Development of an objective measure of movement coordination for swimmers with central motor and neuromuscular impairments

Ana Maia[1], Luke Hogarth[2], Brendan Burkett[2], Carl Payton[1]

[1]Manchester Metropolitan University, UK

[2]University of the Sunshine Coast, Aus

BACKGROUND

- Classification aims to provide a framework for, and ensure, a fair competition
- Para swimming classification protocol review – develop valid, objective and reliable measures of impairment
- Neurological impairment
  - Lack of coordination – Capacity to perform a smooth, rapid and accurate movement

(Fang *et a*l., 2007)

BACKGROUND

- Swimmers with hypertonia, ataxia and athetosis undertake physical assessment involving repetitive single-joint actions at increasing speed
- Each joint scored from 0 to 5 based on subjective assessment of the movement
- Tests not suitable for evidence-based classification
  - high dependent on clinical judgment
  - lack key measurement properties required for evidence-based classification, e.g. reliable, precise, ratio-scaled (Tweedy *et al*., 2016)

AIM

To develop a revised test protocol based on the existing WPS physical assessment for swimmers with central motor and neuromuscular impairments incorporating measures of movement smoothness, rhythm and accuracy

HYPOTHESIS

Para athletes with central motor and neuromuscular impairments will present a less coordinated movement than able bodied participants

METHODS

Participants

19 Able Bodied + 19 Para Athletes

- Quadriplegic
- Hemiplegic
- Diplegic

Data Collection

Accuracy

- Physical Target
- 80% max active ROM
- % of cycles on the same sector

Speed

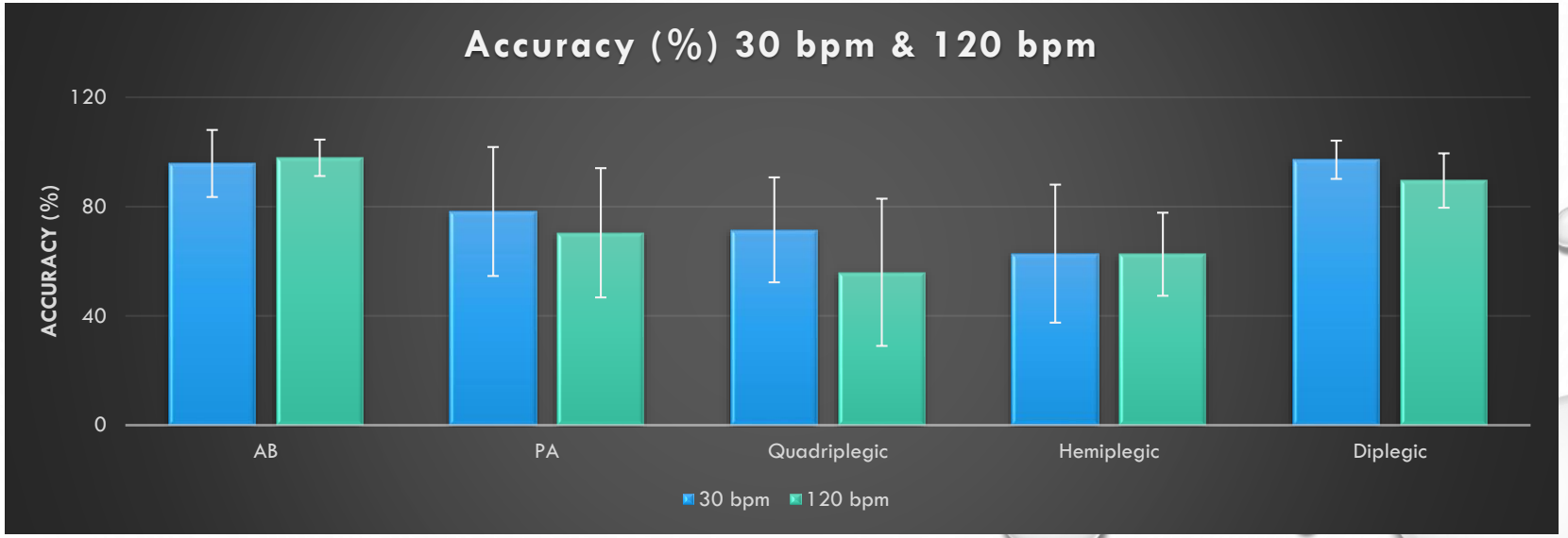
- Metronome (30 bpm & 120 bpm)
- 'Rhythm error'
- Time between beat and hand contact

