SIMFIT2DRIVE

Steering towards Safety

Evaluating & Rehabilitating Senior & Impaired Drivers

Mission

We are dedicated to creating pioneering solutions that empower adults with cognitive or physical impairments to be independent drivers for as long as possible.

By utilising the benefits of digital technologies, AI and biometrics, we aim to provide the best **bias-free**, **time-** and **cost-effective** solution for **assessment, training and rehabilitation** of elderly and impaired drivers - while ensuring **road safety for all**.

Who we are

- Research-driven company
- Focused wholly on medical application of simulator technology
- Building reputation on academic rigour

JAKA SODNIK, PHD
CEO

Full Professor at UoL. Visiting Professor at Surrey & Stanford

KRISTINA STOJMENOVA, PHD
HEAD OF RESEARCH

Researcher with expertise in modelling & driving behaviour

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Commercial Director

Engineering graduate with expertise in measurement & control

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MEDICAL ADVISOR

Traffic & sports medicine expertise
Contributor to international driving safety standards

University of Ljubljana

University Rehabilitation Institute
Republic of Slovenia

Stanford University

UNIVERSITY OF SURREY

Focus Areas

ASSESSMENT

Systems to enable the complete and fair assessment of someone's fitness to drive, with a particular focus on those who are elderly or have physical or cognitive impairments.

REHABILITATION

Driving-simulator based systems to assist in patient rehabilitation, both physical and cognitive.

Our Solutions

Simulator-based solutions

- for assessment of sensor-motoric and cognitive capabilities
- for rehabilitation therapy (ongoing development and validation)
- for diagnostics of neurological impairments and degenerative conditions (early development stage)

Software-based solutions

- Screening/assessment tools for physicians and families (early prototype stage)
- Training tools to aid prolonging of safe driving among elderly and neuro-impaired drivers (early prototype stage)

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Fit-to-Drive Assessments

Fit-to-Drive Assessments

Background

- Aging society is a worldwide challenge, and it is growing
- Personal mobility is important for independence, mental health and longevity
- Wide variance in approaches and methodology across nations
- Healthcare + assessment services stretched and already in need of additional/more-efficient solutions

Approaches

Wide variations across nations – generally consisting of the elements below:

- **Medical** – general physical condition and personal history
- **Vision** – standard ophthalmic testing with peripheral assessment
- **Cognitive** – (not in all countries) generally standard batteries adapted to "suit" traffic medicine application. Sometimes these will include reaction testing.

Challenges

The current systems are not without challenges and inconsistencies:

- **Medical** – Often by GP's who are not necessarily qualified in traffic medicine or independent. Generally, little baseline consistency.
- **Vision** – Standardised testing without the ability to assess in relation to driving.
- **Cognitive** – Often a single test with variable relevance to driving skills and capabilities.

Fit-to-Drive Assessments

SimFit2Drive
state-of-the-art, driving-based patient **assessment** platform.

- Fully driving-relevant
- Strength/reaction measurement
- Cognitive function assessment
- Standardised data can enable deeper insights

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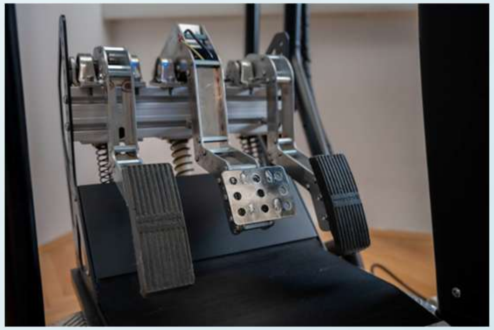
Fit-to-Drive Assessments

Product features

- Realistic driving environment
- Wrap-around HD screens with up to 165° field-of-view
- Fully-instrumented controls (load/torque cells)
- Alternative control configurations (ring accelerator paddles, driving control stick, steering knob, etc.)



