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Decreased Stuttering while Walking: Speech and fMRI Findings

Yürüme Sırasında Azalan Kekemelik: Konuşma ve fMRI Bulguları

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Anahtar Kelimeler: Fonksiyonel manyetik rezonans görüntüleme, ayak hareketi, motor hareket, konuşma akıcılığı, eşzamanlı hareket, kekemelik

Dear editor,

Stuttering is a speech disorder characterized by disruption of either involuntary speech fluency patterns (e.g., blocks, repetitions, prolongations) or various involuntary movements of the face, head, limbs, and body, which can be secondary behaviors that may accompany stuttering (1). Stuttering is not restricted to only speech-motor functions. Recently, it has been indicated that there are subtle motor deficits beyond the stuttering speech domain (2). Extensive research has been conducted on stuttering to date, but the causal mechanism of stuttering remains elusive.

We present a case of a 27-year-old right-handed, bilingual female evaluated for severe developmental stuttering. The audiometric and neurological examinations were normal. The speech samples were recorded in two conditions: speaking while sitting (Video 1) and speaking while walking (Video 2). The samples were recorded before the functional magnetic resonance imaging (fMRI) procedure and were evaluated using Stuttering Severity Instrument-3 (3). As shown in Table 1, the speech sample while walking, including the total overall score, physical concomitants, frequency score, and duration score, was dramatically reduced, respectively, relative to the total overall score of the speech sample while sitting.

Further analysis of the physical concomitants showed that distracting sounds (e.g., noisy breathing) and facial grimaces (e.g., eye blinking) were observed more frequently than other physical concomitants. The secondary behaviors, specifically eye blinking while initiating the speech, were observed mainly in condition 2 (speaking while sitting). Contrarily, secondary behaviors were significantly decreased in condition 1 (speaking while walking).

The overall dysfluency rate was 8.4% in condition 1 and 19.3% in condition 2. The distribution of the dysfluency types was also different in both conditions (Figure 1).

The fMRI procedure acquired T1-weighted structural and functional images on a 3T-MRI scanner (Philips Achieva, Best, Netherlands). The experiment included three conditions: S (speaking only), LM (left and right ankle dorsiflexion, respectively), and SLM (speaking with simultaneous lower limb movement). The case comprised two runs of three blocks containing S, LM, and SLM, respectively. There were five questions per S and SLM. In total, the patient answered 20 questions (e.g., "Talk about your job") along with two runs (Figure 2).

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Table 1. The distribution of stuttering severity components according to SSI-3 for the speech samples in two conditions		
SSI-3	**Speaking while walking**	**Speaking while sitting**
Frequency score (mean)	10	18
Duration score	8	12
Physical concomitants	1	14
Total overall score	19	44
Severity category	Mild	Very severe

In terms of moving lower limbs, item of movements of the extremities, in the physical concomitants section, was non-applicable for the speech sample while walking.
SSI-3: Stuttering Severity Instrument-3

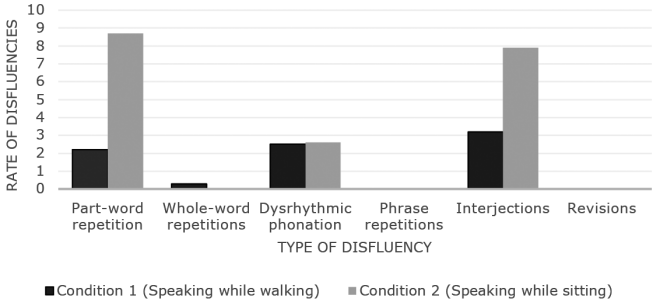

Figure 1. Frequency of different disfluency types in two conditions (speaking while walking and speaking while sitting)

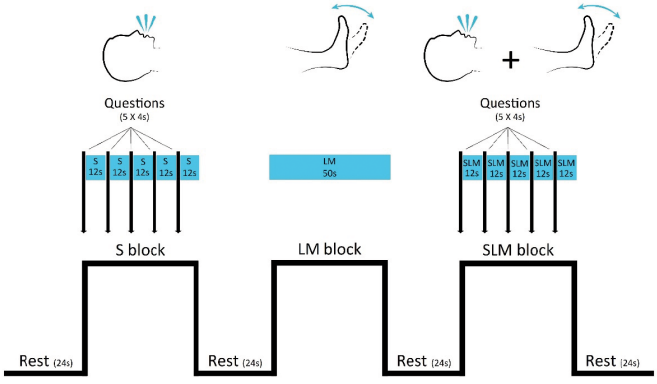

Figure 2. Experimental design
LM: Lower-limb movements only, S: Speaking only, SLM: Speaking during simultaneous lower-limb movements

Whole-brain analysis {SLM > (S + LM) contrast} revealed significantly greater activation at four clusters in the SLM compared to the total of S and LM. The most significant cluster was in the right pre-and post-central gyri and right supplementary motor area (SMA). Increased activations were also observed in the left pre-and post-central gyri and left SMA, the right fusiform gyrus, and the left middle, medial, and superior frontal gyri (Figure 3).

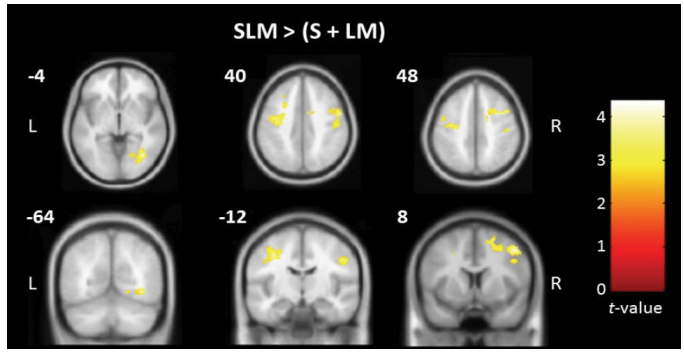

Figure 3. Brain areas that showed significantly greater activation during SLM compared with S and LM (cluster forming threshold uncorrected $P < 0.005$, cluster-level FWE corrected $P < 0.005$). The color bar indicates t-values
L: Left, R: Right, S: Speaking only, SLM: Speaking during simultaneous lower-limb movements

There is no known cure for stuttering, though many treatment approaches may assist the person who has stuttering to some degree. There might be a subtype of stuttering that benefits from rhythmic lower limb movements to improve speech fluency. Locomotor movements or walking have a potential pacemaker effect on stuttering. Knowledge of this subtype of stuttering is crucial because of the potential contribution to the stuttering treatment.

Ethics

Informed Consent: Written consent was obtained.
Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Ö.Ö-D., Ç.U-Y., E.K., Concept: Ö.Ö-D., Ç.U-Y., E.K., T.D., Design: Ö.Ö-D., Ç.U-Y., E.K., T.D., Data Collection or Processing: Ö.Ö-D., Ç.U-Y., E.K., Analysis or Interpretation: Ö.Ö-D., Ç.U-Y., E.K., T.D., Literature Search: Ö.Ö-D., Writing: Ö.Ö-D., Ç.U-Y.

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Video 1. A video recording of an example of speech while the case sits still

https://www.doi.org/10.4274/tnd.2022.40501-video-1

Video 2. A video recording of an example of speech taken while the case walks

https://www.doi.org/10.4274/tnd.2022.40501-video-2

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