



## ***Driving Pedal Reaction Times after right Trans-Tibial Amputations***

**Tim Pauley, PhD (candidate)**

Meikle B, Devlin M, Pauley T. *Driving pedal reaction times after right transtibial amputations.* Archives of Physical Medicine and Rehabilitation, 87 (3), 390-4.



## **Presentation Overview**

- ◆ Brief review of the topic
- ◆ Objective
- ◆ Methods
- ◆ Results
- ◆ Conclusions



## Brief Review of the Topic

*“Every legally qualified medical practitioner shall report to the Registrar the name, address and clinical condition of every person sixteen years of age or over attending upon the medical practitioner for medical services who, in the opinion of the medical practitioner, is suffering from a condition that may make it dangerous for the person to operate a motor vehicle.”*

Ontario Highway Traffic Act, R.S.O. 1990, c. H.8, s. 203 (1)

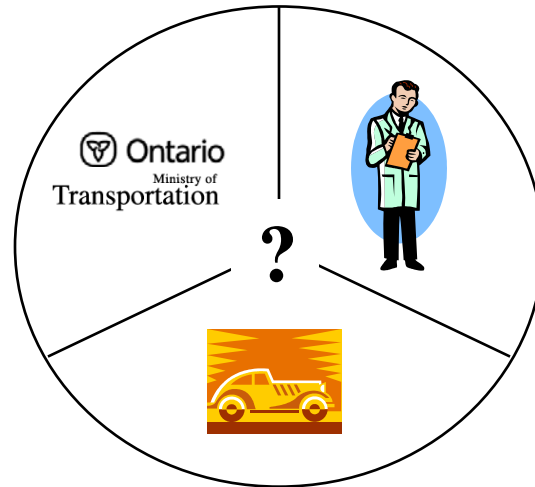


## Brief Review of the Topic

- ◆ Generally accepted that a left-sided amputee can return to driving safely; not so clear for right-sided
- ◆ Studies of driving ability of amputees limited
  - ◆ Assistive devices for upper-extremity amputees
  - ◆ Driving ability of individuals with juvenile onset amputation
  - ◆ Frequency of automobile use vs. alternative forms of transportation following amputation
- ◆ Little attention to the mechanics of driving ability among amputees
- ◆ No evidence available for counseling right transtibial amputees who wish to return to driving



## Brief Review of the Topic



## Objective

- ◆ To measure brake pedal reaction times of right transtibial amputees under various techniques of pedal operation
  - ◆ Do right transtibial amputees have the potential to safely operate vehicles foot pedals with their prosthesis?
  - ◆ Which technique for operating the foot pedals is associated with the fastest reaction, movement and response times?



## Methods

### Design

- ◆ Repeated measures

### Subject Selection

- ◆ All subjects had a right transtibial amputation;
- ◆ were licensed to drive prior to amputation; and
- ◆ were at least 6-months post initial prosthesis fitting.



## Methods



### Apparatus:

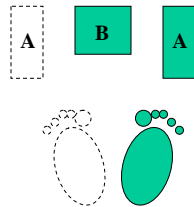
- ◆ Foot pedals: Logitech Inc.
- ◆ Software: Vericom RT software V 1.0; Vericom Computers Inc.
- ◆ Pedal configuration similar to actual vehicle
- ◆ Distance from seat to pedals adjustable
- ◆ Pedals moved laterally for left-sided accelerator; operation reversed in software



## Methods

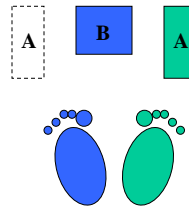
### Test Condition 1

Right-sided accelerator,  
prosthesis operating  
accelerator and brake



### Test Condition 2

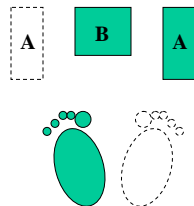
Right-sided accelerator,  
prosthesis operating accelerator,  
left foot operating brake



## Methods

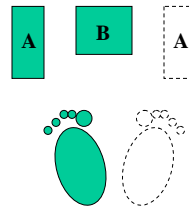
### Test Condition 3

Right-sided accelerator,  
left foot operating  
accelerator and brake



### Test Condition 4

Left-sided accelerator, left  
foot operating accelerator  
and brake





## Methods

### Procedure

- ◆ Subjects began trial with accelerator fully depressed
- ◆ Upon the appearance of a visual stimulus (random delay 2-10 s after onset of trial), subject lifted foot off accelerator and fully depressed brake
- ◆ Test condition varied randomly from trial to trial
- ◆ 4 test conditions x 18 = 72 trials
- ◆ Upon completion of all trials, subjects asked to rank testing conditions in order of preference