Fit-to-Drive Assessments

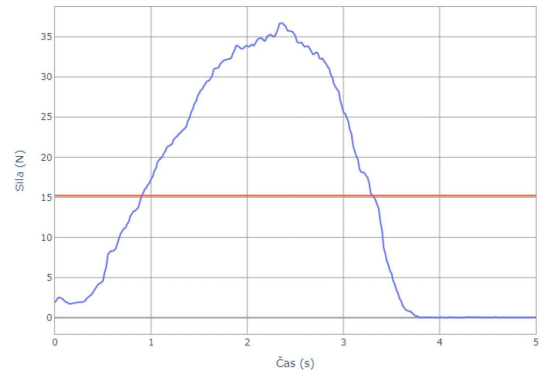
Steering wheel

- Actual manufacturers’ wheels (various models available)
- Multiple measurement parameters available (Torque, turn rate, etc.)
- For specific tests, can be locked or freely rotating or in standard driving mode
- Can be used to determine upper-limb strength, sensitivity and control
- Variable sensitivity (can be adjusted to reflect different vehicle and road settings)

Report for operator

Result

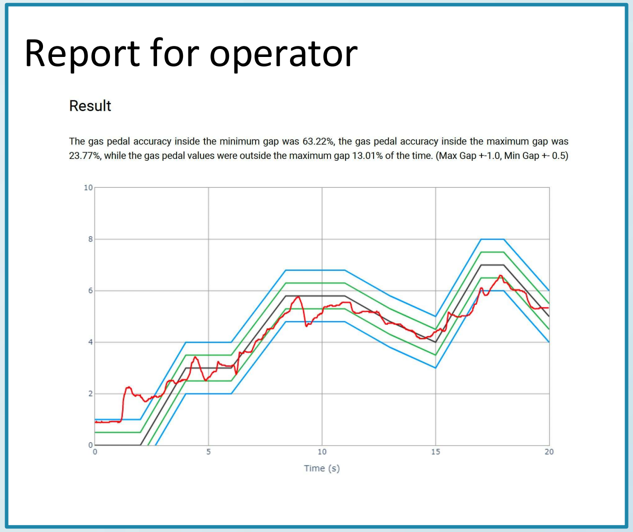
The average steering wheel force is 15.21Nm, while the maximum steering wheel force is 36.69Nm. The steering wheel force is 17.31Nm in the first second, 33.86Nm after two seconds and 25.59Nm in the third second. The patient held the maximum value for 0.03 seconds, and reached the maximum value after 2.37 seconds.



Fit-to-Drive Assessments

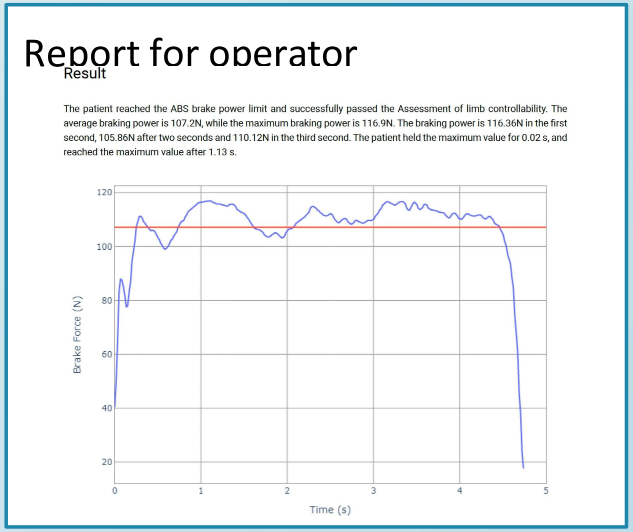
Pedals

- Realistic representation of standard pedals
- Multiple measurement parameters available (Force, %age depression, etc.)
- Can be used to determine lower-limb strength, sensitivity and control
- Accelerator can be designated as right or left pedal, left pedal can also be enabled/disabled for manual/automatic