Smoothness

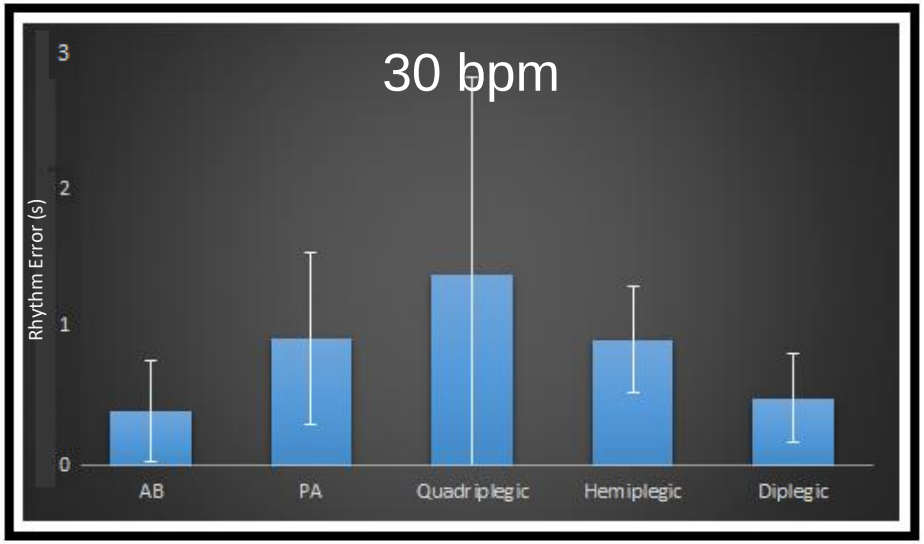
- Accelerometer (GENEActiv 100 Hz)
- Nº acceleration peaks

FINDINGS - Accuracy

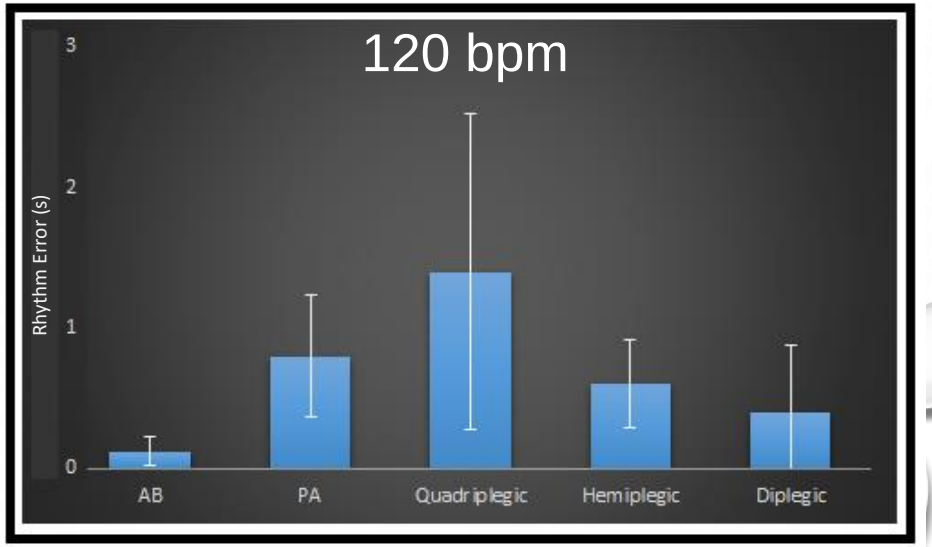
- AB group significantly more accurate than PA group
- PA group
  - ✓ Irregular path trajectory
  - ✓ Lack of neural feedback control (Chang et al., 2005)
- No significant difference between Hemiplegic and Quadriplegic sub-groups



