Assessment of the TMJ in Juvenile Idiopathic Arthritis Using Acoustic Emissions Generated from Jaw Movements in Two Planes

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BACKGROUND

- The temporomandibular joint (TMJ) is one of the most commonly affected joints in juvenile idiopathic arthritis (JIA).[1]

- TMJ sounds (e.g. crepitus) are a common but poorly understood sign.

- Early detection of TMJ involvement in JIA is difficult due to inconsistent symptoms and low sensitivity of conventional imaging (i.e. panorex), and variable physical exam.

- Magnetic resonance imaging (MRI) is necessary for a formal diagnosis, but MRI is time consuming, expensive, require contrast administration, and sometimes sedation.

- Acoustic emissions (AEs) produced during joint articulation have previously been shown to correlate well with affected knees in children with JIA.[2,3]

- These sounds may be able to serve as a non-invasive measurement and/or physiologic biomarker of TMJ involvement in children with JIA.

OBJECTIVE

- To determine TMJ involvement in children with JIA using the TMJ AE's profile.

METHODS

- Subjects: 15 children with JIA (7 with TMJ sounds, 8 without TMJ sounds)
- Custom headgear with embedded uniaxial accelerometers positioned above the TMJ.
- Subjects performed 10 cycles of 2 standardized movements (open/close, medial/lateral) at a rate of 1 cycle per 4 seconds while watching a demonstration video. The video allows children of all ages to easily reproduce the exercises at a constant speed.
- While performing the exercises, the sounds are recorded using a custom MATLAB script that records both microphones simultaneously.
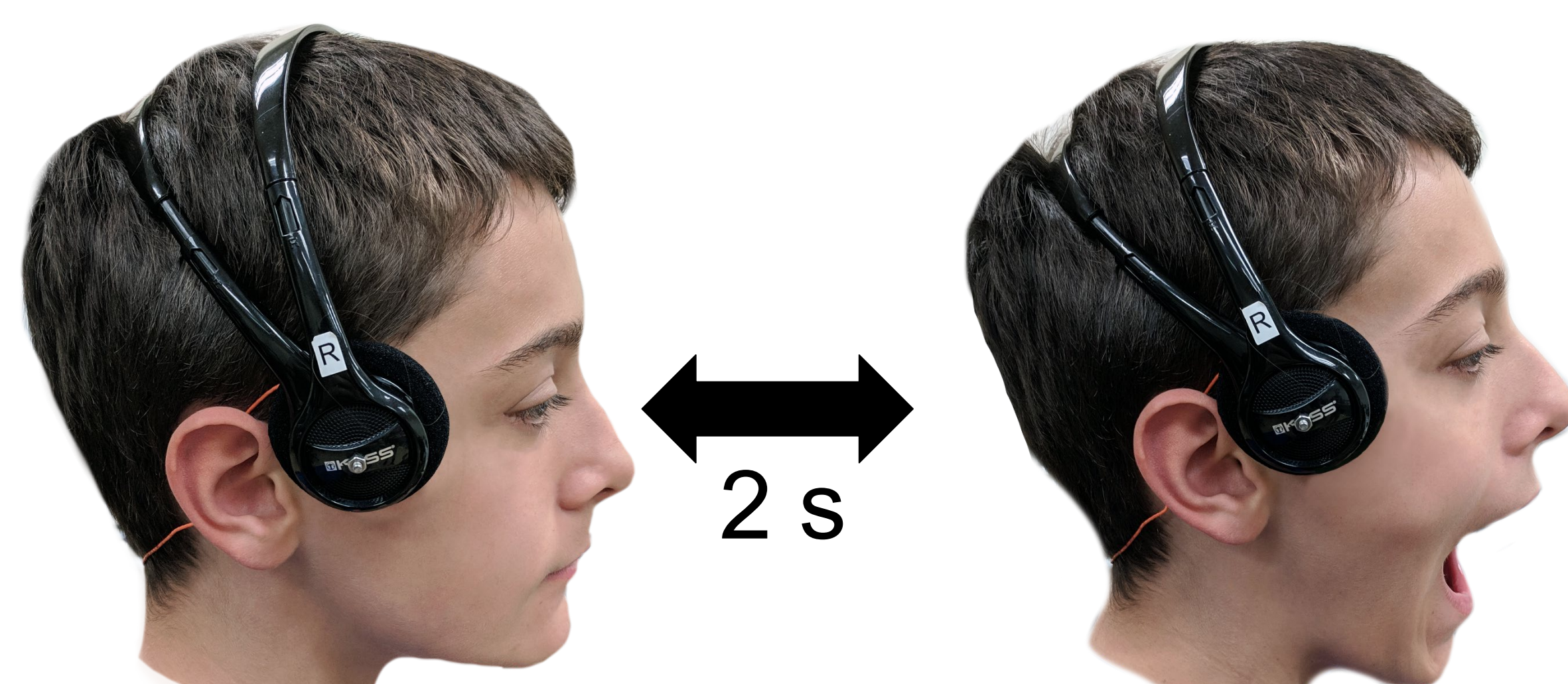

