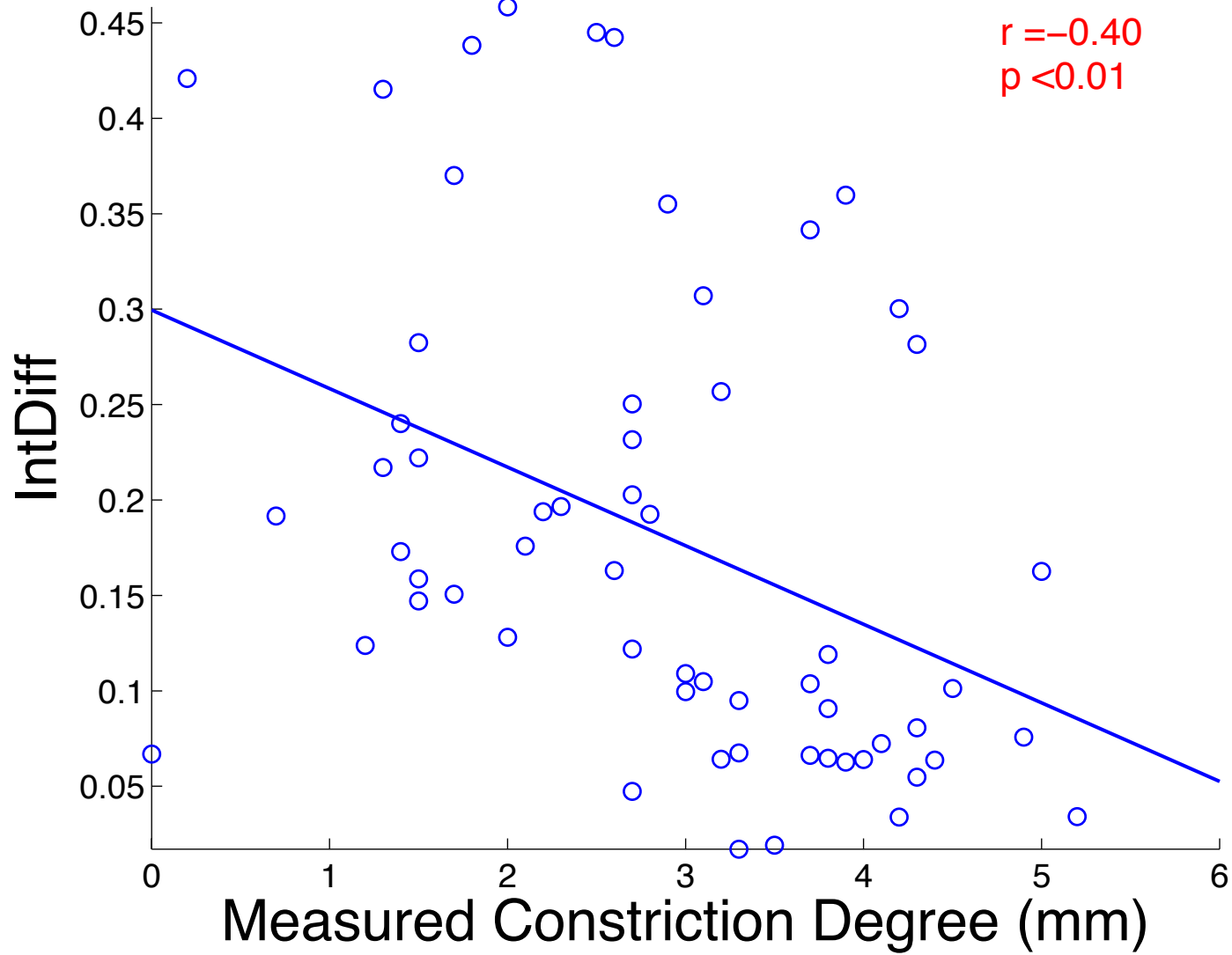
- Which derived acoustic measure of constriction best matches articulatory constriction?
- Does method of calculating intensity make a difference?
- How does filtering out F0 affect measurements?
(Hualde et al. 2010)