FINDINGS - Speed



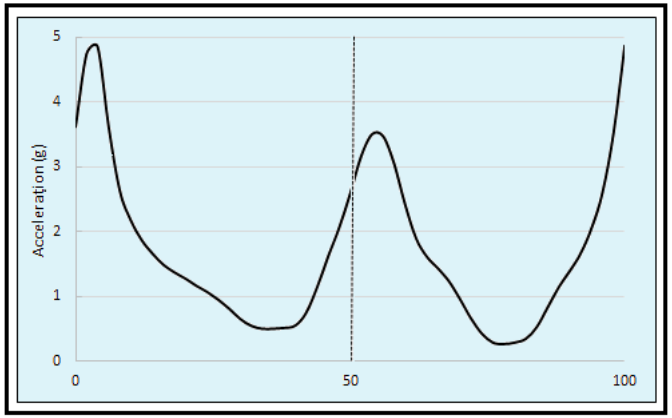
- 20s trial → 30 bpm – 2.5 arm cycles - 8s each
  120 bpm - 10 arm cycles - 2s each
- ↓ Rhythm error = ↑ adherence to metronome
- Continuous, cyclic movement ≠ Episodic movement
- AB group significantly lower rhythm error
- PA sub-groups rhythm error:
  Diplegic < Hemiplegic < Quadriplegic



FINDINGS - Smoothness

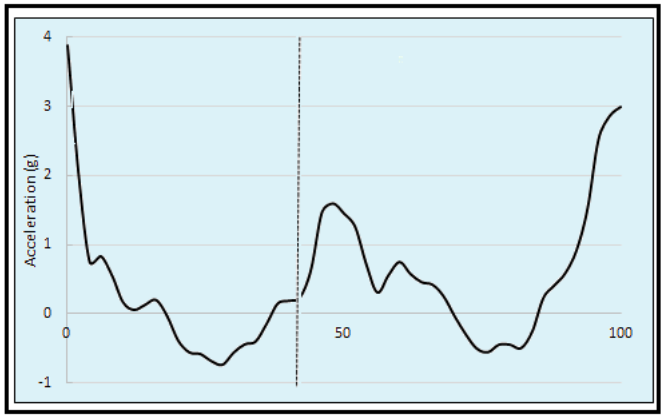
Non-dominant upper limb acceleration profile - 120 bpm

Able Bodied



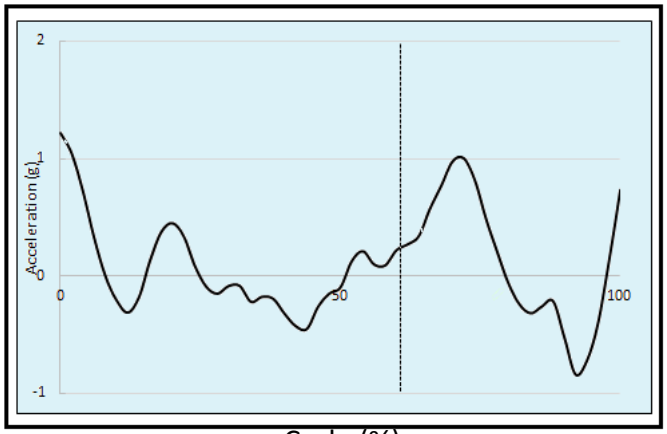
Cycle (%)

Diplegic



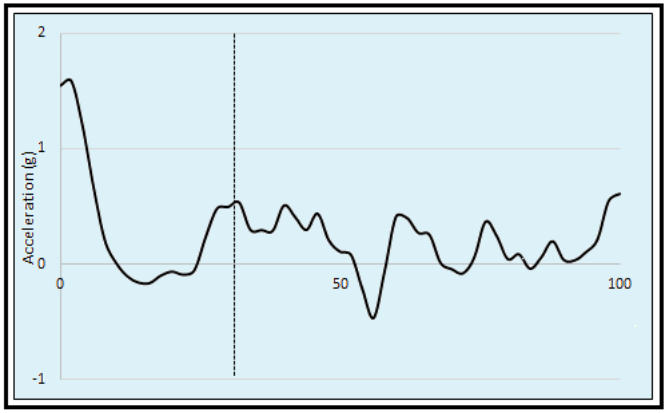
Cycle (%)

