A conceptual framework for the use of Fitts’ Law to detect Intentional Misrepresentation of Skills and/or Abilities (IM) in Paralympic athletics

Rebecca L Deuble, Mark J Connick, Emma M Beckman, Bruce Abernethy, Sean M Tweedy

The University of Queensland, School of Human Movement Studies, QLD 4072, Australia
Introduction

“In athletics there's always been a willingness to cheat if it looks like you're not cheating. I think that's just a quirk of human nature”

Kareem Abdul-Jabbar
Introduction – Classification and IM in Paralympic Sport

• Purpose of classification in Paralympic sport is to minimise the impact of impairment on the outcome of competition

• Paralympic Athletics and focused on 5 impairment types
  - Impaired Strength
  - Impaired Range of Movement
  - Ataxia
  - Hypertonia
  - Athetosis
Introduction - subjective vs. objective tests of Impairment

• Currently use subjective tests rely on clinical judgement

• Measure of impaired coordination: Finger to Nose Test

• IPC mandated development of evidence-based methods of classification

• Objective tests are required which are valid and reliable, so we can look at the relationship between impairment and performance
Objective Test of Impaired Coordination

- Upper Limb Reciprocal Tapping Task
- Objective – measures movement time
- Maximal speed = a valid classification system
Overview of Problem: Intentional Misrepresentation of Skills and/or Abilities (IM)

“Form of cheating in which athletes attempt to exaggerate impairment severity by not fully cooperating on impairment tests” (IPC, 2007)

- Severe punishments are available but not enforced
- Currently no objective tests of impairment to facilitate detection

Research Aim: To develop and evaluate objective methods which can distinguish maximal test results from submaximal

- Closely linked with developed tests of impairment
Fitts’ Law

- Describes established log-linear relationship between movement time and index of difficulty: \( ID = \log_2 \left( \frac{2A}{W} \right) \)

Where \( A = \) amplitude and \( W = \) target width (Fitts, 1954)
Fitts’ Law Relationship

Fitts Original Study (1954) – Results from Reciprocal Tapping Task (n = 16)

\[ R^2 = 0.9897 \]

Under maximal effort conditions – “as fast and as accurately as possible”

Movement time (s) vs. Index of difficulty (ID)

- Movement time (s)
- Index of difficulty (ID)
Fitts Law Literature – Submaximal Effort

Maruff and Velakoulis (2000)

Individuals who feigned an arm injury during visually guided pointing task were unable to conform to Fitts law.

<table>
<thead>
<tr>
<th></th>
<th>Feigning an injury (n =10)</th>
<th>Controls (n =10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear Regression</td>
<td>0.10</td>
<td>0.67**</td>
</tr>
</tbody>
</table>

(*p < 0.01)

Note: individuals in this study were completely naive to purpose of study and had not completed task previously.
Equivalent IDs with different configurations

Amplitude = 606mm
Width = 100mm
ID = 3.6

Amplitude = 304mm
Width = 50mm
ID = 3.6
Fitts’ Law Relationship

Fitts Original Study (1954) – Results from Reciprocal Tapping Task (n= 16)

R² = 0.9897

Under maximal effort conditions – “as fast and as accurately as possible”

movement time (s) vs index of difficulty (ID)
Fitts’ Law literature – Submaximal Effort

Young et al. 2009

Significant differences in movement times for four different configurations of same ID (equivalent difficulty) were achieved by healthy individuals moving at submaximal speeds (n = 12)

![Graph showing movement times vs index of difficulty with R² values of 0.5044 and 0.9367 for natural and fast movements, respectively.](image)
The primary aim of this study is to:
1) Determine whether participants can intentionally move at submaximal speeds and produce a relationship between movement time and ID which conforms to Fitts’ law
   - Strength of association
   - Difference in movement times for IDs that are the same difficulty but differently configured

Participants: 30 non-disabled participants aged between 18-35

Methods: Reciprocal tapping task performed with dominant hand across 7 IDs (4 of the 7 were identical in difficulty but configured differently)

- Task performed on 3 separate occasions
- Maximal and Cheating Conditions
- Monetary reward: $100, $50, $25 awarded to three participants who are best able to conform to Fitts’ law while moving at slower speeds
Results – cheating example

Cheating attempt example

R² = 0.0089
Preliminary Results

Figure 1: Average $R^2$ (+ SD) achieved for both maximal and cheating efforts ($n = 10$) for each of the three visits. (* indicates $p <0.05$)
Potential criteria for identifying IM

Cheating attempt example

Movement time (s)

Index of difficulty (ID)

$R^2 = 0.0089$
Preliminary Results

Figure 2: Mean Differences (+ SD) between the fastest and the slowest movement times for IDs 3.6 (a, b, c, d), for both maximal and cheating efforts. (n= 10) (* p<0.05)
Future Analysis

• Results from preliminary group level analysis highlight Fitts’ law’s potential to differentiate between maximal and cheating efforts

• Receiver Operating Characteristic (ROC) curve analysis will confirm sensitivity and specificity of method – individual analysis (if want to differentiate at individual level)

• Stability of measure over time
Thanks you!

Questions and comments?
References


