Music and Movement: Techniques and Directions in Parkinson's Research

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Introduction

- Parkinson's disease is a neurodegenerative disorder characterized by the loss of dopaminergic neurons in the basal ganglia. This causes abnormal movements/gait among other symptoms[5].
- The basal ganglia is also involved in beat perception; the loss of neurons in this area decreases beat-based rhythm discrimination. This may have implications for walking as impaired beat perception may affect rhythm generation, and walking is a rhythmic movement[1].
- Music has the potential to benefit Parkinson's patients in gait rehabilitation by providing external rhythmic cues[3]. Various aspects of music are currently being investigated to determine which ones most prominently improve gait in Parkinson's disease.
- One of the tools used to conduct this research on the impact of music qualities on gait is the gait mat.

The Gait Mat

- The gait mat, formally the Zeno[TM] Walkway, is a mat with pressure sensors which can detect various elements of gait and stance[4].
- There are numerous variations of the gait mat, depending on their intended use.
  - Smaller gait mats can accommodate walking in a straight line and standing measurements[4].
  - Larger gait mats can also accommodate turning during walks, as well as pressure measurements from walking aids such as canes and walkers[4].

Fig. 1. Example of a Zeno[TM] Walkway[4]. Gait is recorded in the thicker segment of the mat (right in the image) and is not recorded in the thinner strip or on the black border.
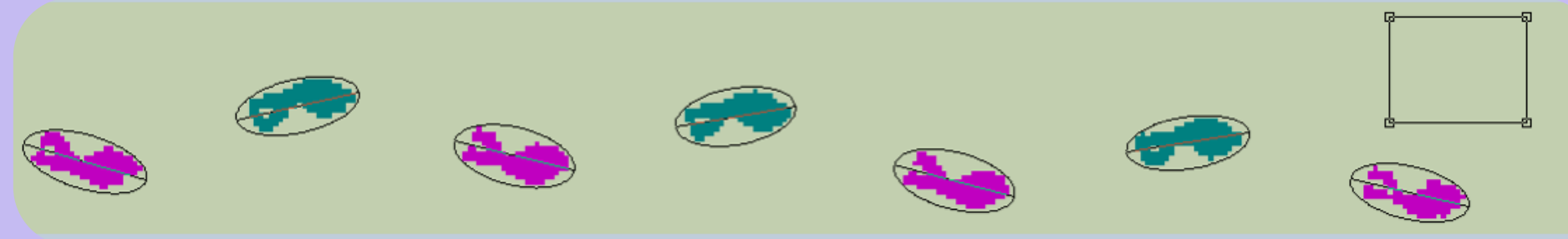
Gait Mat Output

Fig. 2. Recording of a walk using PKMAS software. During processing, the walk is reviewed to ensure that footsteps were recorded correctly. Right steps are labelled as purple and left steps are labelled as green. Steps less than 50% off the mat are marked as other (yellow), as well as any additional pixels that are not part of a footstep.

		First Contact (sec.)	Last Contact (sec.)	Foot Heel X Location (cm.)	Foot Heel Y Location (cm.)	Stride Length (cm.)
19	Right 5	32.892	33.575	229.095	28.223	133.660
20	Left 5	33.408	34.146	161.857	16.191	124.756
21	Right 6	33.967	34.754	95.435	27.881	
22	Left 6	34.517	35.363	37.107	14.943	
23	3: Left 1	41.963	42.746	59.553	24.060	141.912
24	Right 1	42.579	43.288	129.935	12.658	143.737
25	Left 2	43.133	43.842	201.454	22.221	147.429

Fig. 3. Sample table with gait data as produced by PKMAS after processing a walk.

Gait Measurements

The gait mat takes numerous gait measurements, the uses of which depend on the research being done. Some of the measurements include[2]:

Footfall measurements: Foot length, width, area, pressure and angle (relative to direction of walk).

Step length: Distance one foot moves in front of the other, measured from heel to heel.

Stride length: Double step length, measured from heel to heel of the same foot.

Walking base: Distance between feet, measured from center of heels.

Cadence: Number of steps in a given time (i.e. steps per minute).

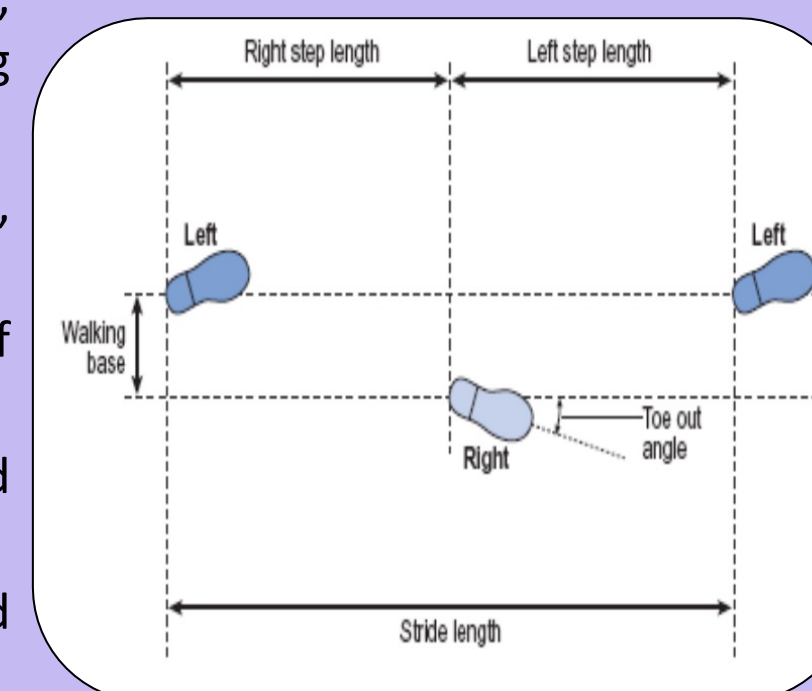**Walking speed:** stride length (m) / cycle time (s)

Fig. 4. Step length, stride length, walking base, and angle[2].

Current Music and Gait Studies

Groove/Metronome Study
(von Handorf & Grahn)

Objective: To determine if high beat salience (i.e. strength of beat) is the element of high groove music which impacts gait.

Implications for Parkinson's disease: The high beat salience of high groove music may be beneficial in gait rehabilitation for Parkinson's disease patients as it may cause longer/faster strides[3].

Parkinson's Disease Imagery Study
(Rose & Grahn)

Objective: To determine if auditory imagery can be used as a cue for gait.

Implications for Parkinson's disease: Using music in real-life situations to cue gait may not be feasible. This study examines whether imagined music can be used to regulate gait in people with Parkinson's disease.

References

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[4] ProtoKinetics. (n.d.). *PKMAS – ProtoKinetics Movement Analysis Software*. ProtoKinetics. https://www.protokinetics.com/pkmas/

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