Report for operator

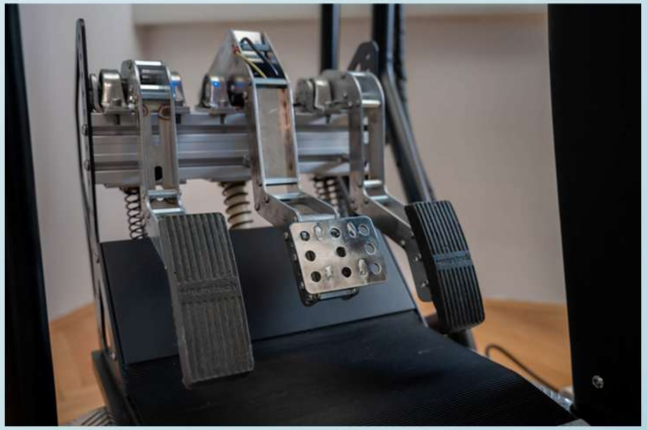
Result

The gas pedal accuracy inside the minimum gap was 63.22%, the gas pedal accuracy inside the maximum gap was 23.77%, while the gas pedal values were outside the maximum gap 13.01% of the time. (Max Gap +-1.0, Min Gap +- 0.5)


Report for operator

Result

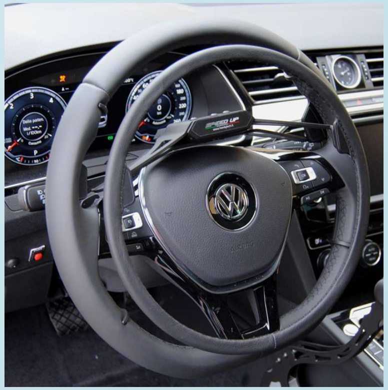
The patient reached the ABS brake power limit and successfully passed the Assessment of limb controllability. The average braking power is 107.2N, while the maximum braking power is 116.9N. The braking power is 116.36N in the first second, 105.86N after two seconds and 110.12N in the third second. The patient held the maximum value for 0.02 s, and reached the maximum value after 1.13 s.



Fit-to-Drive Assessments

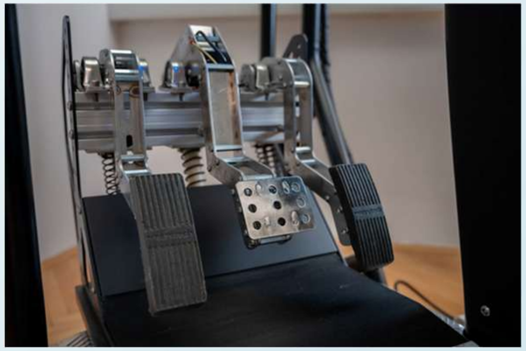
Driving Adaptations

- Alternative driving aids are already integrated
- Standard tests can be run for these also
- Fully-instrumented for measurement of strength, fatigue, reaction + response times, agility
- Many variations (ring steering wheels, satellite accelerators, push-pull manual pedal controls, steering aids, etc.)



Additional features

- Pedal/control functions can be customised (i.e. for amputees)
- Steering force can be adjusted – haptic feedback possible
- Seat can swivel for ease of access (or a shuffleboard can be used)
- Left-hand/Right-hand drive configurations possible
- Manual/auto configurations.



Fit-to-Drive Assessments

Software engine

Static vehicle-based environment

- Tests for motoric assessment
- Tests for sensory-motor assessment

Dynamic driving-based environment

- Tests for cognitive assessment

Fit-to-Drive Assessments

Tests

Static vehicle-based environment

- **Tests for motor assessment** →
- Tests for sensory motor assessment

Dynamic driving-based environment

- Tests for cognitive assessment

Dimension 1: Assessment of limb strength

- Assessment of **upper** limb strength – steering wheel
- Assessment of **lower** limb strength – pedals
- Assessment of **upper** limb strength – adaptation

Dimension 2: Assessment of limb agility

- Assessment of **upper** limb agility – steering wheel
- Assessment of **lower** limb agility – pedal controls
- Assessment of **upper** limb capabilities – adaptations

Fit-to-Drive Assessments

Tests

Static vehicle-based environment

- Tests for motor assessment
- **Tests for sensory motor assessment**

Dynamic driving-based environment

- Tests for cognitive assessment

Dimension 3: Assessment of reaction and response time

- Visual reaction and response time
- Auditory reaction and response time
- Cognitive response time

