Understanding rhythm perception, production and entrainment in relation to dance for people with Parkinson's disease.

University of Hertfordshire

Rose, D., Annett, L. E., & Lovatt. P. J
Dept. of Psychology & Sport Sciences
School of Life and Medical Science
Contact: d.rose3@herts.ac.uk

Work in Progress

1 - Purpose of Study:

Studies have shown that music and dance-based interventions can be of benefit to some people with Parkinson's disease (PD), but not all (see e.g. Benoit et al., 2014; Lewis et al., 2014; Nombela et al., 2013). Why might this be?

Research investigating sensorimotor synchronisation (SMS) in people with PD have shown mixed results in terms of variability and accuracy in comparison to controls (see Jones & Jahanshahi, 2014 for review). Perhaps the timing mechanisms affected by PD in the basal ganglia also affect beat-based rhythm perception for some, as suggested by Grahn & Brett (2007; 2009).

Table 1. Preliminary data showing SMT across modalities

Modality	Group (n=9)	Mean	Std. Deviation	Range
Finger *bpm*[a]	pwPD[b]	108	18.95	69-133
	AMC[c]	121	13.45	98-143
Finger *ms*[d]	pwPD	573	125.33	451-870
	AMC	500	57.45	420-612
Toe *bpm*	pwPD	112	17.45	81-145
	AMC	124	13.81	111-150
Toe *ms*	pwPD	550	88.72	414-741
	AMC	487	50.07	400-541
Marching *bpm*	pwPD	110	11.70	92-134
	AMC	119	20.04	98-161
Marching *ms*	pwPD	549	57.56	448-652
	AMC	515	80.10	373-632

[a] beats per minute, [b] people with Parkinson's Disease, [c] Age Matched Controls, [d] milliseconds

No significant differences between groups or modalities.

2 - External Cueing:

Recently, Cameron et al. (2016) found no difference between PD and neurotypical controls in a music based beat perception test. This suggests music offers additional external cues (in comparison to a metronome). In our current study we explore SMS using naturalistic instrumental musical excerpts in comparison to tempi matched metronome ranging from 77 bpm (779 ms) to 144 bpm (417 ms). We predict that with the metronome stimuli, people with PD will perform with higher levels of asynchrony in comparison to age matched controls (AMC), but that differences between these groups will be less apparent using the tempo-matched music.

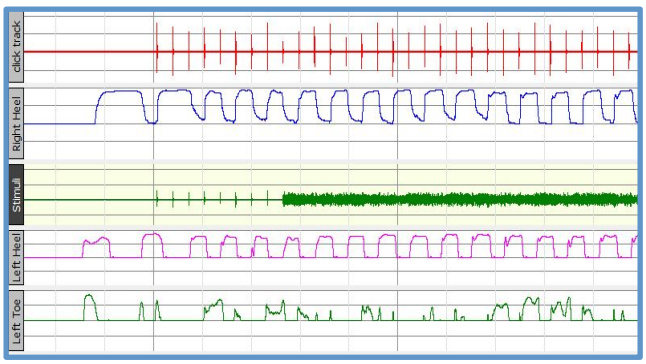

Figure 1. Sample of Marching data, showing graph file from BioPac

3 - Discrete and Continuous Timing:

Recently, Dione and Delevoye-Turrell (2015) suggested there may be a critical tempi threshold which modulates between emergent and predictive timing. With this in mind, we consider the modality of entrainment to music in a novel paradigm. Here we show how we are investigating modality effects by comparing finger tapping and toe tapping (utilising a stomp box), and marching up and down 'on the spot' as a proxy for dance in a sample of healthy students (N=36), as well as people with PD and AMC (data collection is ongoing). We predict higher asynchrony in the finger and toe tapping for people with PD due to the discrete nature of this action, in comparison to the continuous nature of marching.

Measures

- Spontaneous Motor Tempo (Measure of Preferred Beat Period in all modalities)
- Sensori-Motor Synchronisation in all modalities (Finger Tapping, Toe Tapping, Marching up and down 'on the spot')
- Effect of Music (Familiarity/Preference in comparison to matched metronome tempi)
- Effect of Beat Perception Ability (Goldsmiths Beat Alignment Test, Müllensiefen et al., 2014)
- Effect of Musical Experience (Goldsmiths Musical Sophistication Index Müllensiefen et al., 2014)
- Effect of Dance Experience (Gold-Herts Dance Sophistication Index – Rose, Orgs, Lovatt & Müllensiefen in prep 2017)

Figure 2.
Finger Tapping using the Stomp Box

Figure 3.
Toe Tapping using the Stomp Box

Figures 4 & 5. Marching as a proxy for dance using two BioPac Heel and Toe Strike systems.

Research in collaboration with: Delevoye-Turrell, Y. (SCA Lab, Université du Lille, France) & Grahn, J. (Music & Neuroscience Lab, University of Western Ontario, Canada).

Sincere thanks: Juliet Boitout, Dan Cameron, Julia MacKenzie, Laurent Ott, Zoë Sole & Noel Taylor for their time and expertise, and to the participants for their patience and tenacity.

References: Benoit et al., (2014). Musically cued gait-training improves both perceptual and motor timing in Parkinson's disease. *Fronts. in Human Neuroscience*, *8*; Cameron et al., (2016). The effect of dopaminergic medication on beat-based auditory timing in Parkinson's disease. *Fronts. in neurology*, *7*; Dione & Delevoye-Turrell.(2015). Testing the co-existence of two timing strategies for motor control in a unique task: The synchronisation spatial-tapping task. *Human movement science*, *43*, 45-60; Jones & Jahanshahi. (2014). Contributions of the basal ganglia to temporal processing: Evidence from Parkinson's disease. *Timing & Time Perception*, *2*(1), 87-127; Lewis et al., (2016). Mood changes following social dance sessions in people with Parkinson's disease. *Journal of health psychology*, *21*(4), 483-492; Grahn & Brett (2007). Rhythm and beat perception in motor areas of the brain. *Journal of cog. neuroscience*, *19*(5), 893-906; Grahn & Brett. (2009). Impairment of beat-based rhythm discrimination in Parkinson's disease. *Cortex*, *45*(1), 54-61; Müllensiefen et al., (2014). The musicality of non-musicians: an index for assessing musical sophistication in the general population. *PloS one*, *9*(2), e89642; Nombela et al., (2013). Into the groove: can rhythm influence Parkinson's disease?. *Neuroscience & Biobehavioral Reviews*, *37*(10), 2564-2570.