Figure 1. TMJ sound recording headset is worn while performing jaw exercises.
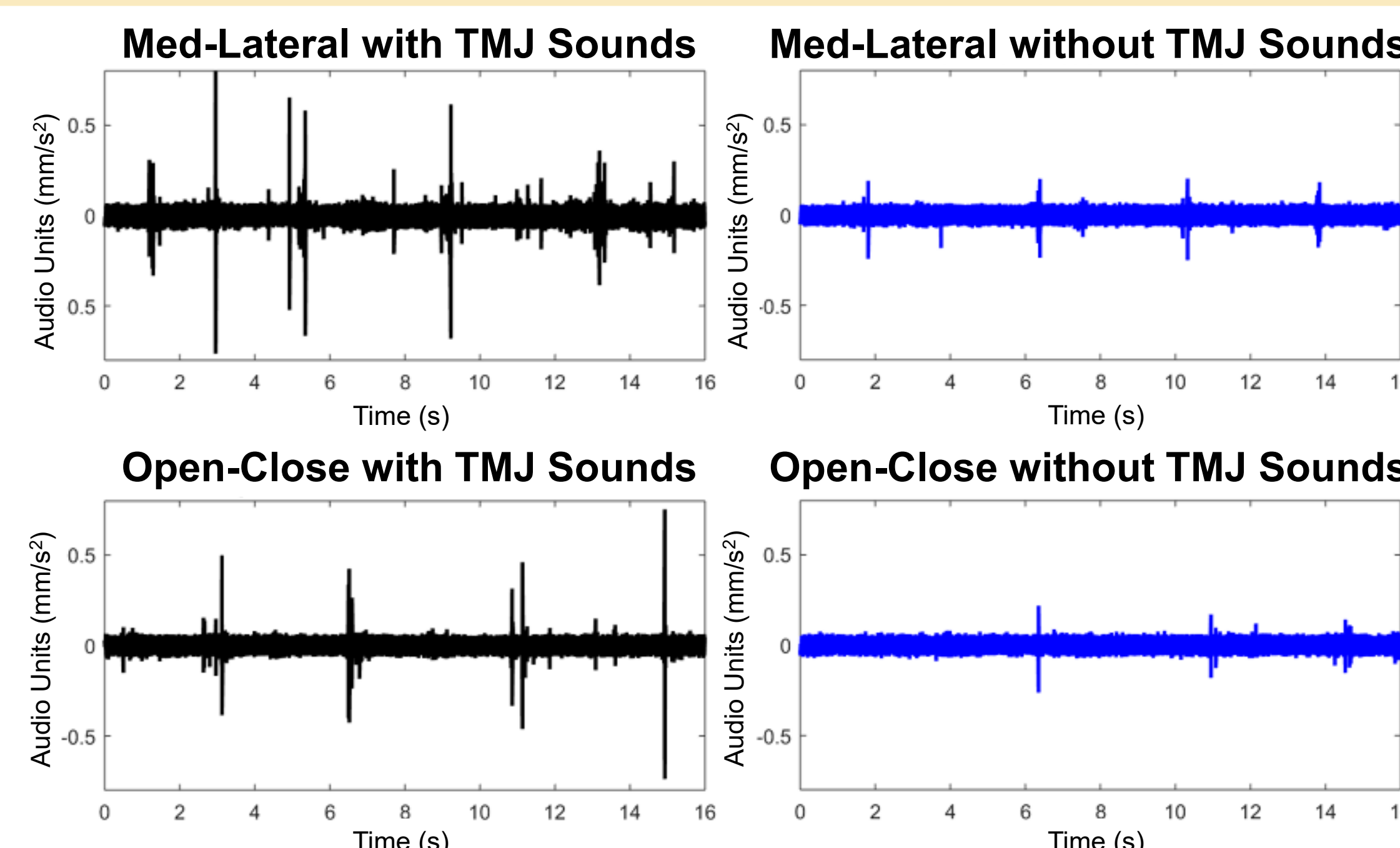