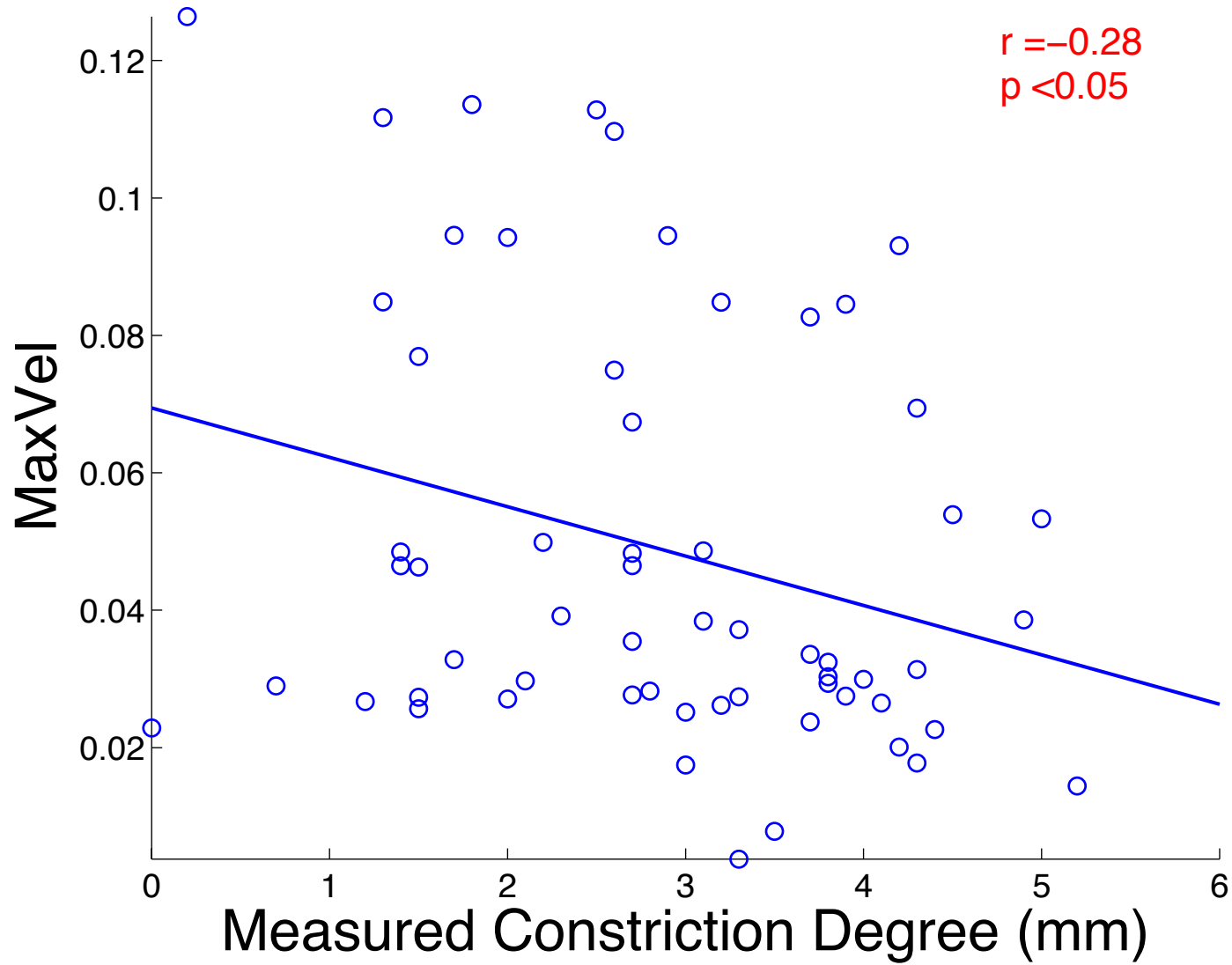
Methods

- Compare various acoustic measurements of constriction for intervocalic /b/ with articulatory measurements of Lip Aperture for same tokens
 - Electromagnetic Articulometry (EMA)
 - 2 subjects, ~ 30 tokens each
- 2 methods for calculating intensity envelope:
 - Root-mean-square (RMS)
 - Low-pass filter (< 20 Hz)
- 6 acoustic measurements:
 - IntRatio, InDiff, MaxVel
 - IntRatio, InDiff, MaxVel (high-pass filter @ 250Hz)