Hemiplegic



Cycle (%)

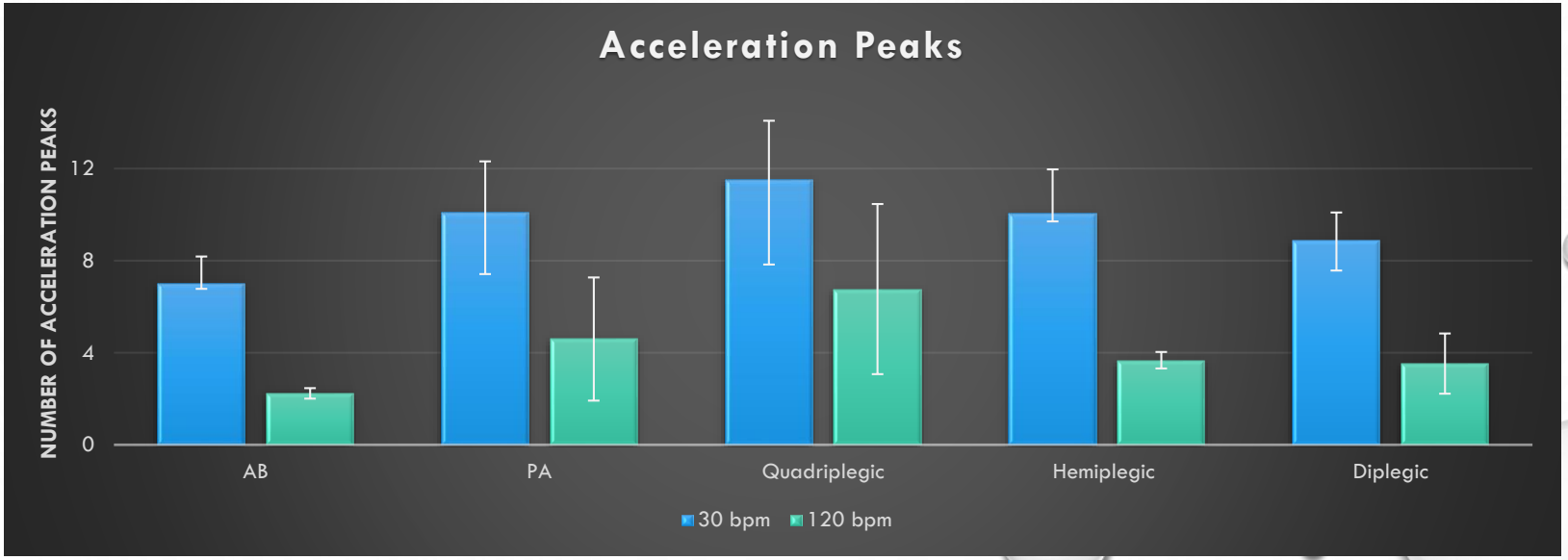
Quadriplegic



Cycle (%)

FINDINGS - Smoothness

- Nº of peaks a valid measure of movement smoothness (Roher et al., 2002; Balasubramanian et al., 2015)
- PA group significantly less smooth than AB group at both speeds
- Trend for Nº of peaks to increase Diplegic-Hemiplegic-Quadriplegic



SUMMARY

- Para athletes performed significantly worse than able-bodied participants in all three elements of movement coordination
- PA sub-groups: Quadriplegic athletes were found to be less accurate, smooth and higher rhythm error
- The objective metrics assessed in this study could be implemented in the protocol currently being used for classifying swimmers with coordination issues

Thank you for your attention

Ana@paralympics.ie