## Methods

### Outcome Measures

<b>Reaction Time</b>	From onset of stimulus to beginning of foot movement
<b>Movement Time</b>	From beginning of foot movement until brake fully depressed
<b>Response Time</b>	Reaction Time + Movement Time



## Methods

### Analysis

- ◆ Descriptive statistics used to summarise data
- ◆ Repeated-measures ANOVA used to compare reaction, movement and response times across 4 pedal conditions
- ◆ Where significant differences found, *t*-tests used for pair wise comparisons
- ◆ Holm's sequential Bonferroni adjustment used to control family-wise error rate across 6 comparisons



## Results

### Subjects

- ◆ 10 transtibial amputee outpatients
- ◆ Age  $53.1 \pm 9.5$  years
- ◆ 7 males, 3 females



## Results

### Driving Characteristics

Driving experience (pre-amp)	29.0 ± 12.24 yrs
Pre-amp accelerator foot	
Right	9 (90%)
Pre-amp brake foot	
Right	9 (90%)
Currently driving	5 (50%)
Current Driving Frequency	
Everyday	4 (80%)
4-6 times per week	
2-3 times per week	1 (20%)
Once or less per week	
Weekly kms	570 ± 542.68 kms



## Results

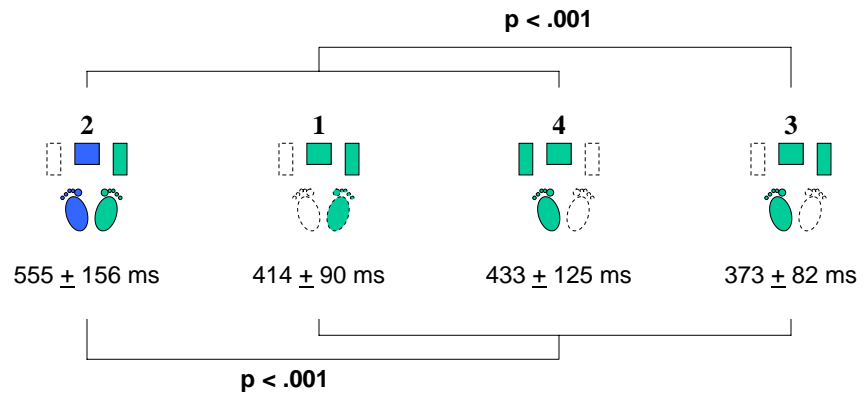
### Modifications/Pedal Operation

Car Modifications	
Left-sided accelerator	1 (20%)
None	4 (80%)
Post-amp accelerator foot	
Right	3 (60%)
Left	2 (40%)
Post-amp brake foot	
Right	2 (40%)
Left	3 (60%)
Post-amp accidents	2 (n=2)