Dimension 4: Assessment of peripheral vision

- Peripheral vision assessment through reaction and response times

Fit-to-Drive Assessments

Tests

Static vehicle-based environment

- Tests for motor assessment
- Tests for sensory motor assessment

Dynamic driving-based environment

- **Tests for cognitive assessment**

Driving Scenario 1: Distractibility and driving behavior

- Reaction and response time
- Driver distraction and divided attention – Lane change task
- Driving behaviour and driving style

Driving Scenario 2: Selective and sustained attention

- Reaction and response time
- Selective and sustained attention

Fit-to-Drive Assessments Examples

Instructions for patient

1. Wait until the steering wheel is centered and only then put your hands on the wheel.
2. Turn the steering wheel as further as you can in the direction shown above the steering wheel (left or right) and hold it for 5 seconds.
3. Look at the countdown clock below the steering wheel for reference.

Left:

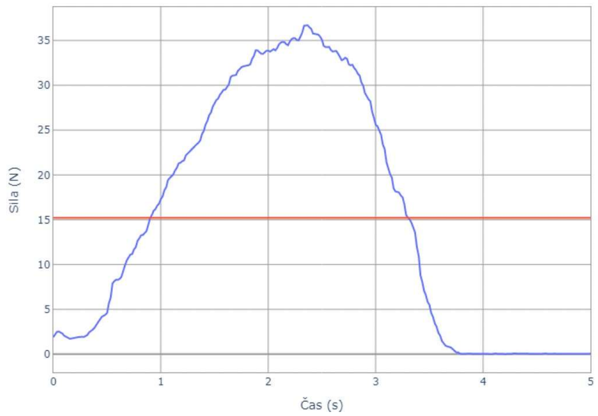
Right:

Countdown: 5

Report for operator

Result

The average steering wheel force is 15.21Nm, while the maximum steering wheel force is 36.69Nm. The steering wheel force is 17.31Nm in the first second, 33.86Nm after two seconds and 25.59Nm in the third second. The patient held the maximum value for 0.03 seconds, and reached the maximum value after 2.37 seconds.



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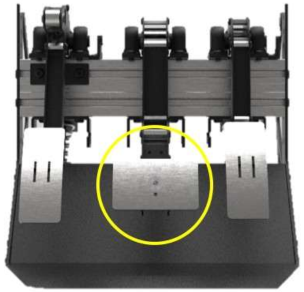
Fit-to-Drive Assessments

Examples

Instructions for patient

1. Press the brake pedal as far as you can and hold it for 5 seconds.
2. Look at the countdown clock below the pedals for reference.

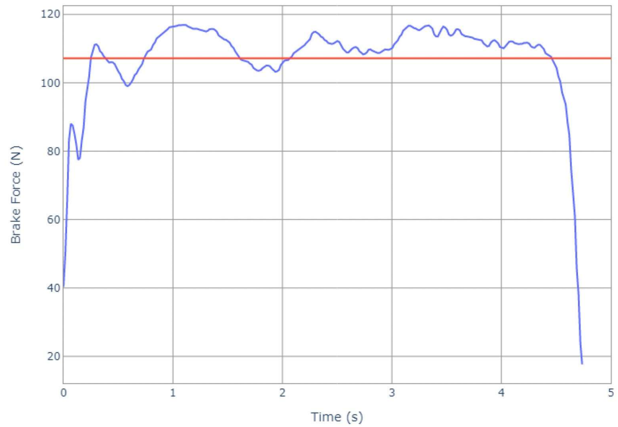


Countdown: 5

Report for operator

Result

The patient reached the ABS brake power limit and successfully passed the Assessment of limb controllability. The average braking power is 107.2N, while the maximum braking power is 116.9N. The braking power is 116.36N in the first second, 105.86N after two seconds and 110.12N in the third second. The patient held the maximum value for 0.02 s, and reached the maximum value after 1.13 s.