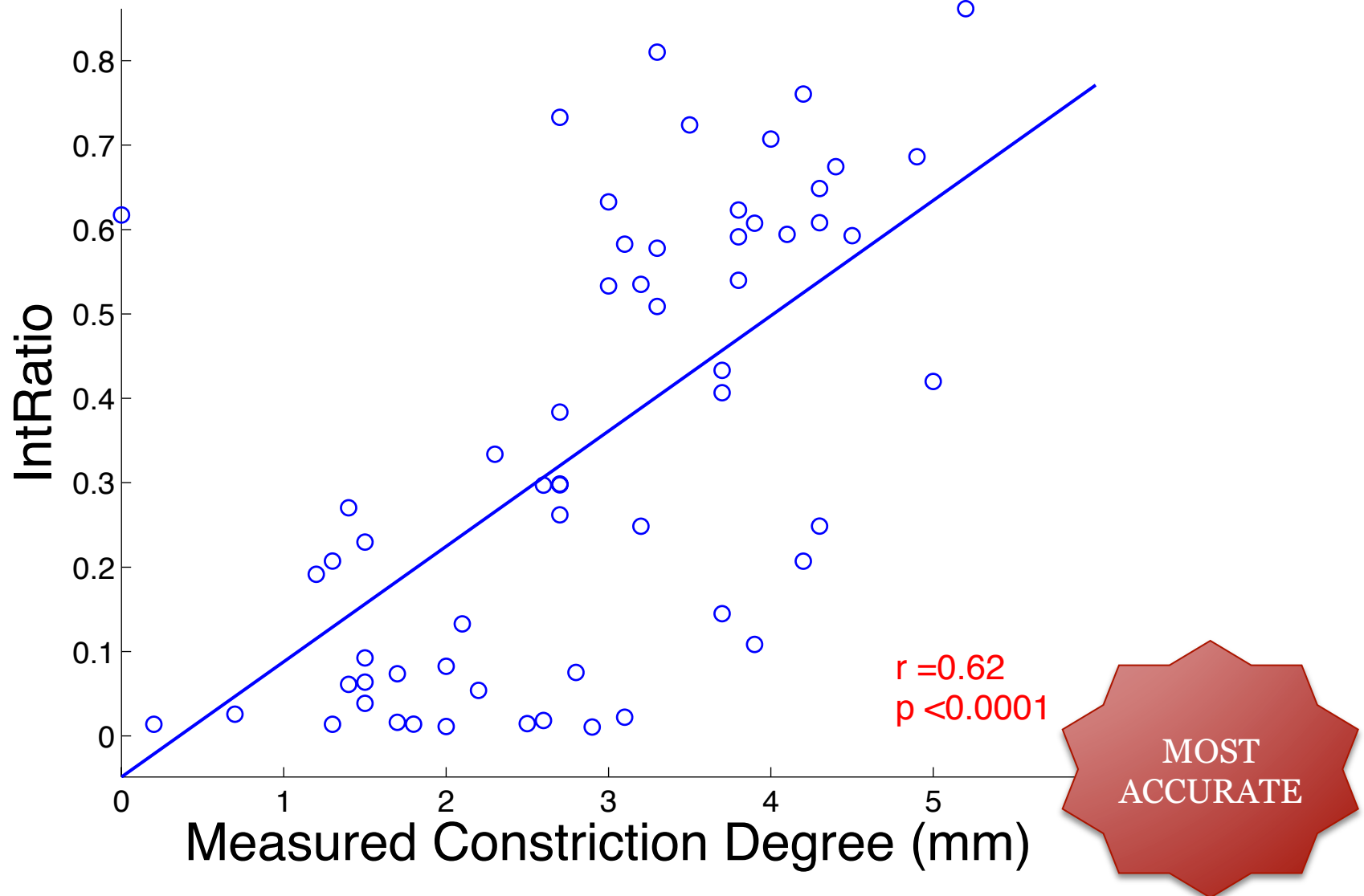
Results: RMS

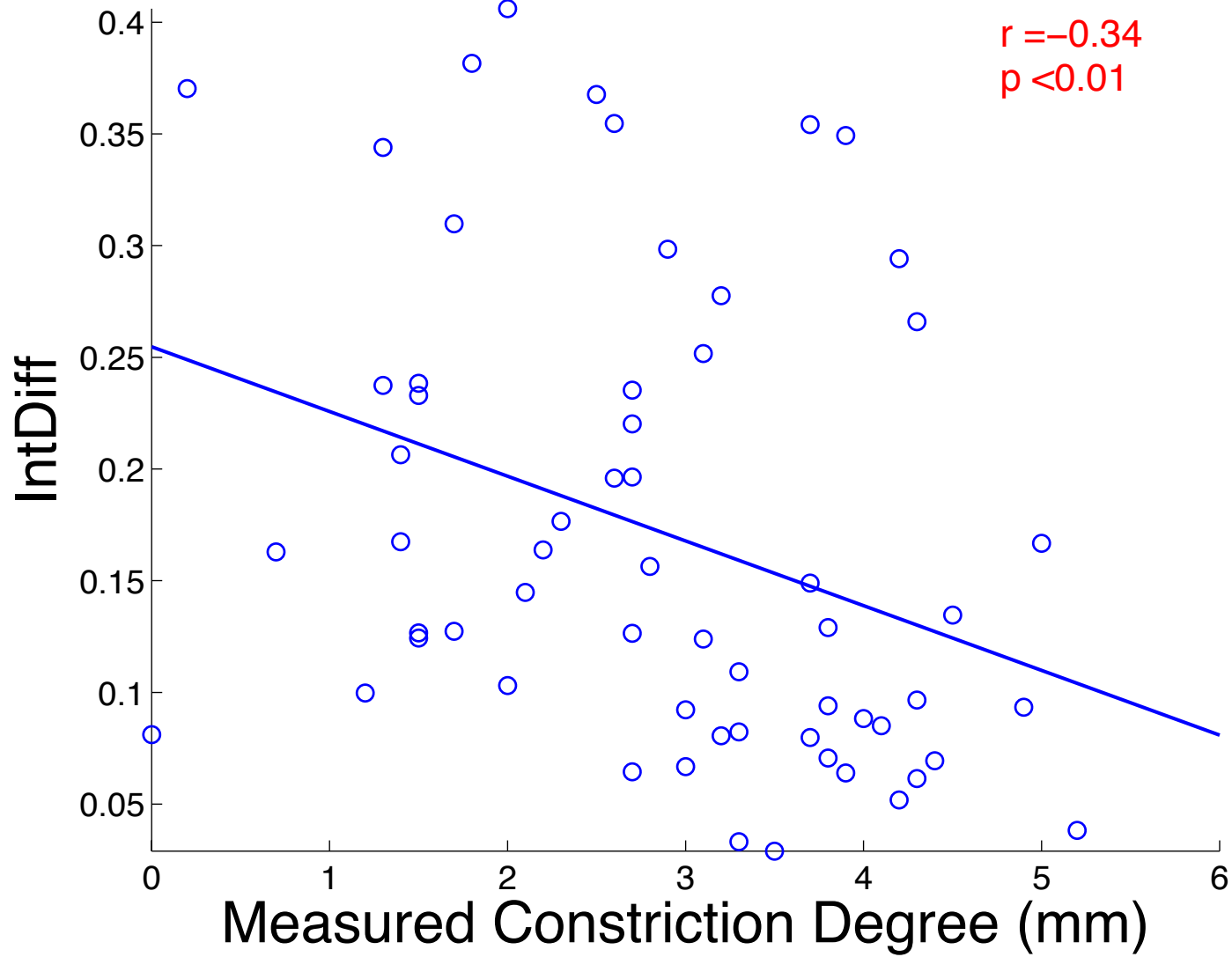


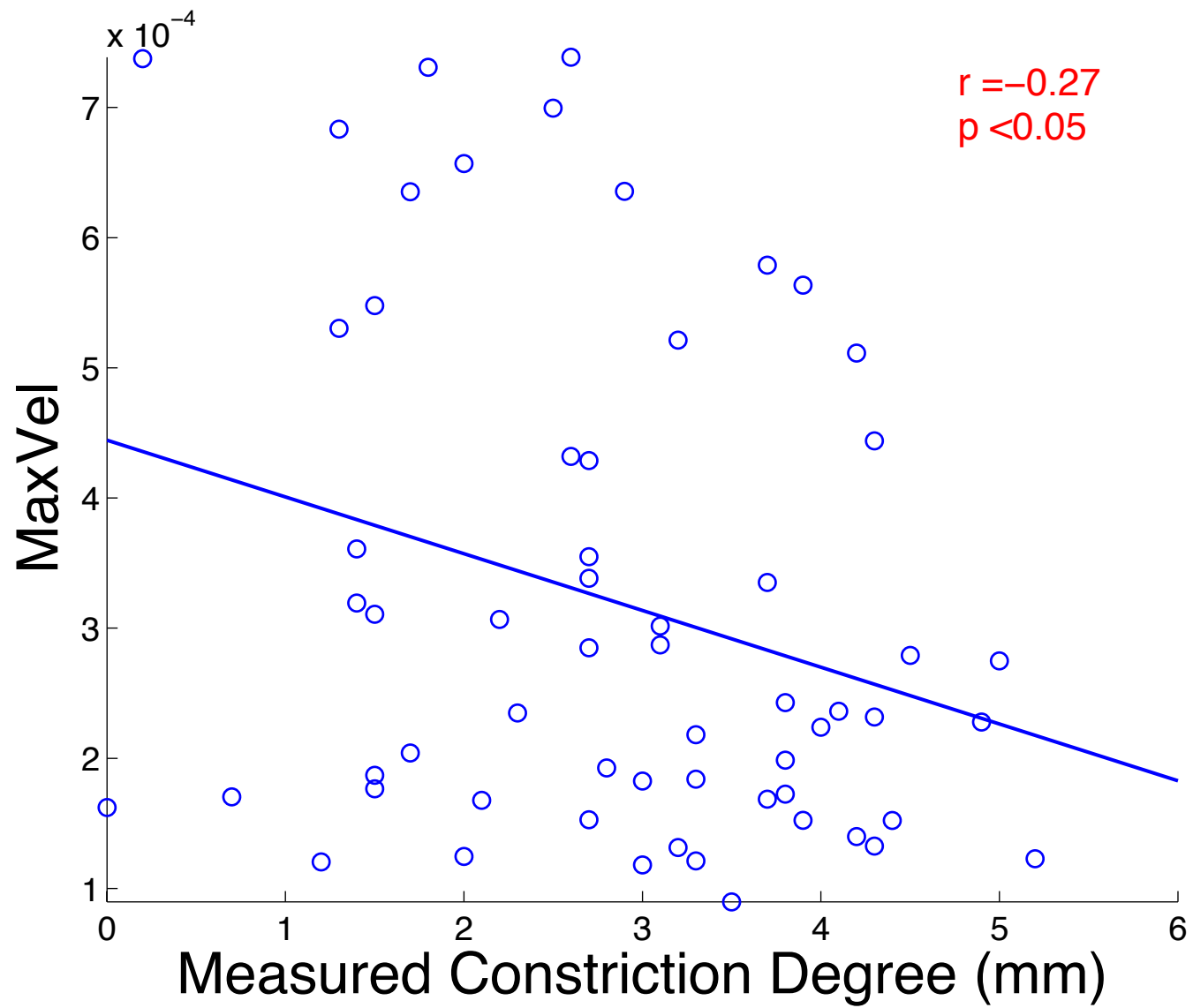




Results: Low-pass Filtering







Results: High-pass filtering

- High-pass filtering does not improve accuracy

	Unfiltered	High-pass filtered
RMS: IntRatio	$r = 0.63$	$r = 0.63$
RMS: IntDiff	$r = -0.40$	$r = -0.40$
RMS: MaxVel	$r = -0.28$	$r = -0.28$
LPF: IntRatio	$r = 0.62$	$r = 0.56$
LPF: IntDiff	$r = -0.34$	$r = -0.20$
LPF: MaxVel	$r = -0.27$	$r = -0.27$

Conclusions

- High-pass filtering to eliminate Fo is unnecessary, and may **decrease** accuracy
- All three acoustic measurements are relatively insensitive to changes in calculation of intensity
- **Intensity Ratio** gives the most accurate measurement from the acoustic signal when compared to the measured articulatory constriction degree

References

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