


## Validation of driving simulation to assess on-road performance in Huntington disease

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Introduction

## Woodie Guthrie - Huntington disease (HD)



- Neurodegenerative
- Hereditary
- Motor, cognitive, behavioral
- Age of motor onset: 35 – 44
- Disease duration: 5 – 20 years
- Prevalence: 4 – 7/100,000
- ? 35,000 in US
- + 150,000 at risk


Introduction

## Symptoms of HD

**CHOREA/DYSTONIA**

Involuntary movement

**Ocular pursuit**



**GAIT**

Voluntary movement

**FINE MOTOR MOVEMENTS**

Walker, Lancet, 2007

Introduction

## Changes in driving behavior

- Motor, cognitive and behavioral symptoms
- Driving is the most self-reported change
- About 70% continue driving after motor onset
- Higher risk of car crashes
- 26% of drivers are advised to stop driving


Walker, Lancet, 2007;  
Rebok et al, Mov Disord, 1995;  
Beginger et al, Mov Disord, 2012

Introduction

## Driving simulator performance

- Comparison of HD with healthy controls

Computerized measures of driving simulation			
Variable	Drivers with HD	Healthy drivers	P value
	N = 29	N = 30	
Tickets, n	1 (1 – 2)	0 (0 – 1)	0.0001




Devos et al, Neurology, 2012

Introduction

## Driving simulator performance

- Comparison of HD with healthy controls

Computerized measures of driving simulation			
Variable	Drivers with HD	Healthy drivers	P value
	N = 29	N = 30	
Car crashes, n	2 (1 – 3)	0 (0 – 1)	< 0.0001




Devos et al, Neurology, 2012

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## Driving simulator performance

- Comparison of HD with healthy controls

Computerized measures of driving simulation			
Variable	Drivers with HD	Healthy drivers	P value
	N = 29	N = 30	
Divided attention			
Correct responses, n	16 (12 – 19)	19 (19 – 20)	0.0003
Response time, s	3.37 (2.04 – 5.34)	1.58 (1.82 – 2.31)	0.0002



Devos et al, Neurology, 2012

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## TRIP

- Test Ride for Investigating Practical fitness to drive
- Clinical evaluation of driving skills
- 4 point ordinal scale

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## TRIP - 13 items

*Hierarchical levels of driving skill*



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## Operational maneuvers

- Item 1: Lateral position on the road at low speed
- Item 2: Lateral position on the road at high speed
- Item 3: Mechanical operations

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## Tactical maneuvers

- Item 4: Speed adaptations at low speed
- Item 5: Speed adaptation at high speed
- Item 6: Gap distance at low speed
- Item 7: Gap distance at high speed
- Item 8: Lane position change

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## Visuo-integrative maneuvers

- Item 9: Quality of traffic participation
- Item 10: Visual behavior and non-verbal communication
- Item 11: Anticipation and perception of road signs and traffic signals

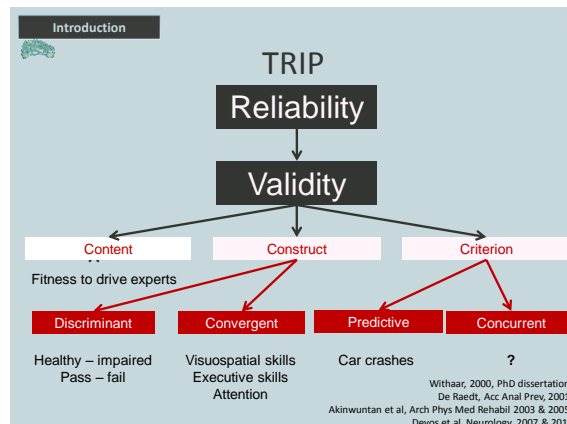
Introduction

## Mixed maneuvers

Item 12: Turning left





Item 13: Joining the traffic stream

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## Aim

- To assess the concurrent validity of our driving simulator scenario against road testing in patients with Huntington disease
  - Correlation of TRIP scores assessed in the driving simulator and on the road
  - Correlation of computer generated simulator measures with TRIP on the road

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Methods

## Participants

- 29 drivers with manifest symptoms of HD
- 2 locations and days, median 7 (2 – 24) days
- Random order

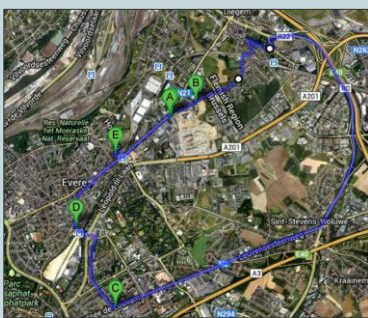
Road test @ Belgian Road Safety Institute

Simulation @ University Hospitals

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## Road test



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## Driving simulation

- STISIM Drive, STI Inc
- 4 practice drives of 2 km
- 15 km evaluation scenario
- Simulated 12/13 TRIP road events
- Unexpected road hazards and divided attention

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## Driving simulation

Overtaking and DA

Stop at cross walks

Negotiating curves

Turning left

Child crossing

Unexpected road hazards

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## Correlations computer measures with total on-road TRIP

Number of traffic tickets

$\rho = 0.06$ ;  $p = 0.76$       weak correlation

Number of crashes

$\rho = -0.58$ ;  $p = 0.001$       strong correlation

Divided attention

$\rho = -0.56$ ;  $p = 0.002$       strong correlation

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## Correlations operational maneuvers

Lateral position on the road at low speed

$\rho = 0.62$ ;  $p = 0.0004$       strong correlation

Lateral position on the road at high speed

$\rho = 0.59$ ;  $p = 0.0008$       strong correlation

Mechanical operations

$\rho = 0.67$ ;  $p < 0.0001$       strong correlation

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## Correlations tactical maneuvers

SPEED  
LIMIT  
30

Speed adaptations at low speed

$\rho = 0.38$ ;  $p = 0.06$   
moderate

SPEED  
LIMIT  
85

Speed adaptation at high speed

$\rho = 0.50$ ;  $p = 0.0006$   
strong

Gap distance at low speed

$\rho = 0.12$ ;  $p = 0.53$   
weak




ONLY



Lane position change

$\rho = 0.47$ ;  $p = 0.0009$   
moderate

Gap distance at high speed

$\rho = 0.32$ ;  $p = 0.0008$   
moderate

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<h2>Correlations visuo-integrative maneuvers</h2>		
	Quality of traffic participation $\rho = 0.49$ ; $p = 0.002$ moderate	
	Visual behavior and non-verbal communication $\rho = 0.36$ ; $p = 0.06$ moderate	
	Anticipation and perception of road signs and traffic signals $\rho = 0.32$ ; $p = 0.009$ moderate	

Introduction	Methods	Results
<h2>Correlations mixed maneuvers</h2>		
	Turning left $\rho = 0.55$ ; $p = 0.007$ strong	
<h2>Correlations total TRIP score</h2>		
	$\rho = 0.72$ ; $p < 0.0001$ strong	

Introduction	Methods	Results	Conclusion
<p>Introduction</p>			

Introduction	Methods	Results	Conclusion
<p>Introduction</p>			
<ul style="list-style-type: none"> <li>• Strongest correlation in overall performance</li> <li>• Cumulative simulator score is a valid index of global on-road driving performance</li> </ul>			
			

Introduction	Methods	Results	Conclusion
<ul style="list-style-type: none"> <li>• Consistent, strong correlations for operational items</li> <li>• Variable strengths of associations for other items</li> <li>• Driving simulator does not replace on-road testing</li> <li>• But may be used adjacent to on-road testing or as screening instrument</li> </ul>			

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