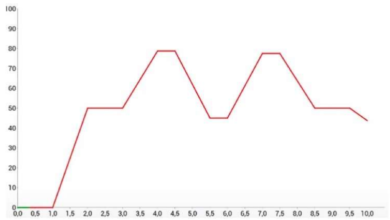


Fit-to-Drive Assessments

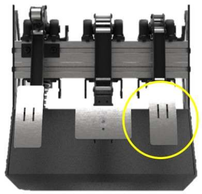
Examples

Instructions for patient

1. You will see a red curve on the screen.



2. Press the pedal indicated and, by adjusting the force used, try to follow the curve as closely as possible.

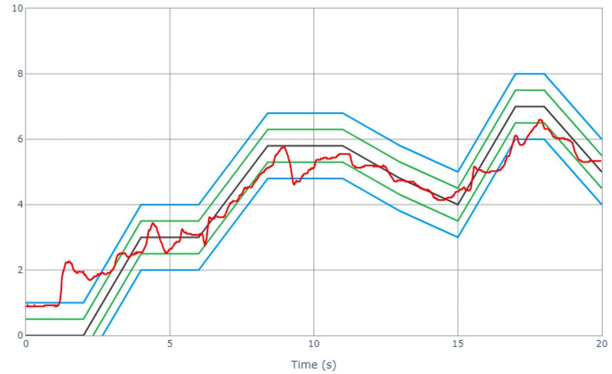


3. You will see your result as a green line on the graph.

Report for operator

Result

The gas pedal accuracy inside the minimum gap was 63.22%, the gas pedal accuracy inside the maximum gap was 23.77%, while the gas pedal values were outside the maximum gap 13.01% of the time. (Max Gap +-1.0, Min Gap +- 0.5)

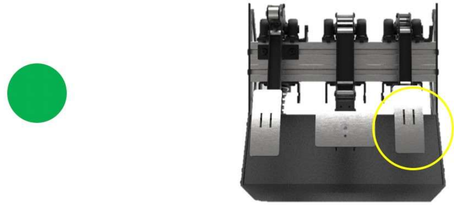


Fit-to-Drive Assessments

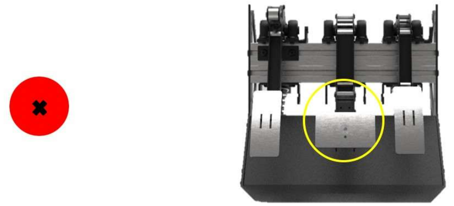
Examples

Instructions for patient

1. Press the accelerator pedal when a green dot appears. Keep pressing the accelerator pedal to at least 30% while the green dot is showing.

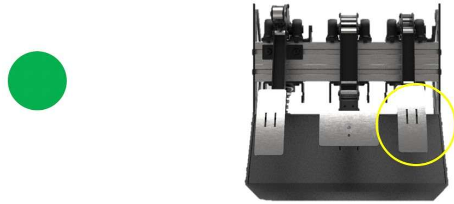


2. Press the brake pedal as quickly as possible, as soon as a red dot appears.

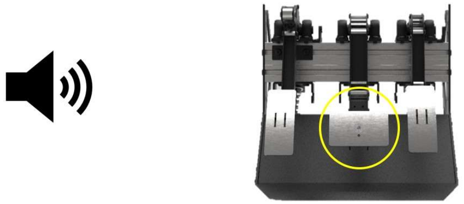


Instructions for patient

1. Press the accelerator pedal when a green dot appears. Keep pressing the accelerator pedal to at least 30% while the green dot is showing.



2. Press the brake pedal as fast as possible, as soon as you hear a beep.

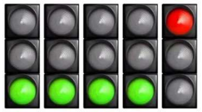


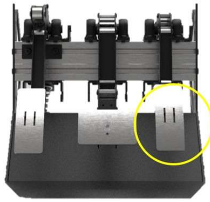
Fit-to-Drive Assessments

Examples

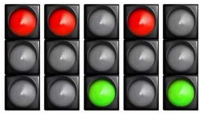
Instructions for patient

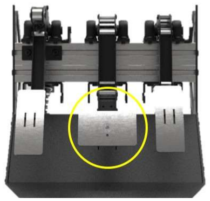
1. Press the accelerator pedal when there are more green lights than red. Press the accelerator pedal as quickly as you can.