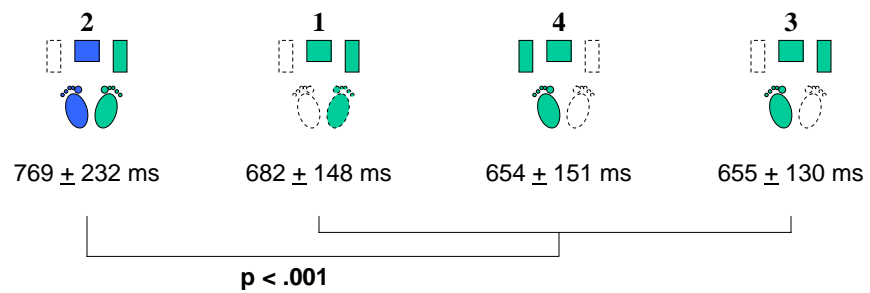
## Results

### Reaction Time



## Results

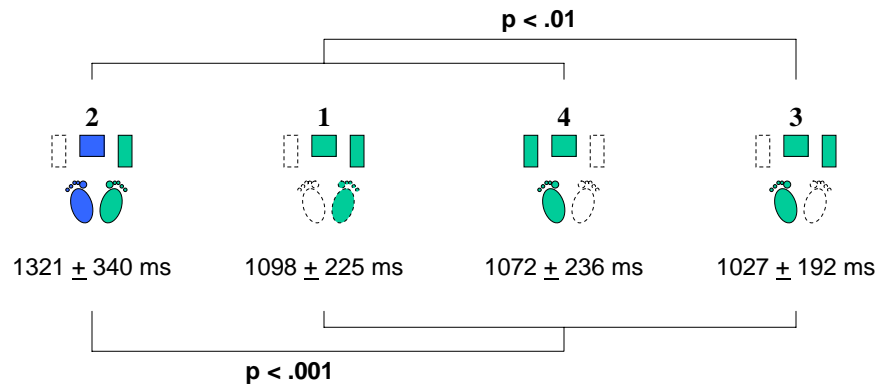
### Movement Time





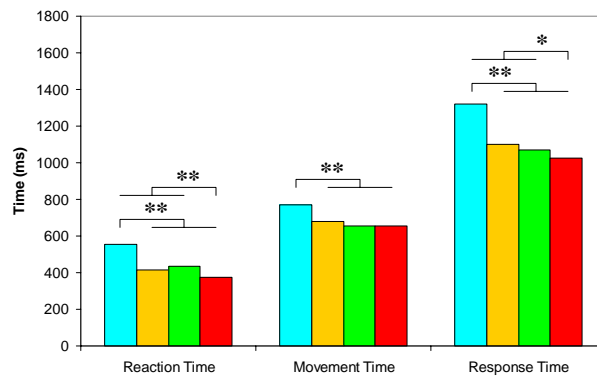
## Results

### Total Response Time



## Results

### Foot Pedal Reaction, Movement and Total Response Time under Various Pedal Conditions



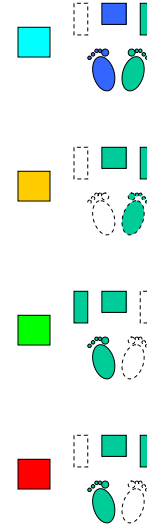
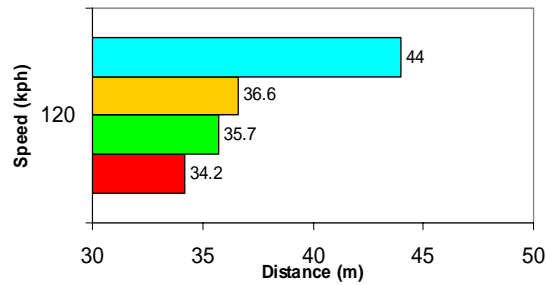
\* p < .01; \*\* p < .001





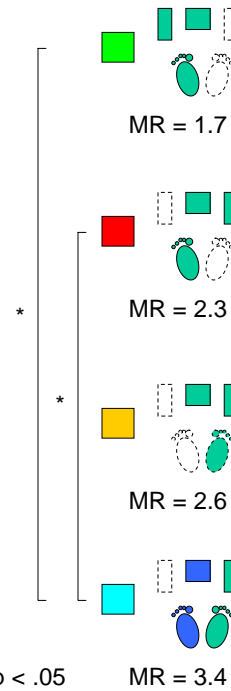
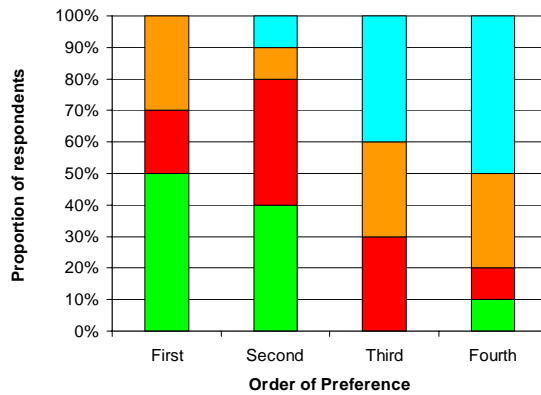
## Results

Distance Travelled Between onset of Stimulus and Activation of Brake



## Results

Foot Pedal Arrangement Preference





## Conclusions

- ◆ Two footed operation has slowest reaction, movement and response time
- ◆ Little to choose from among the other three test conditions



## Conclusions

- ◆ No good indication to prohibit using prosthesis to operate pedals
- ◆ No good indication to use left sided accelerator pedal



## **Conclusions**

### **Study Limitations**

- ◆ Small study (n = 10)
- ◆ Contrived environment
- ◆ No competing stimuli
- ◆ Anticipation of stimuli
- ◆ Pre-programming of response



## **Acknowledgements**

- ◆ **WSIB Ontario**
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- ◆ **The participants**



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