Figure 2. Time Domain Acoustic Emission Signals. Representative time domain signals of two JIA patients, one with (left) and one without (right) TMJ sounds. Patient with TMJ sounds had noticeable clicks and grinding
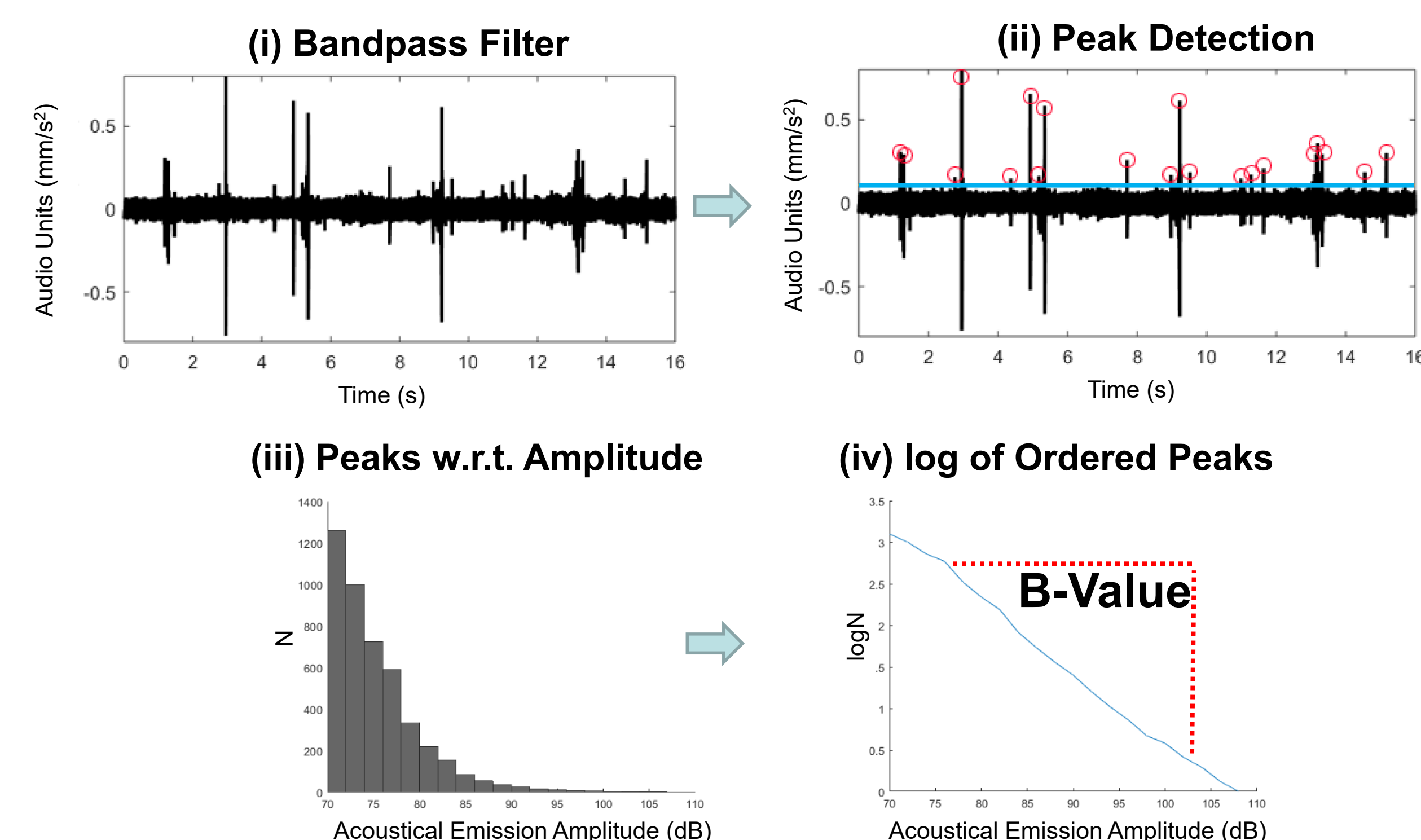