2. Press the brake pedal when **there are more red lights than green**. Press the brake pedal as quickly as you can.





Report for operator

Result

5/20 attempts were invalid. 1/15 attempts was a timeout. The patient made 14/14 attempts. In 10/14 attempts, it took him/her more than a second to respond. The minimum reaction time is 0.66 s, the maximum reaction time is 1.77 s, while the average reaction time is 1.2 s.

ID	LIGHT	TIME[s]	RESULT
1	X X X X X		invalid
2	R R G R G	1.16	succesful
3	G R R G R	1.08	succesful
4	G G G G G	0.66	succesful
5	R G R G R	0.98	succesful
6	G R R G G	0.66	succesful
7	R G R G G	1.77	succesful
8	G G G R G	1.44	succesful
9	X X X X X		invalid
10	X X X X X		invalid

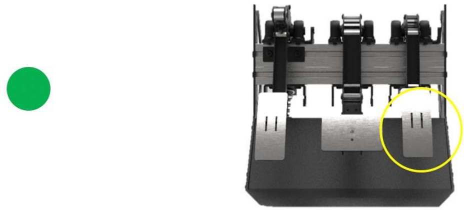
ID	LIGHT	TIME[s]	RESULT
11	X X X X X		invalid
12	X X X X X		invalid
13	R R G R R	1.66	succesful
14	G G G R R	0.91	succesful
15	R G G R G	1.31	succesful
16	G G R R R	1.43	succesful
17	R R R R R	1.29	succesful
18	G G R R R	1.15	succesful
19	R G G G R		timed out
20	R R G G R	1.32	succesful

Fit-to-Drive Assessments

Examples

Instructions for patient

1. Press the accelerator pedal when a green dot appears. Keep pressing the accelerator pedal to at least 30% while the green dot is showing.

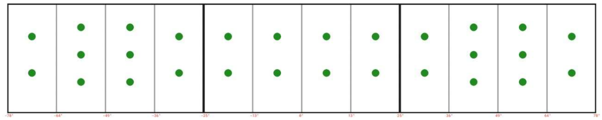


2. Press the brake pedal as quickly as possible as soon as you see the red dot anywhere in your field of view.

Report for operator

Result

The patient made 28/28 attempts and successfully passed the Peripheral vision assessment. In 11/28 attempts, it took him/her more than a second to respond. The average total time is 0.97 s, the average thinking time is 0.54 s, while the average movement time is 0.43 s.



ID	TT[s]	MT[s]	RT[s]	α[°]
1	1.02	0.66	1.68	-19
2	0.90	0.33	1.23	56
3	0.38	0.38	0.76	-30
4	0.35	0.34	0.69	42
5	0.63	0.86	1.49	71
6	0.79	0.35	1.14	-56
7	0.42	0.60	1.02	-7
8	1.02	0.38	1.40	-42
9	0.61	0.40	1.01	42
10	0.37	0.39	0.76	-42
11	0.39	0.33	0.72	30
12	0.46	0.53	0.99	-56
13	0.37	0.38	0.75	56
14	0.36	0.37	0.73	7

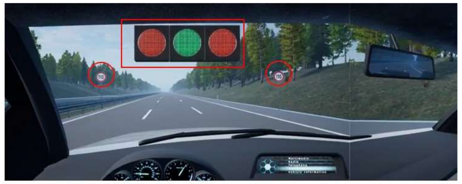
ID	TT[s]	MT[s]	RT[s]	α[°]
15	0.48	0.52	1.00	-71
16	0.39	0.33	0.72	71
17	0.36	0.40	0.76	-30
18	0.36	0.43	0.79	42
19	0.33	0.33	0.66	-42
20	0.53	0.52	1.05	19
21	0.38	0.36	0.74	-56
22	0.38	0.40	0.78	30
23	0.46	0.48	0.94	7
24	0.33	0.31	0.64	-71
25	0.48	0.55	1.03	19
26	0.34	0.46	0.80	-7
27	0.78	0.33	1.11	56
28	1.36	0.32	1.68	-19

Thinking time (TT): MIN: 0.33 s MAX: 1.36 s AVG: 0.54 s
Reaction time (MT): MIN: 0.31 s MAX: 0.86 s AVG: 0.43 s
Response time (RT): MIN: 0.64 s MAX: 1.68 s AVG: 0.97 s

Fit-to-Drive Assessments Examples

Instructions for patient

1. This task takes place on a three-lane carriageway. Follow the speed limits and adjust your speed as quickly as possible.
2. Your task is to always drive in the lane indicated with the green light. Turn on the appropriate indicator as soon as you notice a change in the lights shown and then change lane accordingly.



Report for operator

Options

Gas location: Right lower limb
Brake location: Right lower limb

Result

The driver successfully changed lanes in 76 % of cases.
The turn signal was correctly used in 68% of cases.
Speed on average deviated by 20.49(27.54)km/h - 70% of time outside of the allowed interval.
The average reaction time is 114 ms.
The average response time is 189 ms.
Lane deviation is 12.1 m. Average deviation outside of allowed interval was 0.3 m, 36% of time. The driver's driving style is B.

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Fit-to-Drive Assessments Examples

Instructions for patient

1. This task takes place on a two-lane city road. The speed limit is 30 mi/h. Adjust your speed to the speed limit at all times.
2. Throughout the drive you will be presented with green and red x-es and arrows in the rear-view and wing mirrors.

3. Your task is to change lane only when a **green arrow** is shown in any of the mirrors. Turn on the appropriate indicator as soon as you notice a green arrow, and then change lane accordingly.

Report for operator

Options

Difficulty: Medium
Gas location: Right lower limb
Brake location: Right lower limb

Result

The average reaction time is 100ms.
The average response time is 160 ms.
The driver correctly used indicators with 80% of true signals.
The driver did not use indicators with 20% of false signals. The driver changed lanes in 100% of required cases.
The average speed is 49 km/h, with a standard deviation of 11 km/h.
Before changing lanes, indicators were used in 100% of cases.
The average lane change distance is 93 m.

Fit-to-Drive Assessments

Pre-clinical study for driving-based cognitive tests completed

Participants:

- Patients – Elderly drivers, people with cognitive, sensory and/or motor impairments
- Healthy subjects – Control group

Reference batteries used:

- Tests for attentional performance – Mobility (TAP-M)
- Tower of London

Results

Driving scenario 1 and 2 results correlate with psychological tests, with highest Pearson correlations for:

- Reaction and response time
- Response inhibition
- Traffic rule compliance: speed limits, standard deviation of speed deviation, indicator use
- Driving behavior: lane change task

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Rehabilitation

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Do driving simulators work for rehabilitation?

- A lot of anecdotal evidence
- Several studies , many related to ABIs, several military-related.
- Devos et al (2009) showed it improved driving-related rehab (not general rehab), many others also look at this aspect
- Several simulator companies promote use for rehab, but without validation, and often they actually mean “training/assessment”
- We know it builds confidence, enables a safe re-entry to driving and familiarisation with any driving aids – but it is not PROVEN to aid overall, non driving-related rehabilitation.
- We have also had some positive experiences

Rehabilitation

Research being undertaken

First steps

- Qualitative study using simple driving scenarios – does it aid general rehab
- Variances for different conditions
- Progress measured using standard assessment protocols (non driving-related)

Next steps

- Development of scenarios that target specific conditions/deficiencies
- Gamification of existing assessment tests
- Tuning/optimisation for different conditions
- Variance of treatment scenarios vs standard driving scenarios
- Progress measured using standard assessment protocols (non driving-related)

Rehabilitation

Current capabilities

- Goal-oriented use of general driving scenarios – “unproven” yet potentially useful
- Full assessment capabilities to understand patient readiness for driving (pre-screening/testing)
- Use of different rig capabilities for general assessments (strength, sensor-motoric functions, etc.)
- Internal research and evaluation

Rehabilitation

Research opportunities

- SIMFIT2DRIVE wishes to partner with different academic institutions to drive research + validation
- Partner in product developments
- Help to build regional "centres of excellence" in this form of neurotechnology
- Tie platform in with ICF and standard record-keeping in order that all data becomes usable

Thank you!

Rob Howland, Commercial Director

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SIMFIT2DRIVE

Steering towards Safety: Evaluating & Rehabilitating Senior & Disabled Drivers