Figure 3. Signal Analysis and Representative b-Value Calculations. (i) Each microphone's recorded acoustic signal is bandpass filtered (250 Hz – 20 kHz), (ii) then the peaks are detected above a threshold (RMS Power + noise maximum). (iii) The peaks are ordered based on amplitude, and (iv) the log of the ordered peaks is taken. The slope of the line in (iv) is the b-Value.
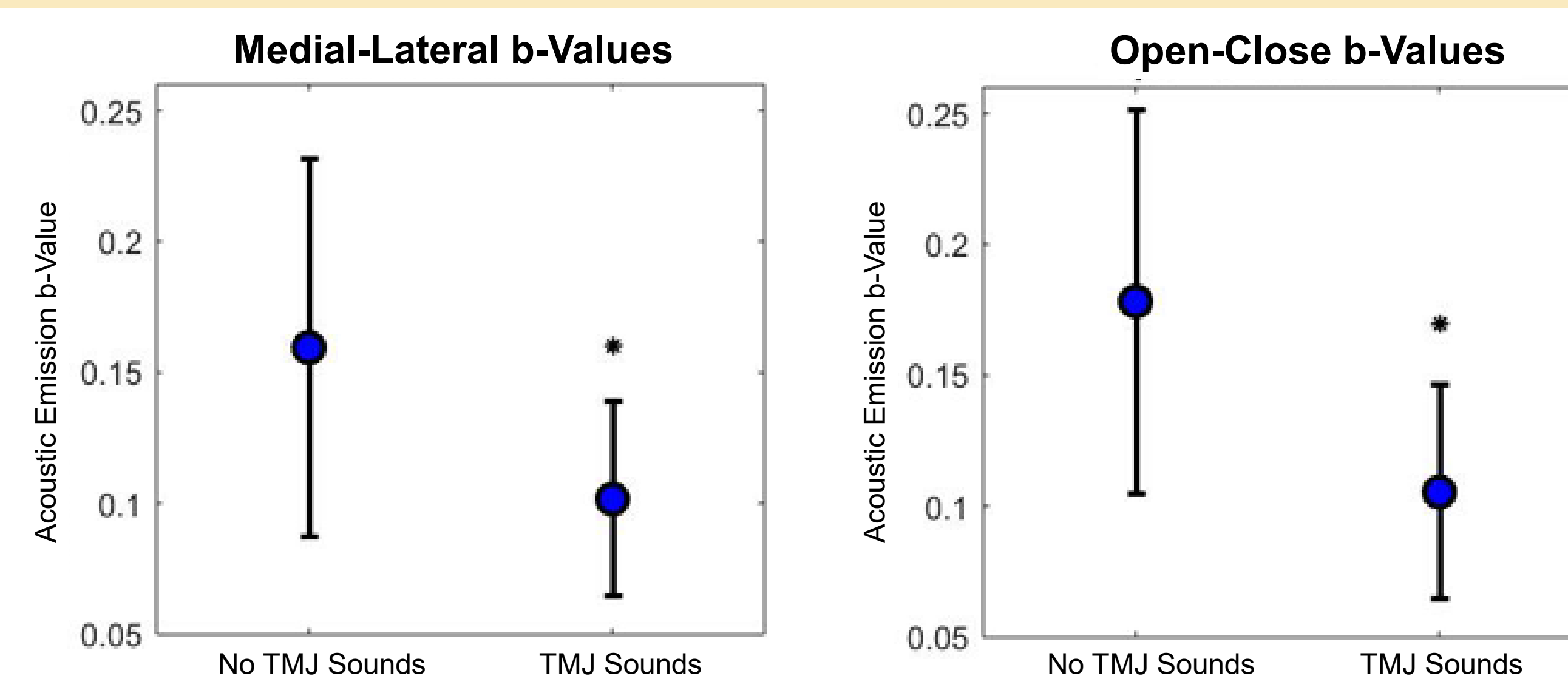

Figure 4. b-Value Analysis: The b-Value was compared between the JIA groups with and without TMJ signs. The mean b-value was significantly different when compared using a one-tailed, unmatched t-test in both exercises. **(p=0.0059 & 0.0009)**

RESULTS

- Qualitatively, the time-domain AE signal appears more chaotic in patients with TMJ sounds.
- TMJs of patients with JIA without TMJ involvement produced a comparatively smoother signal
- The b-Value metric showed significant differences between the two groups for both medial-lateral and open-close exercises (p=0.0059; 0.0009, respectively).

CONCLUSIONS

- In this group of patients, AEs were different in children with JIA and TMJ sounds and without TMJ sounds.
- With further recruitment of subjects and refinement of this technique, assessment of TMJ sounds may one day serve as a viable screening tool for TMJ involvement in JIA.

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